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TÍTULO: Problemas de la enseñanza de las matemáticas a los estudiantes de ex-repúblicas soviéticas en universidades médicas y sus posibles soluciones.

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RESUMEN: La experiencia de la formación de los estudiantes de las ex-repúblicas soviéticas demuestra que los solicitantes que requieren ingresar tienen ciertas competencias lingüísticas al nivel de comunicaciones cotidianas y un bajo nivel de los conocimientos de la física y las matemáticas; por eso, la mayoría de ellos tiene enormes problemas con su estudio de las matemáticas como una de las asignaturas profesionales de carácter general. Para resolver este problema, hemos desarrollado una tecnología de enseñanza que les permite a los estudiantes de los países de la CEI consolidar sus habilidades lingüísticas y tener éxito en su estudio del curso de las matemáticas superiores. Este método está basado en la aplicación de la teoría psicológica y pedagógica de la actividad y la teoría de formación gradual de acciones y nociones mentales.

PALABRAS CLAVES: enseñanza de las matemáticas a futuros médicos, formación de los estudiantes extranjeros, desarrollo de competencias lingüísticas en los estudiantes extranjeros.

TITLE: The problem of teaching mathematics to students from the near abroad in medial universities and possible ways of solution.

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ABSTRACT: As the experience of teaching students from the near abroad countries shows, entering prospective students have particular language skills on the level of social interaction and a low level of physics and mathematical training; therefore, most of them have huge problems during studying mathematics as one of the general professional disciplines. For solving this problem, we developed an educational technique that allows strengthening language skills of the CIS countries students and to master the course of higher mathematics. The given methods are based on the application of psychological pedagogical activity theory and the theory of gradual formation of mental actions.

KEY WORDS: teaching mathematics to future doctors, teaching foreign students, developing language skills among foreign students.

INTRODUCTION.

Traditionally Russian universities have been the most attractive ones for the countries of the near abroad. Friendly relations between the CIS countries as well as relatively inexpensive tuition fee are as a rule the main reasons for prospective students from the near abroad to choose Russian universities. That's why the number of students from the given countries increases each year. Thus, for example, over the past 7 years, the number of prospective students coming from the CIS countries to enter Astrakhan State Medical University has increased by an average of 29.5%.

Students from the near countries, who come to study, speak either broken Russian or basic Russian. The expression "broken" Russian means that foreign citizens partially understand everyday language, as their parents spoke Russian, but they lack practice of using the language and the present generation has both linguistic and phonetic problems. Besides, during the ascertaining experiment we established that students from the CIS countries have a low level of mathematical knowledge as compared to the

students from the far abroad as well as Russian citizens. There is a relatively low level of intellectual development.

In spite of the given difficulties, foreign students in the conditions of global economic crisis, seeking to obtain higher medical education in Russia, refuse to study at the pre-university training faculty. While the dynamics of the number of prospective students from the CIS countries is positive, there is a decrease in the number of prospective students for preparatory departments (Fig.1). Undoubtedly, an insufficient level of mathematical knowledge, aggravated by the presence of language problems, leads to negative learning outcomes; students can hardly cover educational material and retake tests and exams.

Moreover, the current practice of teaching students of medical universities, as well as the methods proposed by the authors of the research for teaching mathematics to future doctors, for the most part isn't oriented for the specifics of teaching students from the CIS countries.

Thus, there appear contradictions:

- (from the university part) between the need to receive students from the near abroad as one of the financing sources, and the impossibility of teaching them because of the low level of knowledge in mathematics and physics on the background of language problems.
- (from the prospective students' part) between the desire to get higher professional education in a Russian medical university and the impossibility to study at the pre-university faculties.
- (from the students' part) between the need to study a course of mathematics regulated by the federal state standard of higher professional education, and the lack of methods for teaching mathematics to students of the CIS countries in a medical university.

DEVELOPMENT.

The goal of the research.

The given contradictions confirmed the relevance of our research and prompted to form its goal: to develop methods of teaching students of the near abroad aimed at grasping the education according to the language difficulties.

Materials and research methods.

The goal of the research was reached in several stages. Different methods of research activity were applied at each stage. Thus, at the initial stage – the stage of search for a psychological pedagogical basis for developing methods of teaching mathematics to students of the CIS countries, the following methods were applied: analysis of academic literature and practice of teaching mathematics, generalization of the obtained data and formulation of a conceptual idea.

