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THE PROBLEM OF CONTINUITY IN THE STUDY OF THE TOPIC "FUNCTION" BETWEEN SCHOOL AND UNIVERSITY

Abstract. The article deals with the problem of succession in the study of the topic "Function" between school and university mathematics courses and presents analysis and interpretation of the main results of this test study.

The problem of continuity in teaching mathematics is connected with the tasks of implementing intra-subject and meta-subject connections, with the sequence of presentation of educational material, the levels of increasing its complexity, with the search for optimal forms and methods of organizing the process of teaching mathematics at different educational stages. In this regard, the article deals with the problem of continuity in the study of the topic "Function" between the school and university courses of mathematics, presents an analysis and interpretation of the main results of the knowledge and skills of first-year students in three different streams with the Russian language of instruction.

Keywords: mathematics, continuity, function, graphs, construction of charts.

Introduction. The continuity problem in teaching mathematics relates to the problems of realization of intra subject and metasubject communications, with the sequence of statement of academic material, levels of increase of its complexity, with the search of optimum forms and methods of organization of process of teaching mathematics at different educational stages.

Continuity in teaching mathematics is a necessary condition for a possibility of implementation of interrelation between representations, concepts, skills. It promotes awareness of the main ideas of mathematics and allows to establish connection with other subjects and also to deeper judgment and the best storing of the studied material. Existence of continuity in learning is one of conditions of formation of students' mindset and their mathematical competence [1].

The concept of continuity is understood by the authors differently. Some consider it as communication between separate subjects in the course of learning, others - as simple use of knowledge gained earlier at further studying of the same subject, the third - as constancy and uniformity of the requirements imposed on pupils upon transition from grade to grade. But in all cases continuity is understood as some communication. "Continuity in pedagogical processes and the phenomena is understood as such communication of old with new and new with old when the dialectic contradictions arising in the conditions of this communication are resolved by organized interaction of the corresponding components" [2].

Despite deep development of problems of continuity of learning, in modern conditions they demand a further research and implementation of results in practice. Recently many authors of scientific and methodical publications note weak mathematical training of the students who entered technical and pedagogical colleges. Having graduated from school, graduates are most often not ready to education continuation. They do not own methods of receiving and processing of information, are not able to work independently with material and very often try to learn everything on a school habit, that is to learn by rote [1, 3, 4].

Practice of teaching mathematical disciplines in technical college also confirms insufficiency of training of school graduates for education continuation. When studying courses of advanced mathematics students experience expressed difficulties in mastering and practical application of basic concepts connected with this subject, and in recent years this problem complicates studying of important sections of course of mathematics in higher education institution which roots go to the problems of school course of not only algebra and the elements of analysis, but also a course of algebra of main school. First-year students poorly own computing skills, mathematical speech, do not know definition of some main elementary functions, their properties. They badly imagine function graphs, cannot explain geometrical sense of properties of functions (parity and oddness, monotony, frequency), etc. For example, when studying the subject "Continuity of Function in a Point" for definition of points of a gap, it is previously necessary to construct a function graph and only then to find unilateral limits. They did not gain abilities to work with task, to apply analysis, synthesis, analogy and other methods while searching the solution of task, to use geometrical method and geometrical representations in different situations. Many first-year students cannot draw conclusions and generalizations, to give examples on the studied theoretical material, etc.

Getting to work with students, a teacher of higher education institution has to be guided by some knowledge and skills acquired by them at school. In improvement of quality of mathematical education, the major role is played by establishment of closer continuity between school and high school course of mathematics, between various courses of mathematics at school.

The continuity problem purpose is to increase efficiency of traditional teaching mathematics. The question of studying of continuity came down to the examination and specification of inter-subject and intra-subject communications and also communications between separate links in an education system. Thus, the success of studying of mathematical analysis in higher education institution is predetermined continuity of courses of school and higher mathematics. Only that student who mastered school course of mathematics will be able to unmistakably operate with all concepts and to continue training of higher mathematics course.

Mathematical training of students of higher education institution is a basic making natural-science training of the expert which provides first of all sequence, continuity of teaching mathematics upon transition from college to higher education institution, full use of knowledge, the skills acquired earlier in a school course of mathematics [5].

