МАТЕМАТИКА И МАТЕМАТИЧЕСКО ОБРАЗОВАНИЕ, 2016
MATHEMATICS AND EDUCATION IN MATHEMATICS, 2016
Proceedings of the Forty Fifth Spring Conference
of the Union of Bulgarian Mathematicians
Pleven, April 6–10, 2016

THE GAME "GEOMETRY SCRABBLE IN CLOUD" AN ORGANIZATIONAL FORM OF THE INTERNATIONAL STUDENT RESEARCH GROUPS*

Maria Shabanova, Rosa Atamuratova, Marina Belorykova, Veselin Nenkov, Maria Pavlova

Today the provisions of many competitions encourage cooperation of students from different countries. The international competition "Mathematics and projecting" isn't an exception. For the tenth competition, the organisers have offered to submit projects led by student research groups, which include students from three countries: Bulgaria, Kazakhstan and Russia. The purpose of this paper is to present one organisational form of collaboration between geographically distributed groups of young researchers. It is an organisational-activity game. The idea was borrowed from the game "Scrabble", which is well-known in many countries. The paper describes the rules of the game and the example of its use. Here the interim results of the game for the group of 9 students from three countries, Bulgaria, Kazakhstan and Russia, are also presented.

1. Introduction. The international competition "Mathematics and projecting" celebrates its 10th anniversary in 2016. The organisers of the competition proposed establishing international student research groups for the preparation for the competition. This competition is part of a Russian - Bulgarian and Kazakhstan project "Methods and information technologies in education". For this reason, students from all three countries, participating in the project, were included in the research groups. The organization of teamwork of students from different countries has become one of the problems for the authors' thesis paper. Another problem for us was to find ways of using computer tools in the research carried out by students. Traditionally, students use dynamic geometry software for solving research tasks (GeoGebra, Geometer's Sketchpad et.). We decided to add cloud services to this set for complex solution of these problems. It became possible, due to the emergence of cloud services that include dynamic geometry software as applications. Google cloud service is an example. It includes GeoGebra as one of its applications.

2. The game rules. We proceed to describe the rules of the organisational-activity game "Geometry Scrabble in cloud". The idea of this organizational-activity game was borrowed from the game "Scrabble". The selection of this particular game was determined by two factors.

*Key words: organizational-activity game, Google cloud service, GeoGebra, Geometer's Sketchpad, international student research groups..

1. The term “Scrabble” means to “rummage in search of something”. The term implies that the participants will “rummage” in the search of ways to solve the problem, in the search of new tasks, in the search of more information about the theoretical basics and the history of tasks.

2. This game is well-known to people from many countries. The participants of the game will find it easy to understand the game rules.

Figure 1 shows the game board of “Geometry Scrabble in cloud” . It was created using Google Spreadsheets.

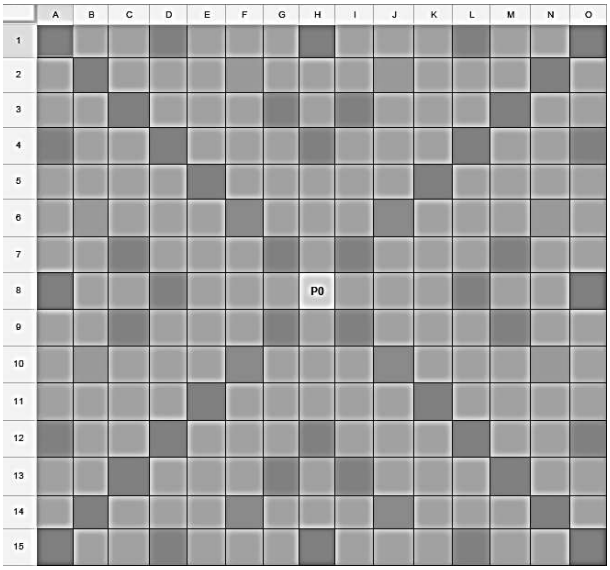

Fig. 1. Game board of “Geometry Scrabble in cloud”

The Coordinator of the game places the starting problem (P0) in the middle of the game board as a footnote. Students must solve this problem and put a new problem in a neighboring cell of the board. If the new problem (P1) is a generalization of P0, it takes the position I8. If the new problem (P1) is a modification of the geometry construction which is described in P0, it takes the position H7. If the new problem (P1) is a new question about the geometry construction which is described in P0, it takes the position H9. If the new problem (P1) is an especially interesting case of P0, it takes the position F8. Now, the students can solve the problem P1, or create new tasks, which are the modification of either P0 or P1. They have to put new problems in the cells of the game board according to the rules, as described above.