At the stage of introducing the developed methods, lesson observation was applied. It represents monitoring the activity of specialized departments teachers as well as students. At the final stage – the stage of evaluating the efficiency of mathematics teaching methods, methods of qualitative and quantitative analysis were applied. Their reliability was confirmed by the methods of mathematical statistics. 20 university teachers and more than 250 students of the near abroad studying at Russian medical universities took part in the pedagogic experiment.

Data analysis was implemented while comparing the results of diagnostic and control work of the control and experimental groups. At the beginning of the experiment, a study was conducted aimed at establishing the level of mathematical preparation of students in these groups and the level of Russian language proficiency. As a result of using formulas to calculate the average scores obtained during the acceptance test and variances, the following was determined:$\overline{x_1} = 34$,$\overline{x_2} = 38$, σ_1^2 =278,9, σ_2^2 = 265,4. According to statistics tables for the quantity of the degree of freedom $n_1 + n_2 - 2$ =498 the significance point of Student's coefficient is t_{sp} =1,940 for p≤0,05 and t_{sp} =2,7850 for p≤0,01. Empiric value t_{emp} =0,1642 lies in the insignificance zone, therefore the differences between the averages are unreliable, that is, students in the control and experimental groups have the same level of mathematical and language training.

Introduction and the obtained results.

We will briefly reveal the results of each stage of the study.

Results of the 1st stage. Based on the analysis of academic and psychological literature it was established that the opinions of psychologists coincide in the issues of influence of internal and

external factors on the process of teaching foreign students at the universities. According to this opinion, the main condition of successful study of foreign citizens in Russian universities is fast and effective mastering of Russian.

“Faced with a foreign language, students are faced with a different sign system, semantic structure that varies from the native language, a different articulatory structure and melody of speech, and a different conceptual sphere” [1, p. 57]. The better the language is mastered, the more effective the adaptation, the faster the student ceases to be shy about addressing his requests and questions to Russians, i.e. the communication process becomes easier, which means becomes easier to learn new things, which is very important.

Psychologists and sociologists (S.I. Samygin, L.D. Stolyarenko) note a person’s need "to join - to enter into long lasting close relationships with other people that guarantee positive experiences and results.” [2, p. 148] Foreign students painfully endure misunderstanding particularly conflicts with teachers. In their opinion, the best “accelerator” of adaptation is creating the atmosphere of a “kind house”, where each foreign student would “find oneself” [3, 4, 5 and others]. However, it isn’t always possible to achieve this. Unfortunately, some teachers don’t want to go into the problems of foreign students because of the lack of experience or spare time, thus they treat foreigners subjectively, showing signs of nationalism. не всегда этого удается достичь, but more often problems appear due to the communicatory failure in such cases when a teacher does not take into consideration the communicatory peculiarities of a foreign student with poor knowledge of Russian.

Therefore, the methods of teaching mathematics to students from the CIS countries in medical universities must on the one hand promote the development of communication skill, and on the other hand promote the successful acquisition of mathematical knowledge. What should a theoretical basis for developing such methods of teaching be? We studied the well-known nowadays pedagogical [6, 7, 8 and others] and psychological [9, 10 and others] approaches to teaching and came to a conclusion, that we need to refer to the theory of gradual formation of mental actions and notions developed by a famous Russian psychologist P.Y. Galperin [11]. Thus, according to the theory:

I. In order for the student to acquire knowledge it is necessary to match each element of knowledge to the activity based on the content of the given knowledge; for example, for acquiring the notion of "differential equation of first order" it is necessary to organize the activity aimed at work with the content of the given knowledge formulated in its definition as well as to the solution of equations of the given type. Each type of activity consists of actions adequate to the content of the knowledge.

II. For the successful and conscious implementation of the activities, it is necessary to equip the students with the indicative basis of activity (*IBA*), i.e. the system of orienting points and indicators, data on all the components of actions (subject, product, means and the order of operations) in a generalized way. This allows implementing the given system if actions (IBA) while solving a wide range of tasks.

III. Success of the implementation of the generalized system of activities depends on the measure of its generality as well as of the methods of its formation. Galperin distinguished 6 stages of formation of mental actions: the 1st stage – the motivational stage, where the "internal" or cognitive motivation is created; the 2nd stage –IBA scheming, where a student together with a teacher finds out the IBA based on the analysis of the previously solved tasks; the 3rd stage – forming actions in a material or a materialized form. The action is carried out as an external, practical one with real objects (material form of actions). The action is carried out with the converted material: models, schemes, diagrams, drafts, etc. (materialized form). At the same time, all operations of the action are realized, and their slow performing allows seeing and understanding the content of both operations and the entire action as a whole. "The essential condition of the given stage is a combination of a material form with a spoken one, which allows separating the acquiring action from the subjects or their substitutes that help to perform this action. When the action begins to proceed smoothly, accurately and more quickly, the indicative card and material supports are removed" [11]; the 4th stage – forming actions in loud speech.