Method. For respect for continuity of mathematical education it is necessary to hold diagnostic testing of knowledge, skills of the students admitted to higher education institution. Without diagnostic check it is impossible to operate effectively didactic process, to achieve optimum results. As one of effective methods of diagnostics, the current testing according to coinciding sections of mathematics can serve in standards of secondary and higher education [6].

For the purpose of detailed study and establishment of readiness for training in a course of higher mathematics in higher education institution, testing of knowledge and abilities of first-year students in three various groups with Russian language of instructions was held:

1) mechanical engineering faculty, specialties: 5B071200 "Mechanical engineering", 5B073200 "Standardization, certification and metrology", 5B072400 "Technological machines and equipment", 5B0721000 – "Chemical technology of organic substances", 5B072000 – "Chemical technology of inorganic substances"

2) economics faculty, specialties: 5B050800 - "Account and audit", 5B050700 - "Management", 5B050600 - "Economy"

3) polytechnical and agronomical faculties, specialties: 5B073100 "Health and safety and environmental protection", 5B090100 "Organization of transportations and traffic", 5B072700 "Technology of food products".

Testing is an effective way of check of level of relevant proficiency of students, besides allows to assess current state of level of students' knowledge, to carry out comparative analysis, to introduce necessary pedagogical amendments. That is, the level of retained knowledge is an indicator of professional education of students

Tests were made on the subject "Function" of school course of mathematics. The subject of the test completely corresponded to the substantial lines of obligatory minimum of content of education on mathematics. The test work consisting of three stages was offered to students. Let's consider the second and third stages which included the test work like test consisting of 25 tasks.

Test No. 1 purpose – research of formation of main operations at students at school course of mathematics, namely work with function graphs. According to the drawing, students needed to specify: function range of definition, set of values of function, schedule of increasing or decreasing function, zero function; to find all x values at which function accepts non-positive or positive values, negative or non-negative values; to define intervals of monotony of function; to determine function by chart, to specify its type.

The purpose of test No. 2 was to check knowledge of main properties of functions and also ability to apply them. It was offered to solve problems: on a range of definition or area of value; to check function for parity or oddness; to find inverse function; to find extremum points; to find intervals of increase or decrease of function; to find critical points of function; to find zero function and also a task on transformation of function graphs.

Results and Discussion. Let's give results of two tests:

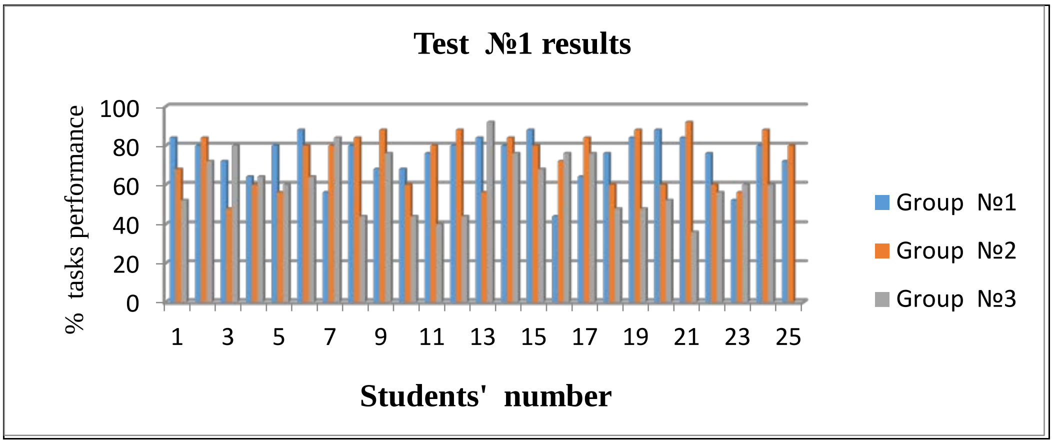

Fig. 1. Distribution of the test No. 1 results by each student

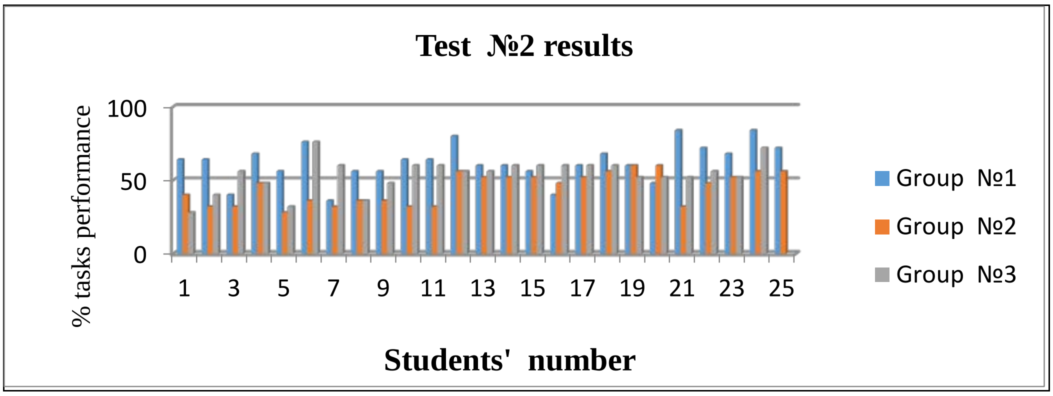

Fig. 2. Distribution of the test No. 2 results by each student

To solve the task students previously were told what units of school course of mathematics were necessary to re-cap. To answer the test questions, it was required to show rather high level of mathematical knowledge and abilities. Average percent of performance of tasks in group No. 1: test No. 1 – 74.7, and test No. 2 – 62.2.; in group No. 2: test No. 1 – 73.4, and test No. 2 – 44.6; in group No. 3: test No. 1 – 61.3, and test No. 2 – 58.8. Apparently from the chart, the results of performance in group No. 1: test No. 1 fluctuates from 44 to 88%, and test No. 2 – from 36 to 84%; in group No. 2: test No. 1 from 48 to 92%, and test No. 2 – from 28 to 60%; in group No. 3: test No. 1 from 36 to 92%, and test No. 2 – from 28 to 76%. The results of test No. 2 were lower in comparison with No. 1 that says that students carry out the most typical tasks of school course easily, and here when performing tasks of more difficult level students experience difficulties though test questions are included into the program of school course of mathematics.

Observed results can be explained as follows: these tasks are generally for definition of extremum and intervals of increase (decrease) of function which students did not master during algebra and elements of analysis course of secondary school. The difference of mathematics from other school disciplines is that here studying of each subject leans on earlier received facts therefore it is necessary for deep assimilation of each new subject that knowledge, skills gained when studying of earlier passable material were at rather high level. The research showed that due to it further training of such students is at a loss, and sometimes becomes impossible at all. Not superficial, but deep, strong development of mathematical language, concepts, theorems, methods of school course of mathematics is a necessary condition of ability to put the gained knowledge into practice in a high school course of mathematical analysis. The analysis shows that because of ignorance of simple concepts they cannot sometimes finish the solution. For example, when it is required to find intervals of its increase, having constructed a function graph $y = x^2 + 2$, , instead of $(0;+\infty)$ they specify the area of values of this function by the interval $(2;\infty)$. Such mistakes, when performing elementary exercises are possible because of misunderstanding of simple concepts. For this purpose it is necessary for students: to strongly master key concepts, terms; to master main theorems, formulas, rules, to develop general mathematical culture in the course of learning (to be able to argue logically, to be able to prove assumption, to know problem highlights, to exclude insignificant details, to be able to find rational solutions of tasks).

Let's carry out the analysis of test No. 1 and test No. 2 questions.