The participants get points when they create or solve a problem. The number of points for the created problems is determined by the color of the cell. If the cell color is grey or green, they get 1 point. They receive 2, 3, 4 or 5 points if the cell color is blue, pink, dark blue or red, respectively. The number of points awarded for solving problems

is determined by task complexity and the beauty of the solution. They can earn from 5 to 20 points for solving problems.

Every participant of the team can get extra points. The teams get extra points, if they replenish the collection of *additional results*. Additional results are defined as the use of historical or application information, description of theoretical basics of problem solving and computer visualization. The team earns from 1 to 5 extra points for theoretical, historical or application information, one extra point goes for computer visualization.

The game stops at specified day and time. The winning team gets a prize.

3. Interim results of the game. We formed three teams of students for the game "Geometry Scrabble in cloud": 3 students from each of the participating countries, Bulgaria, Kazakhstan, and Russia. The game started on 15 September 2015. An account on Google Disk was prepared for it (Fig. 2).

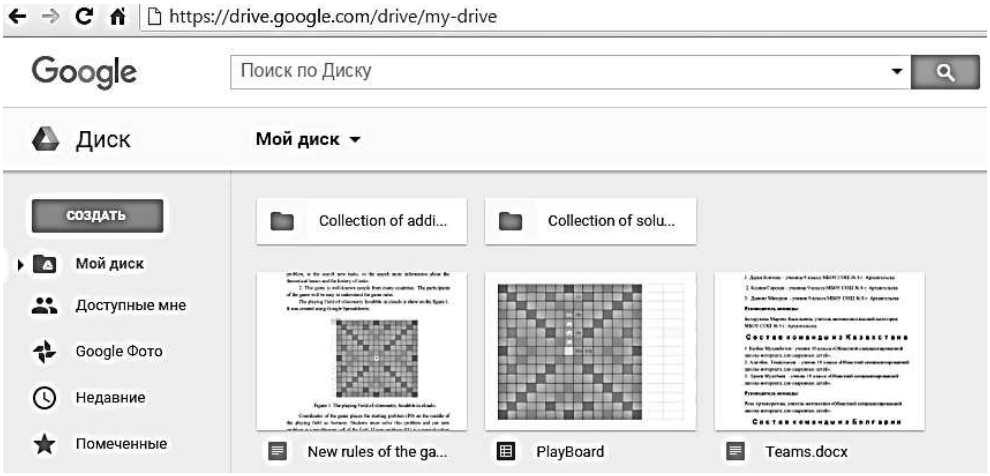

Fig. 2. Cloud service for the game "Geometry Scrabble in cloud"

The Coordinator of the game used the following problem as task P0: "Segment AB is divided by point C into two parts. Triangles AMC and CNB are constructed on each of these parts. Points M and N lie in the same half-plane relative to AB. After that, CT – bisector of the triangle MCN was constructed. Find the locus of points T, in relation to the movement of the point C".

The Russian team uploaded the computer solution of P0 on 28 September 2015 and got 1 point (Fig. 3). This team found the equation of the locus for a fixed length of the segment.

On October, 4th they presented an analytical solution for P0; additionally they created tree new problems (P1, P2, P3 on Figure 2).

P1: "Segment AB is divided by point C into two parts. Right triangles AMC and CNB are constructed on each of these parts. Points M and N lie in the same half-plane relative to AB. After that, C – *the height* of the triangle MCN is constructed. Find the locus of points T in relation to the movement of the point C".

