Asesorías y Tutorías para la Investigación Científica en la Educación Puig-Salabarría S.C.
José María Pino Suárez 400–2 esq a Lerdo de Tejada. Toluca, Estado de México. 7223898475
RFC: ATI120618V12

Revista Dilemas Contemporáneos: Educación, Política y Valores.
http://www.dilemascontemporaneoseducacionpoliticayvalores.com/
Año: VII **Número: Edición Especial** **Artículo no.:30** **Período: Octubre, 2019.**

TÍTULO: Modelado de simulación en la formación de futuros profesores de matemáticas.

AUTORES:

1. Ph.D. Andrey V. Kostin.

2. Ph.D. Natalya N. Kostina.

3. Ph.D. Aleksandr V. Minkin.

4. Assist. Prof. Ellina S. Anisimova.

RESUMEN. Actualmente, se está prestando cada vez más atención a los temas del modelado de simulación en la capacitación de especialistas de diferentes campos. En particular, en la práctica pedagógica se puede utilizar activamente durante las clases en métodos de enseñanza de diversas materias. En la práctica ordinaria, los futuros maestros realizan sus primeras clases de prueba para "estudiar a los estudiantes". Llevar esta lección a la realidad se puede hacer de dos maneras. Por ejemplo, un maestro selecciona material para la lección que sería similar al material en la escuela libro de texto, pero no es familiar o poco conocido por el público, reemplazando a los "estudiantes que estudian". El documento muestra el uso efectivo de un simulador virtual para la formación de futuros profesores de matemáticas.

PALABRAS CLAVES: simulación de modelos, futuros docentes, práctica pedagógica, métodos de enseñanza de diversas asignaturas.

TITLE: Simulation Modelling in Training Future Teachers of Mathematics.

AUTHORS:

1. Ph.D. Andrey V. Kostin.
2. Ph.D. Natalya N. Kostina.
3. Ph.D. Aleksandr V. Minkin.
4. Assist. Prof. Ellina S. Anisimova.

ABSTRACT: Issues of simulation modeling are currently being given more and more attention in training specialists from different fields. In particular, in pedagogical practice it can be actively used during classes in teaching methods of various subjects. In ordinary practice, the future teachers conduct their first test classes for “studying students". Bringing this lesson to reality can be done in two ways; for example, a teacher selects material for the lesson that would be similar to the material in the school textbook, but is either unfamiliar or little known to the audience, replacing the “studying students”. The paper shows the effective use of a virtual simulator for the training of future teachers of mathematics.

KEY WORDS: simulation modeling, future teachers, pedagogical practice, teaching methods of various subjects.

INTRODUCTION.

Our interest in this topic arose after listening to the report by Frederic Castel (ESPE de l'académie de Reims au sein de l'Université de Reims's insight: Frédéric CASTEL, directeur adjoint de l'ESPE de l'académie de Reims, en charge des sites de Chaumont et Troyes.), the director of the branches of the Pedagogical Institute at the University of Reims in the cities of Troyes and Chaumont. Frederic Castel made his presentation at a conference dedicated to the 25th anniversary of the Faculty of Mathematics and Informatics of the Pedagogical University of the city of Naberezhnye Chelny in

2015. He spoke about the experience of French scientists in creating a virtual classroom and the first results in the use of their proposed methodology. In our work, we consider other areas of simulation modeling in training future teachers of mathematics.

Issues of simulation modeling are currently being given more and more attention in training specialists from different fields (Drews & Backdash, 2013). In particular, in pedagogical universities it can be actively used during classes in teaching methods of various subjects (Sharma, 2015; Carrington et al., 2011; Hixon & So, 2009; De Jong et al., 2012). Simulation modeling involves the replacement of a real process by its model, reflecting the most significant characteristics of a real process from the point of view of the goals set. In order to learn the skills of conducting lessons before starting pedagogical practice at school, the student of a pedagogical university needs to acquire the initial skills of conducting lessons, and it is desirable to get this experience in conditions close to real as much as possible (Anisimova, 2015).