Marks on a hundred-ball system were the following:

Tab. 1. **Analysis of tests No. 1 and No. 2**

№ of student	Group №1		Group №2		Group №3	
	Test №1	Test №2	Test №1	Test №2	Test №1	Test №2
1.	84	64	68	40	52	28
2.	80	64	84	32	72	40
3.	72	40	48	32	80	56
4.	64	68	60	48	64	48
5.	80	56	56	28	60	32
6.	88	76	80	36	64	76
7.	56	36	80	32	84	60
8.	80	56	84	36	44	36
9.	68	56	88	36	76	48
10.	68	64	60	32	44	60
11.	76	64	80	32	40	60
12.	80	80	88	56	44	56
13.	84	60	56	52	92	56
14.	80	60	84	52	76	60
15.	88	56	80	52	68	60
16.	44	40	72	48	76	60
17.	64	60	84	52	76	60
18.	76	68	60	56	48	60
19.	84	60	88	60	48	52
20.	88	48	60	60	52	52
21.	84	84	92	32	36	52
22.	76	72	60	48	56	56
23.	52	68	56	52	60	52
24.	80	84	88	56	60	72
25.	72	72	80	56	-	-
Average	74,7	62,2	73,4	44,6	61,3	53,8

Let's find selective Spearman rank correlation coefficient between marks according to two tests.

Let's appropriate ranks x_i to the marks according to test No. 1. These marks are in the decreasing order therefore their ranks x_i are equal to serial numbers (table 2). Let's appropriate ranks y_i to the marks according to test No. 2, for what at first these marks we will arrange in the decreasing order and we will number them (table 3).

Tab. 2. **Assignment of ranks x_i to the marks according to test No. 1**

Group №1		Group №2		Group №3	
Ranks x_i	Marks of test No. 1	Ranks x_i	Marks of test No. 1	Ranks x_i	Marks of test No. 1
1.	88	1.	92	1.	92
2.	88	2.	88	2.	84
3.	88	3.	88	3.	80
4.	84	4.	88	4.	76
5.	84	5.	88	5.	76
6.	84	6.	84	6.	76
7.	84	7.	84	7.	76
8.	80	8.	84	8.	72
9.	80	9.	84	9.	68
10.	80	10.	80	10.	64
11.	80	11.	80	11.	64
12.	80	12.	80	12.	60
13.	80	13.	80	13.	60
14.	76	14.	80	14.	60
15.	76	15.	72	15.	56
16.	76	16.	68	16.	52
17.	72	17.	60	17.	52
18.	72	18.	60	18.	48
19.	68	a.	60	19.	48
20.	68	19.	60	20.	44
21.	64	20.	60	21.	44
22.	64	21.	56	22.	44
23.	56	22.	56	23.	40
24.	52	23.	56	24.	36
25.	44	24.	48		

Tab. 3. **Assignment of ranks y_i to the marks according to test No.2**

Group №1		Group №2		Group №3	
Ranks y_i	Marks of test No. 2	Ranks y_i	Marks of test No. 2	Ranks y_i	Marks of test No. 2
1.	84	1.	60	1.	76
2.	84	2.	60	2.	72
3.	80	3.	56	3.	60
4.	76	4.	56	4.	60
5.	72	5.	56	5.	60
6.	72	6.	56	6.	60
7.	68	7.	52	7.	60
8.	68	8.	52	8.	60
9.	68	9.	52	9.	60
10.	64	10.	52	10.	60
11.	64	11.	52	11.	56
12.	64	12.	48	12.	56
13.	64	13.	48	13.	56
14.	60	14.	48	14.	56
15.	60	15.	40	15.	52
16.	60	16.	36	16.	52
17.	60	17.	36	17.	52
18.	56	18.	36	18.	52
19.	56	19.	32	19.	48
20.	56	20.	32	20.	48
21.	56	21.	32	21.	40
22.	48	22.	32	22.	36
23.	40	23.	32	23.	32
24.	40	24.	32	24.	28
25.	36	25.	28		

Let's find rank y_1. Index $i=1$ specifies that the considered mark of the student who takes the first place according to the test No. 1 in the table No. 2 (this mark is equal to 88); from the condition (table 1) it is visible that according to the test No. 2, the student got 76 points (table 3), that is a rank $y_1 = 4$.

Let's find rank y_2. Index $i=2$ specifies that the considered mark of the student who takes the second place according to the test No. 1 in the table No. 2 (this mark is equal to 88); from the condition (table 1) it is visible that according to the test No. 2, the student got 56 points (table 3), that is a rank $y_1 = 21$.

Similarly, we find other ranks (table 4).