During the given stage, a student devoid of material supports of actions, speaks the IBA out loud. This allows implementing a "leap" – a passage from the internal action to the thought of this action. The acquiring knowledge goes through the further generalization, but is left unabridged, non-automated; the 5th stage – forming actions in external speech "silently". A student uses the IBA for solving the task without speaking it out loud, but with the step-by-step control of the teacher; the 6th stage – forming actions in internal speech; during this stage a student solves tasks independently without using the IBA.

Comparing this approach in teaching with other approaches well-known nowadays, we can suppose that the theory of a gradual formation of mental actions allows controlling the process of acquiring knowledge, while traditional approaches are mostly oriented to the spontaneity of forming knowledge and activity. As a rule, students don't realize at what stage they make mistakes, while the theory of gradual formation excludes such possibility. Moreover, a great advantage for teaching mathematics to students from the CIS countries is the opportunity of forming communication skills at the lessons of mathematics, where the students should speak the content of IBA out loud. Additionally, the collective speaking out loud (in a chorus) must lessen the discomfort and shyness of students.

Thus, the obtained results allowed forming the conceptual idea of the research: methods of teaching mathematics to students of medical universities from the near abroad must be constructed in the following way: 1) elements of mathematical knowledge must be included in the activity adequate to the content of the given knowledge; 2) students must have an opportunity to single out the content of the activity in a generalized way; 3) there should be a possibility to organize all the 6 stages of the formation.

The results of the 2nd stage.

At the given stage of our research, we implemented the previously formed conceptual idea. With this idea we developed special methodic recommendations for the teaching staff of specialized departments of medical universities that included the systemized teaching material in the form of notion definitions, scientific facts, theorems and axioms studied in the course of mathematics in a

medical university. An important component of the given material was signifying the types of activity based on the content of the given elements of knowledge. Thus, for example, the notion "differential equation of first order" corresponds to the activity on singling out the equations of such type from the range of the suggested equations based on the definition of the given notion, particularly establishing the presence of such features as the "explanatory variable *(x)*", the "required function *(y)*" and the "derivative of the second order *(y'')*". Besides, for acquiring notions on "differential equation of first order" there is a corresponding activity for solving these equations.

As we noted before, for the application of the activity on solving a wide range of tasks, it is necessary to single out a generalized content of the activity (IBA), that's why we singled out the generalized systems of actions for each element of knowledge.

Speaking of the recognition activity, the generalized structure would consist of the following actions: 1) form the definition of the notion; 2) single out words that indicate the gender of the given notion; 3) single out words that indicate the generic features of the given notion; 4) establish the presence of all the defined features in the suggested task; 5) form the conclusion. The generalized system of actions on solving differential equations of the second order and the results of performing these actions are presented in table 1.

Table 1. Content of the generalized technique on solving differential equations of the second order and the results of the performed actions.

Task 1. Find the general solution of the simplest differential equation of the second order $y'' = 12x^2$.	
Actions	**Results of actions**
1. Define whether the given equation is the simplest differential equation of the second order.	The given equation is $y'' = 12x^2$ the equation of the second order as the highest order of the derivative is second. The equation is the simplest differential equation of the second order as it has a type of $y'' = f(x)$.

2. Introduce the substitute $y' = p(x)$, then $y'' = p'$. Place the substitute and get the differential equation of the first order with separable variables.	Introducing the substitute $y' = p(x)$, then $y'' = p'$. Obtaining $p' = 12x^2$ the differential equation of the first order with separable variables.
3. Depict $p' = \frac{dp}{dx}$.	$\frac{dp}{dx} = 12x^2$
4. Transform the equation in such a way as to obtain the equation of the form of $\frac{f_1(p)}{f_2(p)}dp = \frac{g_2(x)}{g_1(x)}dx$.	Multiplying both sides of the equation by dx, we obtain $dp = 12x^2dx$
5. Integrate both sides of the equation. Write down the general solution of the intermediate differential equation in the form of $p = f(x) + C_1$	$\int dp = \int 12x^2dx$, $p = 4x^3 + C_1$
6. Return to the original variable $y' = p(x)$. Obtain the differential equation of the first order with separable variables.	$y' = 4x^3 + C_1$
7. Depict $y' = \frac{dy}{dx}$.	$\frac{dy}{dx} = 4x^3 + C_1$
8. Transform the equation in such a way as to obtain the equation of the form of $\frac{f_1(y)}{f_2(y)}dy = \frac{g_2(x)}{g_1(x)}dx$.	Multiplying both sides of the equation by dx, we obtain $dy = 4x^3dx + C_1dx$
9. Integrate both sides of the equation. Write down the general solution of the intermediate differential equation in the form of $y = f(x) + C_1x + C_2$	$\int dy = \int 4x^3dx + \int C_1dx$, $y = x^4 + C_1x + C_2$