Modern students of Russian universities, regardless of the chosen specialty, have great problems with oral presentation of the material due to the lack of the ability to correctly express any thoughts. This, of course, is a consequence of the fact that in the present school they are little taught to speak verbally, for example, to verbally prove the theorems. In addition, they have no experience of taking oral examinations. Therefore, it is easier for the trainee to silently solve the problem and write it down on the board, which, of course, cannot satisfy the majority of the students. In addition, when they come to practice in school, students find themselves in an environment that is often far from being friendly to them, where, along with tasks from the subject area, circumstances require the solution of pedagogical problems. Due to these reasons, the approach to "classroom" preparation of students for pedagogical practice should be very serious.

The student conducts his/her first test lessons for “students" - his/her groupmates, but since the school material of the lesson is too familiar to these "students" and their behavior is too predictable, the pedagogical practice carried out in this form is far from effective, since it has nothing to do with the real school lesson. "Students" are familiar with all the material that the "teacher" represents to them, and, of course, this cannot but affect the reaction of "students" during the test lesson, influences their behavior, which in turn reduces the effectiveness of such training lessons for a student who plays the role of a teacher.

DEVELOPMENT.

Methods.

In order to bring such test lessons closer to reality, we can go in two ways. One of the ways is to select material for the lesson that would be similar to the material in the school textbook, but unfamiliar, or little known to the audience, which plays the role of schoolchildren; for example, geometry lessons are not based on the material of Euclidean geometry, which is studied at school, but on a material reflecting similar questions of non-Euclidean geometry, for example, Lobachevsky geometry. In this case, we apply a kind of imitation technology, which consists in teaching students of own group not based on school material, but on material similar to school one.

We may also include new theorems of Lobachevsky geometry in the educational process that are analogous to known theorems from Euclidean geometry; for example, such as those considered in papers (Kostin & Sabitov, 2014; Kostin & Kostina, 2016).

On the other hand, learning of how to conduct the lesson itself is the most important task.

Another possibility to simulate real school lessons when conducting test lessons with student is the use of olympiad problems.

Another way of approaching the lesson of the trainee to reality is to replace the groupmate-“students" with simulators. That is, the student conducts test lessons in a computer class, where the role of students is played by computers with the programmed behavior of students. Such a lesson can already be conducted on the material of school textbooks, since these "students" will now play a role according to the pre-set scenario, which has as its goal the verification of all possible skills of the trainee (Power & Sharda, 2007).

In this paper, we will consider in more detail the second method of approaching the lesson of the trainee to reality. Obviously, several important issues come to the fore. First, the reaction of such “students" may require the teacher's efforts to explain or interpret some theoretical nuances or questions with the solution of concrete examples (the trainee is not sure in advance which questions and problems in understanding the lesson material will arise with the "student"). Secondly, the simulator, in order to approach the reality of the lesson, has also the pre-set behavioral "anomalies" of such "students", i.e. it allows also checking both the methodical preparation of the student and his/her pedagogical knowledge and skills. Thirdly, this allows assessing the level of preparedness of future teachers of mathematics on the example of solving olympiad problems in geometry with the help of a simulator.

Objective of this work is to assess the effectiveness of the use of simulation modeling in the process of training future school teachers of mathematics and compare their level of preparedness for the future profession, depending on the course they study, and also with the professional level of working teachers.

Pedagogical experiment, observation and modeling were used as research methods. Let's consider in more detail one of the possible scenarios of the simulator operation on the example of the geometric task block (see Figure 1).