We find the differences of ranks $d_i = x_i - y_i$:

Tab. 4. **Finding of ranks according to tests**

Group №1		Group №2		Group №3	
Ranks x_i	Ranks y_i	Ranks x_i	Ranks y_i	Ranks x_i	Ranks y_i
1.	4	1.	21	1.	11

2.	21	2.	16	2.	3
3.	22	3.	3	3.	12
4.	10	4.	1	4.	19
5.	14	5.	4	5.	4
6.	17	6.	18	6.	5
7.	1	7.	7	7.	6
8.	11	8.	8	8.	21
9.	18	9.	19	9.	7
10.	19	10.	17	10.	1
11.	3	11.	20	11.	20
12.	15	12.	22	12.	23
13.	2	13.	9	13.	15
14.	13	14.	5	14.	2
15.	8	15.	12	15.	13
16.	5	16.	15	16.	24
17.	23	17.	23	17.	16
18.	6	18.	13	18.	8
19.	20	19.	6	19.	17
20.	12	20.	2	20.	22
21.	6	21.	14	21.	9
22.	16	22.	25	22.	14
23.	25	23.	10	23.	10
24.	9	24.	11	24.	18
25.	24	25.	24		

Tab. 5. **Finding of difference of ranks** $d_i = x_i - y_i$**:**

Group №1			Group №2			Group №3		
№	d_i	d_i^2	№	d_i	d_i^2	№	d_i	d_i^2
1.	-3	9	1.	-20	400	1.	-10	100
2.	-19	361	2.	-14	196	2.	-1	1
3.	-19	361	3.	0	0	3.	-9	81
4.	-6	36	4.	3	9	4.	-15	225
5.	-9	81	5.	1	1	5.	1	1
6.	-11	121	6.	-12	144	6.	1	1
7.	6	36	7.	0	0	7.	1	1
8.	-3	9	8.	0	0	8.	-13	169
9.	-9	81	9.	-10	100	9.	2	4
10.	-9	81	10.	-7	49	10.	9	81
11.	8	64	11.	-9	81	11.	-9	81
12.	-3	9	12.	-10	100	12.	-11	121
13.	11	121	13.	4	16	13.	-2	4
14.	1	1	14.	9	81	14.	12	144
15.	7	49	15.	-3	9	15.	2	4
16.	11	121	16.	1	1	16.	-8	64
17.	-8	64	17.	-6	36	17.	1	1
18.	12	144	18.	-5	25	18.	10	100
19.	-1	1	19.	13	169	19.	2	4
20.	8	64	20.	18	324	20.	-2	4
21.	14	196	21.	7	49	21.	-12	144

22.	6	36	22.	-3	9	22.	8	64
23.	-2	4	23.	13	169	23.	13	169
24.	15	225	24.	13	169	24.	6	36
25.	1	1	25.	1	1	-	-	-
Sum	-	2276	Sum	-	2138	Sum	-	1604

Let's calculate the sum of squares of ranks differences: $\sum d_i^2$.

Let's find required Spearman rank correlation coefficient, considering that $n=25$ and $n=24$, $\rho_в = 1 - \frac{6\sum d_i^2}{n^3 - n}$.

Let's check a null hypothesis about equality to zero general Spearman rank correlation coefficient, at signification value $\alpha = 0{,}01$. In other words, we will check whether rank correlation communication between marks according to two tests is significant.

Let's find a critical point of bilateral critical field of Student distribution on significance level $\alpha = 0{,}01$ and number of freedom degrees $k = n-2$, we will find $t_{кр}(\alpha; k)$. Also, we will find a critical point: $T_{кр} = t_{кр}(\alpha;k)\sqrt{\frac{1-\rho_в^2}{n-2}}$.

Tab. 5. **Finding of main coefficients**

Main coefficients:	Group 1	Group 1	Group 1
	$n=25$	$n=25$	$n=24$
$\rho_в$	0,12	0,18	0,30
$k=n-2$	23	23	22
$t_{кр}(\alpha;k)$	2,81	2,81	2,82
$T_{кр} = t_{кр}(\alpha;k)\sqrt{\frac{1-\rho_в^2}{n-2}}$	0,58	0,56	0,56
Conclusion: Comparison $\rho_в$ and $T_{кр}$	$\rho_в < T_{кр}$	$\rho_в < T_{кр}$	$\rho_в < T_{кр}$

Conclusion. So, we received $\rho_в < T_{кр}$ - there are no bases to reject a null hypothesis about equality to zero general coefficient of rank correlation of Spearmen. In other words, rank correlation communication between marks according to two tests is insignificant [7].