P2: "Segment AB is divided by point C into two parts. Right triangles AMC and CNB are constructed on each of these parts. Points M and N lie in the same half-plane

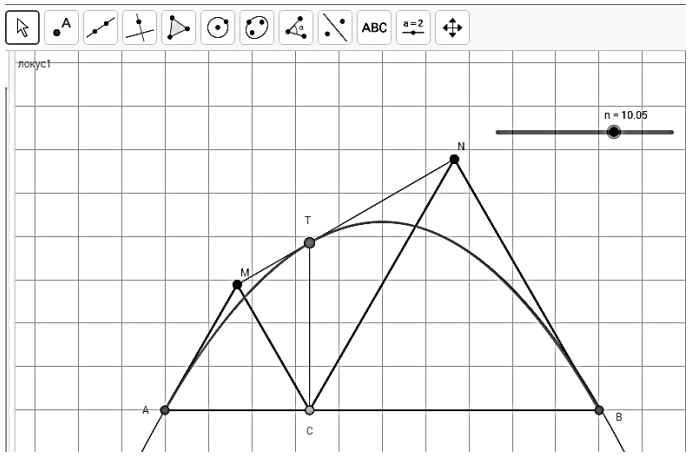

Fig. 3. The computer visualization for solution of Problem P0

relative to AB. After that, C – *the median* of the triangle MCN is constructed. Find the locus of points T in relation to the movement of the point C".

P3: "Segment AB is divided by point C into two parts. Right triangles AMC and CNB are constructed on each of these parts. Points M and N lie in the same half-plane relative to AB. After that, CP – *chord, which connects the intersection points of the circles c and w* (circumcircles of triangles and CNB) is constructed. Point T *is the point of intersection of line* CP *and segment* MN. Find the locus of points T in relation to the movement of the point C".

The Russian team received 10 points (7 points for the solution of P0 and 3 points for creating new problems).

The Kazakhstan team sent solution of P0 on 14th October 2015, but their solution was erroneous. They didn't get points for that solution. They created two new problems (P4, P5) on October, 16th.

P4: "Segment AB is divided by point C into two parts. Right triangles AMC and CNB are constructed on each of these parts. Points M and N lie in the same half-plane relative to AB. After that circumcircles of triangles and CNB and SP – common tangent to these circles are constructed. Point T is point *of intersection of lines* SP *and* MN. Find the locus of points T in relation to the movement of the point C".

P5: "Segment AB is divided by point C into two parts. Right triangles AMC and CNB are constructed on each of these parts. Points M and N lie in the same half-plane relative to AB. After that circumcircles of triangles and CNB and SP – radical axis intersecting circles. Point T is point *of intersection of lines* SP *and* MN are constructed. Find the locus of points T in relation to the movement of the point C".

Kazakhstan team received 3 points, because P4 was created in the blue cell. Then on October, 18th the Kazakhstan team sent solution for P2. This solution was correct. They got extra 7 points. They also sent two new computer visualizations and received 2 more points.

The Bulgarian team sent information later than all the other participants (on November

9th), but it was a very interesting information. They sent many new problems with solutions.

P6 (generalization of the P0): "Segment AB is divided by point C into two parts. Right triangles AMC and CNB are constructed on each of these parts. Points M and N lie in the same half-plane relative to AB. After that *line MN and point T, put on it, such that* $\frac{MT}{TN} = k\frac{MC}{CN}$, *where $k \neq 0$ is arbitrary real number* are constructed. Find the locus of points T in relation to the movement of the point C".

P7 (generalization of the P6): "Segment AB is divided by point C into two parts. *Isosceles triangles AMC* and CNB are constructed on each of these parts. Points M and N lie in the same half-plane relative to AB. *Triangles AMC and CNB have angles at the base, equal α and β, respectively.* After that line MN and point T put on it, such that $\frac{MT}{TN} = k\frac{MC}{CN}$, where $k \neq 0$ is arbitrary real number are constructed. Find the locus of points T in relation to the movement of the point C".

P8 (generalization of the P2). "Segment AB is divided by point C into two parts. *Isosceles triangles AMC* and CNB are constructed on each of these parts. Points M and N lie in the same half-plane relative to AB. *Triangles AMC and CNB have angles at the base, equal α and β, respectively. After that line MN and point T put on it, such that* $\frac{\overline{MT}}{\overline{NT}} = k$, *where $k \neq 0,\ 1$ is arbitrary real number are constructed.* Find the locus of points T in relation to the movement of the point C".