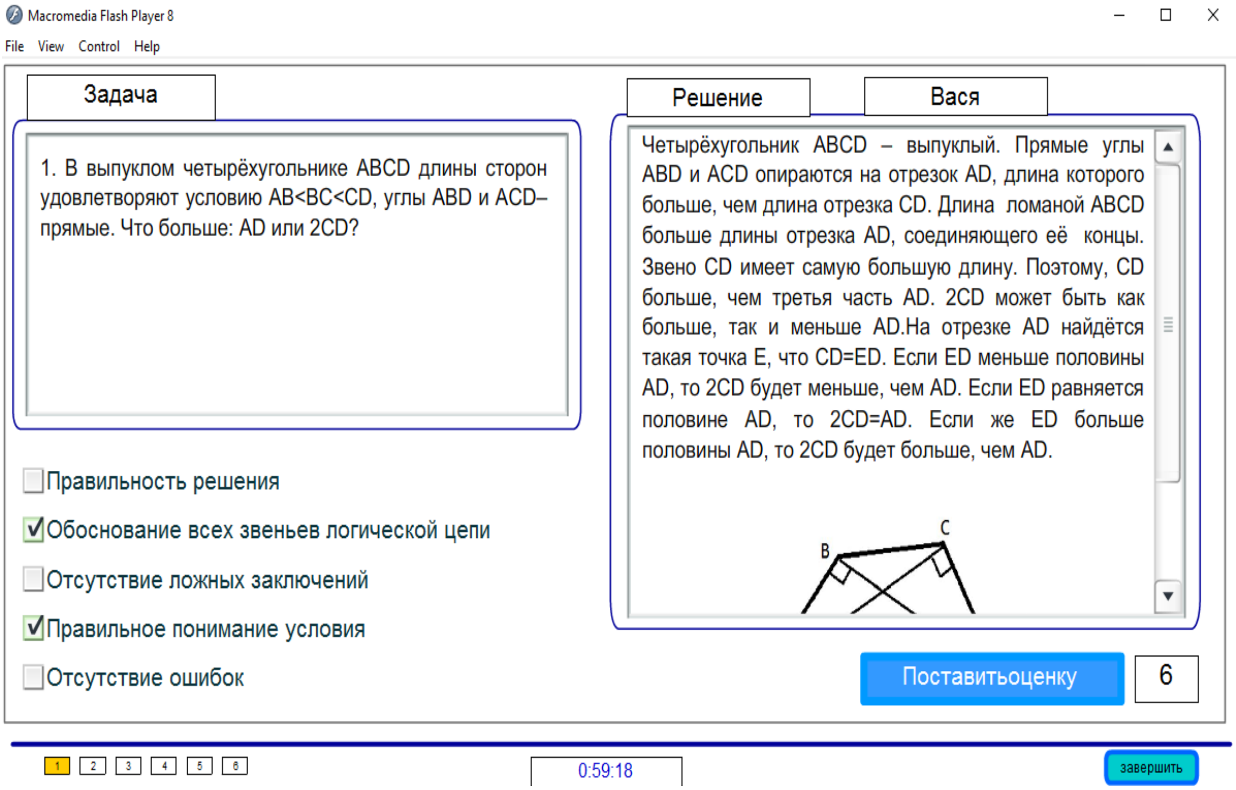

Fig. 1. Working with a geometric task block on the simulator.

A virtual class consists of 6 "students" with the names assigned. The trainee is asked to consistently evaluate the solutions to each of the six tasks by all the "students", i.e. check out 36 solutions. Let us give an example of one such task with six "solutions".

Task. The triangle ABC has the value of the angle A equal to 75°, the value of the angle B is 45°. Is it true that the points symmetric to the orthocenter H (the point of intersection of heights) relative to the sides of the triangle ABC are the vertices of a right-angled triangle?

Solution 1.

The points symmetric to the orthocenter of the triangle ABC lie on the circumscribed circle. The triangle MNK is similar to the triangle XYZ with the similarity factor 2. The heights of the triangle ABC are the bisectors of the orthic triangle XYZ. Because of their similarity, they will be bisectors for the triangle MNK. Therefore, the arc MB will be equal to the arc BN. The right-angled triangle

BXC has the angle B equal to 45°. Hence, the angle CSB is also equal to 45°. If O is the center of the circle, then the angle MOV is right, since it rests on the same arc as the inscribed angle XCB=MSW. The angle BON is also right, since it is equal to the angle MOV. It follows that the center O lies on the segment MN, that is, MN is the diameter. The angle MKN, resting on it, is right.