Moreover, university teachers were suggested the developed by us illustrative scenarios of lessons, didactic means of teaching mathematics to students of the near abroad in the form of the so-called "Workbooks" that contain tasks, areas for solving them and clues in the form of IBA.

The results of the 3rd stage.

For assessing the efficiency of the developed approach of teaching mathematics to students from the near abroad countries, we developed a control – diagnostic apparatus that allows estimating: 1) maturity of knowledge and types of activity; 2) development of communication skills from the point of view of the application of mathematical research vocabulary and informal speech while explaining the performed actions. For the implementation of the first goal of the research students were offered to perform work consisting of tasks on recognizing situations that correspond to notions, judgments enclosed in theorems, tasks on application of theorems consequences, tasks on the application of mathematical modeling methods and tasks for solving differential equations of the first and second order. A prerequisite for completing tasks was the indication of actions performed and their feasibility.

Works were assorted according to the following features: 1) a student didn't perform the tasks (educational actions) upon the whole, but was able to perform only separate operations without their internal connection to each other or copy the internal form of actions; the content of activity isn't realized (level 1); 2) a student realizes the content of activity and its operational composition, begins performing actions, however, he can't organize his actions and finish them without the outside help; a teacher's help is accepted rather easily; a student works efficiently at a step-by-step control, independent educational actions are almost absent (level 2); 3) a student applies the acquired mode of actions to solving a new task, however, he isn't able to bring even insignificant changes into it to adapt it to the conditions of a peculiar task, i.e. he uses the acquired method "blindly", without correlating it with the task conditions; he can only implement such correlation and transformation with the help of a teacher, but not independently; a student can successfully perform actions independently in case the conditions are unchangeable (level 3); 4) a student rather fully analyzes the task conditions and accurately correlates them with known methods; a student easily accepts indirect teacher assistance; he realizes and is ready to describe the causes of his difficulties and the features of the new mode of actions (level 4); 5) solving a new task a student independently builds a new

mode of actions or modifies the mode that he is familiar with, doing it gradually step by step and in the end he solves the tasks correctly without any help from the outside (level 5); 6) mastering a new mode, a student realizes its content as well as the principles of its composition (i.e. what it is based on), realizes the similarity between different modifications and their connections with the task conditions (level 6).

Figure 1 presents the comparative data of a control and an experimental group that illustrate the positive effect of the methods of teaching mathematics to students from the CIS countries developed by us in the context of forming knowledge and different types of educational activity.