During our research we concluded: that teaching mathematics promoted establishment of substantial continuity by a student, it is necessary to provide:

- studying sequence of academic material
- understanding of material mastering
- understanding of arising contradictions
- prospects in learning

In general, comparing results of two tests, it is possible to draw the following conclusions: the given mistakes and defects speak about inability to use cogitative operations or low level of proficiency in them. Weak results testify to a not studied condition of basic concepts of this subject at the level of comprehension. In other words, definition of basic concepts of the considered subject can be retained for some time by students, but without being deeply acquired, are quickly forgotten and cannot be correctly applied at the solution of difficult tasks.

The results of our research allow drawing the following conclusions: studying of such fundamental mathematical concept as concept "function" without preliminary work at school is extremely complicated and ineffective. Besides, we consider it necessary to repeatedly go through this subject in higher education institution in addition since it is that base on which further studying of mathematical analysis in higher education institution is based. It is very important to accompany "transformation of function graphs" by visual images, using multimedia technologies that students could visually see "shifts" and by that to acquire, understand and be able to reproduce, since the main way of studying of function properties - to study them by means of chart. B chart it is easy to determine at what values of argument the value of function is equal to zero, in what intervals the function values are positive (negative), in what intervals function increases (decreases), to be able to define its properties.

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«ФУНКЦИЯ» ТАҚЫРЫБЫН ОҚЫТУДАҒЫ МЕКТЕП ПЕН ЖОО АРАСЫНДАҒЫ САБАҚТАСТЫҚ МӘСЕЛЕЛЕРІ

Аңдатпа. Баяндамада «Функция» тақырыбын оқытудағы мектеп теп ЖОО-дағы математика курсы арасындағы сабақтастық қарастырылған, тесттік зерттеулерінің негізі нәтижелерінің талдауы және жинақталуы көрсетілген.

Математиканы оқытудағы сабақтастық мәселесі пәнішілік және мета-пәндік байланыстарды жүзеге асыру міндеттерімен, оқу материалын ұсыну дәйектілігімен, оның күрделілігінің өсу деңгейімен, әртүрлі білім беру кезеңдерінде Математиканы оқыту процесін ұйымдастырудың оңтайлы формалары мен әдістерін іздеумен байланысты. Осыған байланысты мақалада мектеп пен университеттің математика курсы арасындағы "Функция" тақырыбын зерттеудегі сабақтастық мәселесі қарастырылады, орыс тілінде оқытудың үш түрлі ағымында бірінші курс студенттерінің білімі мен дағдыларының негізгі нәтижелерін талдау және түсіндіру ұсынылған.

Негізгі сөздер: математика, сабақтастық, функция, графика, график құру, проблема, оқыту.

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ПРОБЛЕМА ПРЕЕМСТВЕННОСТИ ПРИ ИЗУЧЕНИИ

ТЕМЫ «ФУНКЦИЯ» МЕЖДУ ШКОЛОЙ И ВУЗОМ

Аннотация. В статье рассматриваются проблема преемственности при изучении темы «Функция» между школьным и вузовским курсом математики, представлен анализ и интерпретация основных результатов данного тестового исследования.

Проблема преемственности в преподавании математики связана с задачами реализации внутрипредметных и метапредметных связей, с последовательностью изложения учебного материала, уровнями возрастания его сложности, с поиском оптимальных форм и методов организации процесса обучения математике на разных образовательных этапах. В связи с этим, в статье рассматриваются проблема преемственности при изучении темы «Функция» между школьным и вузовским курсом математики, представлен анализ и интерпретация основных результатов знаний и умений студентов первого курса в трех различных потоках с русским языком обучения.

Ключевые слова: математика, преемственность, функция, графики, построение графиков, проблема, обучение.