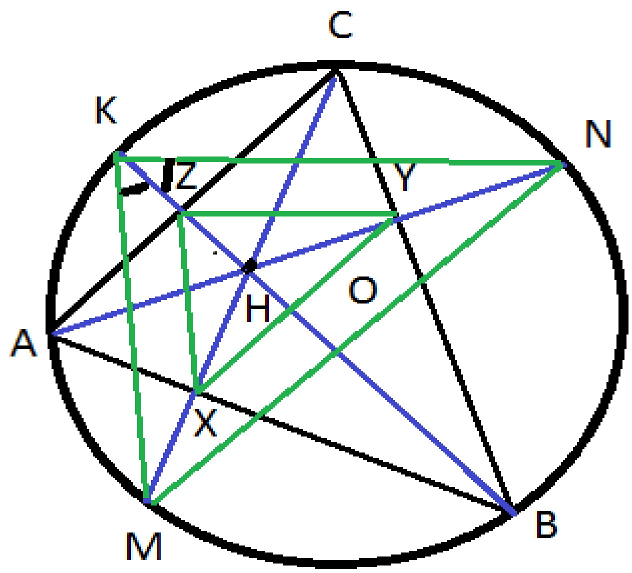

Fig. 2. Solution No.1

Answer: yes.

Solution 2.

Let $A_1 B_1 C_1$ be an orthic triangle, and A_2, B_2, C_2 be the points symmetric to the orthocenter H relative to the sides of the triangle ABC. These points lie on the circumscribed circle of the triangle ABC.

$B_2||A_1 B_1$, $B_2C_2||B_1C_1$. Consequently, the angle B_2B is equal to the angle $A_1 B_1B$, the angle B_2B is equal to the angle $C_1 B_1B$. Since these angles are equal to each other, the central angles A_2OB и C_2OB will also be equal. If the angle B is equal to 45°, then the angle BAA_1 is also equal to 45°, since BA_1 is the height of the triangle ABC. Therefore, the angle $BB_2A_2(=BAA_2)$ is also equal to 45°. Similarly, the angle $BB_2C_2(=BCC_2)$ is 45°. The sum of these angles will be a right angle.

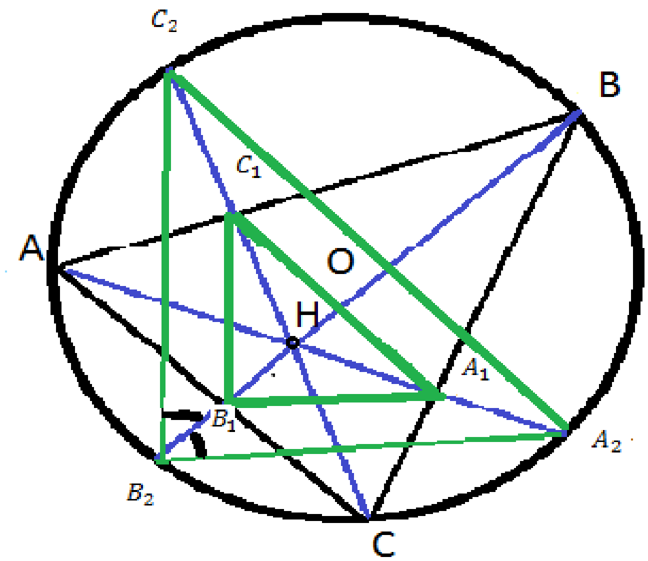

Fig. 3. Solution No.2

Answer: Yes.

Solution 3.