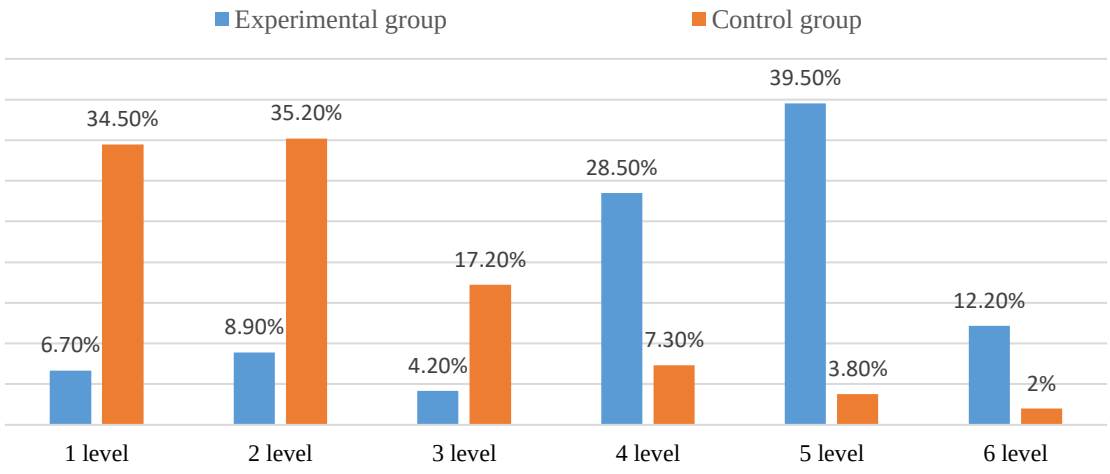

Fig. 1. Comparative data of the pedagogical experiment

Assessment of the development of communication skills was implemented during interviews with students. In the course of the interviews it was suggested to explain a task solution in this or that subject, tell about the possible variants of applying the mathematical material in the future professional activity and tell about the favorite subjects of the course of mathematics at school, university, etc. The obtained audio records were analyzed and it allowed distinguishing 3 levels of language skills proficiency: level 3 – a student actively uses the subject vocabulary in Russian with the application of complex phrases and sentences, confidently arguments and makes conclusions, actively uses the terminology; level 2 – uses Russian vocabulary, but tries to compose short phrases and sentences, can form a conclusion and explain the performed action, but he thinks slowly and takes

time to compose phrases; he uses mathematical terms in speech and is initiative; level 1 – a student uses clichés while answering, he stops all the time for thinking over the phrases, can hardly formulate conclusions, is shy during conversation.

Figure 2 presents the comparative data of a control and an experimental group that illustrate the positive effect of the methods of teaching mathematics to students developed by us in the context of the development of their language and communicative skills.

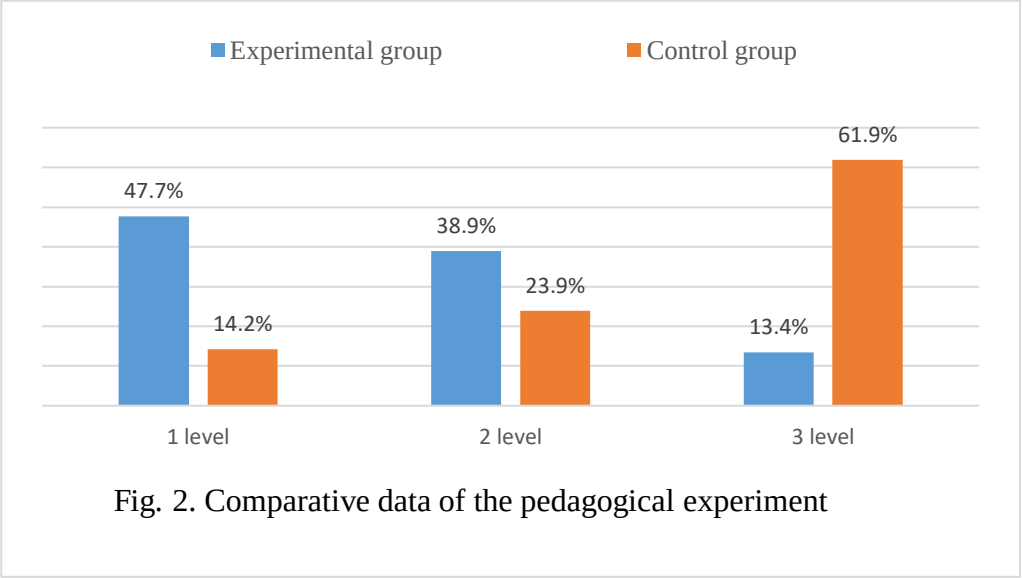

Fig. 2. Comparative data of the pedagogical experiment

For estimating the results validity, we applied the method of G-sign test that allows defining the presence of verifiable changes (shifts) in the measurable indicator. To achieve this, a number of positive, zero and negative shifts was counted up in relation to language and communication skills as well as skills of implementing mathematical knowledge solving tasks of different types. It was established that in the experimental group (n=250 – the number of students in the experimental group) G_{emp}= 98. Significance points: G_{sp}=105 p≤0,05 G_{sp}=100 for p≤0,01. As $G_{emp} < G_{sp}$, then a hypothesis is accepted that a shift towards increasing the level of knowledge maturity and the corresponding types of activities and communication skills is not a random result, but is a consequence of the methods of teaching mathematics to students of medical universities from the CIS countries developed by us.

CONCLUSIONS.

Thus, the application of the gradual formation of mental actions and notions has a positive Impact in two main directions: students master the activity on applying mathematical knowledge and acquire skills of using the mathematical research vocabulary, become more initiative during classes, while their shyness in communicating with teachers and Russian speaking students disappears.

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