P9 (generalization of the P4). "Segment AB is divided by point C into two parts. *Isosceles triangles AMC* and CNB on each of these parts are constructed. Points M and N lie in the same half-plane relative to AB. *Triangles AMC and CNB have angles at the base, equal α and β, respectively.* After that circumcircles of triangles and CNB and SP – common tangent to these circles are constructed. Point T is point of intersection of lines SP and MN. Find the locus of points T, in relation to the movement of the point C".

P10 (generalization of the P5). "Segment AB is divided by point C into two parts. *Isosceles triangles AMC* and CNB on each of these parts are constructed. Points M and N lie in the same half-plane relative to AB. *Triangles AMC and CNB have angles at the base, equal α and β, respectively.* After that circumcircles of triangles and CNB are constructed. Point P is second point of intersection of the circles. Point T is point *of intersection of lines CP and MN.* Find the locus of points T in relation to the movement of the point C".

P11 (generalization of the P1). "Segment AB is divided by point C into two parts. *Isosceles triangles AMC* and CNB on each of these parts are constructed. Points M and N lie in the same half-plane relative to AB. *Triangles AMC and CNB have angles at the base, equal α and β, respectively.* After that, *C – the height* of the triangle MCN is constructed. Find the locus of points T in relation to the movement of the point C".

The Bulgarian team presented the solutions of all these problems. Some of problems were complicated for the students. The students had to learn more about curves to solve them. Moreover, they offered to solve problem P12 to everyone.

P12. "Segment AB is divided by point C into two parts. *Isosceles triangles AMC* and CNB on each of these parts are constructed. Points M and N lie in the same half-plane relative to AB. *Triangles AMC and CNB have angles at the base, equal α*

and β, respectively. After that, points H, G and O – orthocenter, enter of gravity and circumcenter for *triangle* MNC are constructed. Find locuses of the points H, G and O in relation to the movement of the point C. Is there a relationship between their locuses?".

Bulgarian team got 99 point for solving the problems.

4. Summary. The game is not finished yet. But it is now clear that its idea is very productive. We hope that the teams will create and solve a lot of problems. The team leaders are reporting that the students find this game interesting.

Maria Shabanova
e-mail: :m.shabanova@narfu.ru
Maria Pavlova
e-mail: m.pavlova@narfu.ru
Northern (Arctic) Federal
University M. V. Lomonosov
Severnaya Dvina Emb. 17
163002 Arkhangelsk, Russia

Roza Atamuratova
Regional special boarding school
for gifted children with profound
studying of different subjects
32b microdistrict
130000 Aktau, Kazakhstan
e-mail: r.atamuratova@mail.ru

Marina Belorukova
Public Secondary school № 8
30, Avenue Obvodni kanal
163046 Arkhangelsk, Russia
e-mail: marina.9149@yandex.ru

Veselin Nenkov
Technical College Lovech
31, Sajko Saev Str
5500 Lovech, Bulgaria
e-mail: vnenkov@mail.bg

ИГРАТА "ГЕОМЕТРИЧЕН SCRABBLE В ОБЛАЦИТЕ" КАТО ОРГАНИЗАЦИОННА ФОРМА ЗА МЕЖДУНАРОДНА ИЗСЛЕДОВАТЕЛСКА ГРУПА УЧАЩИ СЕ

Мария Шабанова, Роза Атамуратова, Марина Белорукова, Веселин Ненков, Мария Павлова

Понастоящем много конкурси поощряват провеждането на съвместни изследвания на учащи се от различни страни. Международният конкурс „Математика и проектиране“ не се явява изключение. На десетия конкурс организаторите предложиха да се представят проекти, подготвени от групи участници, в които влизат представители от три страни: България, Казахстан и Русия.

Целта на статията е да се представи формата на организация на взаимодействие между географски разпределени групи от млади изследователи. Идеята ѝ е заимствана от играта "Scrabble", която е известна в много страни. В статията са представени правилата на играта и пример за нейната реализация. Тук също са представени промеждутъчни резултати от съвместните изследвания на учащите се от трите страни: България, Казахстан и Русия.

Ключови думи: организационна дейност на игра, облачна технология Google, GeoGebra, Geometer's Sketchpad, международна изследователска група.