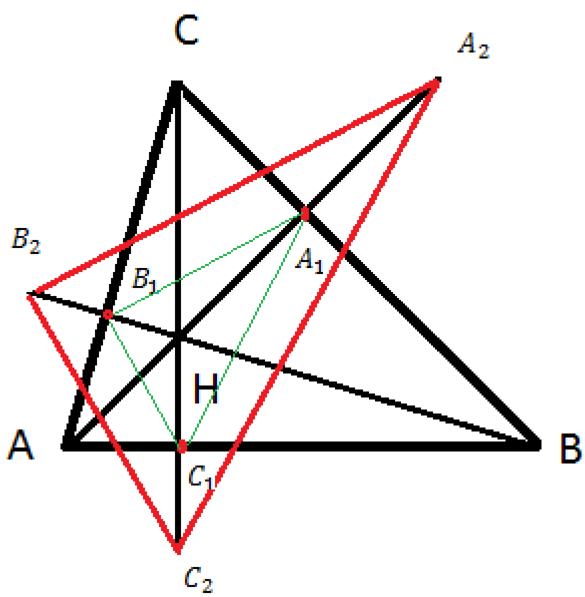

Fig. 4. Solution No.3

Let $A_1B_1C_1$ be an orthic triangle, $A_2B_2\,C_2$ be a triangle with vertices symmetric to the orthocenter H relative to the sides. The quadrangle AB_1HC_1 is inscribed, since it has two opposite right angles. Angles C_1B_1A and C_1HA are equal (as leaning on the same arc). Angles C_1HA and CHA_1 are equal as vertical. Similarly, in the inscribed quadrilateral CA_1HB_1, the arc CA_1 supports the angles CHA_1 and CB_1A_1. Hence, the angles C_1B_1A and CB_1A_1 are equal. Consequently, the angles CB_1H and A_1B_1H are also equal. Each of these angles is equal to the angle B. Hence, the angle $C_1B_1A_1$ is equal to $45^{\circ}+45^{\circ}=90^{\circ}$. The angle $C_2B_2A_2$ is equal to it. Consequently, the triangle $A_2B_2\,C_2$ is rectangular.

Answer: yes.

Solution 4.

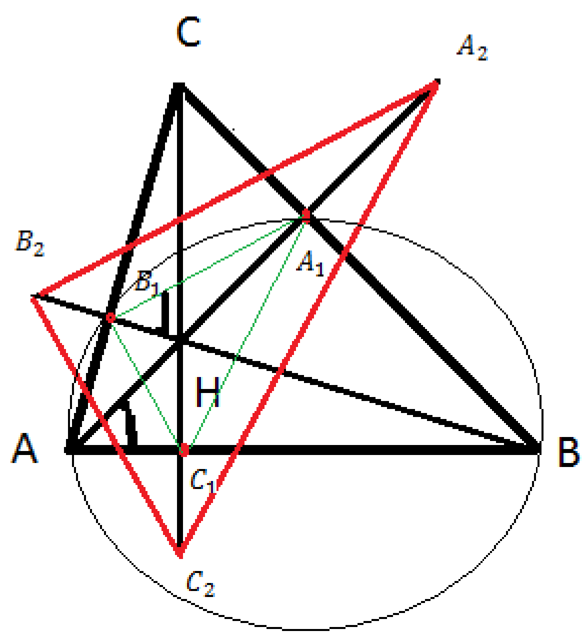

Fig. 5. Solution No.4

The quadrangle AB_1A_1B is inscribed. The circumscribed circle is constructed on AB as on a diameter. Angles A_1B_1B and A_1AB are equal (lean on the arc A_1B).

Since AA_1 is the height, then in a rectangular triangle AA_1B with angle B of 45° degrees, the angle A_1AB will also be equal to 45°. That is, the angle A_1B_1B will be equal to A_1B_1B. By analogy, the angle C_1B_1B will be equal to the angle C. Its value will be equal to $180^\circ - 45^\circ - 75^\circ = 60^\circ$.

That is, the angle $A_1B_1C_1$ will be equal to 105°. The triangle $A_2B_2C_2$ is homothetic to the triangle $A_1B_1C_1$. Consequently, the angle $A_2B_2C_2$ is also equal to 105°. Therefore, it is obtuse.

Answer: no.

Solution 5.

The triangle ABC has the angles equal to $75^\circ, 45^\circ$ and 60°. A triangle, which vertices are symmetric to the orthocenter relative to the sides, will be similar to this one. Its angles will be equal to the angles of the triangle ABC. Hence, it will be acute-angled.

Answer: no.

Solution 6.

Let XYZ be an orthic triangle, M, N, K be points symmetric to the orthocenter with respect to the sides. These points must lie on the circumscribed circle of the triangle ABC. The line MC is the height of the triangle ABC. So, it divides the angles YXZ and NMK in half. The angle KBC is equal to the angle KMC (arc KC). Its value is half the angle KMN. Similarly, the value of the angle ABK is equal to half the angle KNM. Hence, the value of the angle ABC is equal to half of the sum of the angles KMN and KNM. The angle ABC is

$180^{\circ} - 45^{\circ} - 75^{\circ} = 60^{\circ}$.

Hence, the sum of the angles KMN and KNM is equal to $180^{\circ} - 120^{\circ} = 60^{\circ}$. The angle MKN is equal to 120°.

Similarly, the angle KNM will be equal to

$180^{\circ} - 75^{\circ} = 105^{\circ}$.

There is an obtuse angle, so the triangle MNK is obtuse.

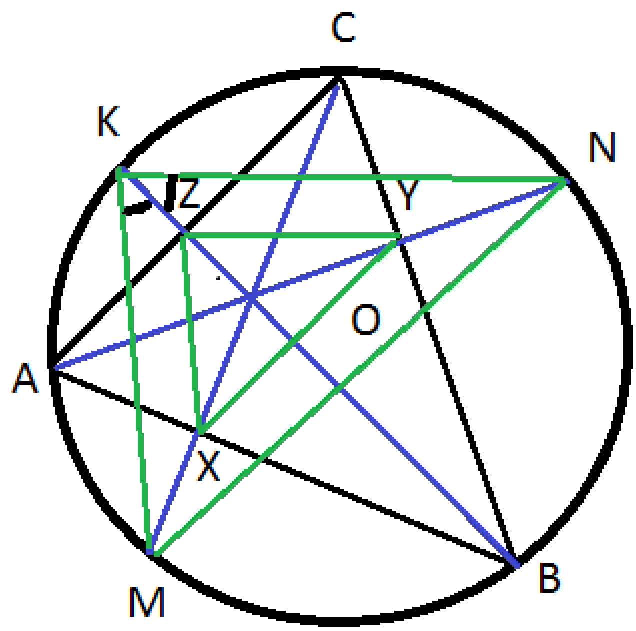

Fig. 6. Solution No.5

Answer: no.

The solution of each problem is evaluated according to several particular criteria, such as the presence of logical errors, unreasonable conclusions, technical errors associated with incorrect calculations or inattention. Each solution requires its total assessment. According to this general assessment, the student's rating is determined, based on which the program assigns him/her the solution of the following task. Thus, the student who got the highest score from the "teacher" for the first task "gives out" one of the best solutions to the second task, and vice versa, the student who got the smallest score would be the author of one of the worst solutions for the second time.

Similarly, the program works with the following tasks. Solutions of the first task are assigned to students in a pseudo-random way. These features of the algorithm are not reported to students. The work of the "teacher" is evaluated by the coincidence of the overall assessment of each task and by the coincidence of the particular criteria pre-set in the program. The program has an option of limiting the test time by the teacher. At the end of the test, the results of all students and the final score earned by the teacher are displayed on the screen. With the correct work of the teacher, the results of the students in the described algorithm should be stabilized, i.e. “well-advanced" and “slow-advanced" should be identified. In addition, the total score given to the teacher immediately provides information about the quality of checking the student's performance (see Fig. 7).

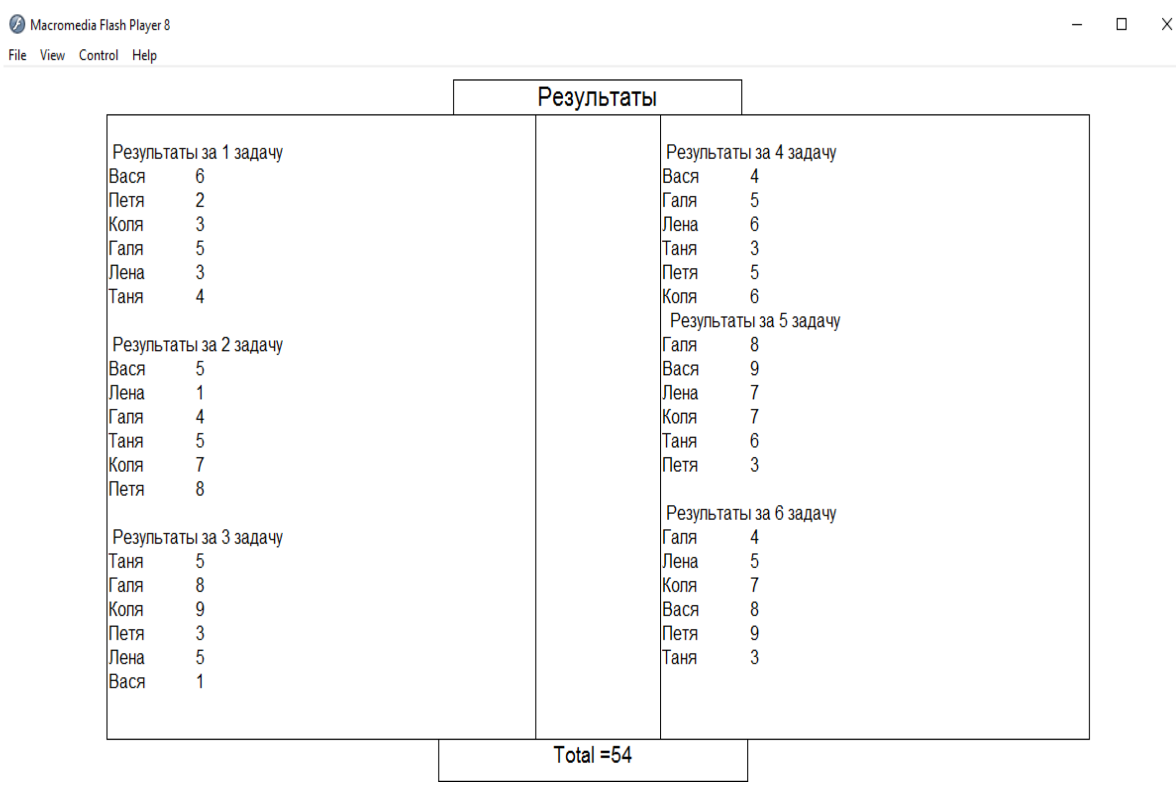

Fig. 7. Total score output screen.

Results.

The tasks in the block selected by us are chosen in such a way that the information from elementary mathematics not always studied in detail at school is solidified simultaneously. For example, the problems of a combination of circles and polygons use the property of the degree of a point with respect to a circle, and some properties of the orthic triangle. The same problem can be solved by different "students" both by analytical and synthetic methods.

The drawings to the same task made by different "students” also vary, but in general, this way of testing a student is aimed at identifying and developing, mainly, his/her methodological preparedness in the subject. It assumes the possibility of passing the test simultaneously by a group of students. The proposed approaches were tested in preparation for the pedagogical practice of mathematics students at Naberezhnye Chelny Pedagogical University and Elabuga Institute of KFU. The simulator was also tested by the students of the advanced training courses at Elabuga Institute of KFU. Some results of testing are shown in Table 1.

Table 1. Results of testing students and teachers on the simulator

Test group	Mean value (%) of correct general estimates of works	Mean value (%) of correctly defined partial criteria
2nd year students	52	33
5th year students (Double Master Degree Program)	73	48
Postgraduate course attenders	89	86

Discussion.

It is worth noting that teachers in general show higher performance on the simulator, but the time limitation significantly worsens their results. while the same time limitation insignificantly affects the results of the students.

We believe that it is necessary to develop a cycle of such simulator programs for secondary school mathematics courses. The scenario described in this paper can be subjected to several modifications, leading to the identification of already psychological characteristics of the future teacher. For example, with the same number of "students" in the class, we increase the bank of solutions. Then, even with relatively successful test results, some teachers can help all "students" become straight-A students, and other teachers can make them C-level students.

The conducted experiment showed the effectiveness and consistency of the application of the simulation method in the process of training future teachers of mathematics. The virtual simulators used during the training allow us to assess not only the students' preparedness for future pedagogical activity, but also to determine the quality of the teacher's work. In general, it should be noted that the use of virtual subject simulators contributes to strengthening the pedagogical potential of students, as well as improving the teaching skills of teachers.

CONCLUSIONS.

As the results of the experiment show, the use of the simulator helps to quickly and effectively diagnose the preparedness of students for the upcoming pedagogical practice. However, in our opinion, in order to improve the psychological and pedagogical competencies, a simulator is also useful, helping the "teacher" to practice their “introduction" in various problematic pedagogical situations.

In order to be ready to react adequately to some contingencies, frequent in the educational process, one needs to have a set of options for action, i.e. reactions to the circumstances. Of course, it is impossible to think ahead about each nuance, but the future teacher should have at least some explicative tools in his/her baggage of knowledge.

To create such a simulator, a bank of pedagogical situations and variants of their solutions is created, the source of replenishment of which is student pedagogical practice at school. Thus, we see the prospect of expanding the functional of the simulator, as well as the development of its network version, which would allow for more flexible conduct and evaluation of psychological and pedagogical research.

Acknowledgements.

The work is performed according to the Russian Government Program of Competitive Growth of Kazan Federal University.

BIBLIOGRAPHIC REFERENCES.

1. Anisimova, T. I. (2015). Forming Bachelors Labor Actions in Teacher Training When Studying Disciplines of Mathematical and Natural Science Cycle. IEJME-Mathematics Education, 10(3), 157-165.
2. Carrington, L., Kervin, L., & Ferry, B. (2011). Enhancing the development of pre-service teacher professional identity via an online classroom simulation. Journal of Technology and Teacher Education, 19, 351-368.
3. De Jong, T., Lane, J., & Sharp, S. (2012). The Efficacy of Simulation as a Pedagogy in Facilitation Pre-Service Teachers' Learning about Emotional Self-Regulation and its Relevance to the Teaching Profession. Australian Journal of Teacher Education, 37(3), 34-43.
4. Drews, F. A., & Backdash, J. D. (2013). Simulation training in health care. Reviews of Human Factors and Ergonomics, 8, 191-234.
5. Girod, M., & Girod, G. R. (2008). Simulations and need for practice in teacher preparation. Journal of Technology and Teacher Education, 16(3), 307-337.

6. Hixon, E., & So, H.-J. (2009). Technology's role in field experiences for preservice teacher training. Educational Technology & Society, 12, 294-304.
7. Kostin, A. V., & Kostina, N. N. (2016). An interpretation of Casey's theorem and of its hyperbolic analogue. Siberian Electronic Mathematical Reports, 13, 242-251.
8. Kostin, V., & Sabitov, I. Kh. (2014). Smarandache Theorem in Hyperbolic Geometry. Journal of Mathematical Physics, Analysis, Geometry, 10(2), 221–232.
9. Power, D., & Sharda, R. (2007). Model-driven decision support systems: Concepts and research directions. Decision Support Systems, 43(3), 1044– 1061.
10. Seppanen, M. S., & Kumar, S. (2002). Using simulation to teach business process design and improvements. Proceedings of the 2002 Winter Simulation Conference, 1809-1814.
11. Sharma, M. (2015). Simulation Models for Teacher Training: Perspectives and Prospects. Journal of Education and Practice, 6(4).

DATA OF THE AUTHORS.

1. Andrey V. Kostin: Kazan Federal University

2. Natalya N. Kostina: Kazan Federal University

3. Aleksandr V. Minkin: Kazan Federal University

4. Ellina S. Anisimova: Kazan Federal University. Email: ellin_a@mail.ru

RECIBIDO: 9 de septiembre del 2019. **APROBADO:** 23 de septiembre del 2019.