Competitions in knowledge via world wide web as a way of teaching and learning science

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Abstract. *At Faculty of electrical engineering the competitions in space visualisation via world wide web have been organised since 1999. It is possible to participate at school competitions, national competitions and on International Space Visualisation Olympiad. Last years we added International Olympiad in Mathematical Logic, Competition in Symmetry Recognition and Competition in recognition of Slovenian settlements and mountain peaks. The competition could be used by teachers for homework and marking, students could use them for self-marking their knowledge and abilities. Such tests are very economic if the number of participants is large enough.*

Keywords. Competition in knowledge, geography, logic, space visualization, world wide web.

1. Introduction

There is a long tradition in organising competitions for students of different parts of knowledge in Slovenia. These competitions are primarily intended for gifted students. The spirit of competition is a very strong motivation, which could hardly be achieved in any other form of education. Most of the talented high students cannot read scientific text, follow long deductive sequences or work abstractly. On the other hand problems posed on competitions are challenging and many of them are even reasonable for common student. So our intention was to make a large set of computer generated problems from different parts of science to be constantly available to students. Maintaining lists of competitors for each school it is even possible to use competitions for tests and homework (using pseudonym). Since we provide lists for each country and each Slovenian school the competition are open to a large population.

Figure 1, International Space Visualization Olympiad

On the other hand the use of Internet as a medium is of relatively new date even if we look at world wide situation. So far we organise four competitions that cover different parts of knowledge and skills Figs. 1, 2, 3, 4[4].

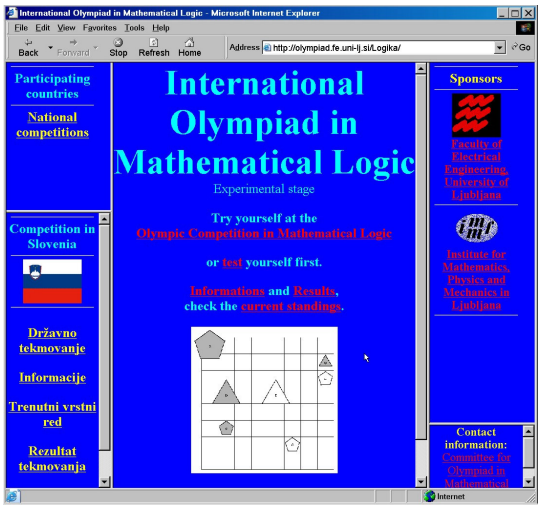

Figure 2, International Olympiad in Mathematical Logic

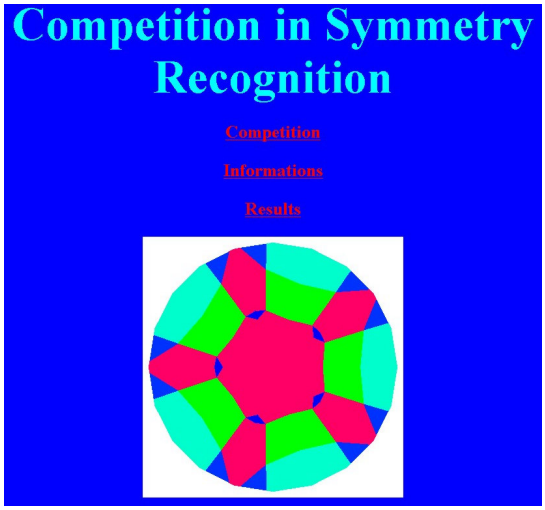

Figure 3, Competition in Symmetry Recognition

The science that is involved in producing problems and in organisation ranges from computer science which is responsible for realisation to specific sciences: geometry, mathematics, logic, linguistics and geography.

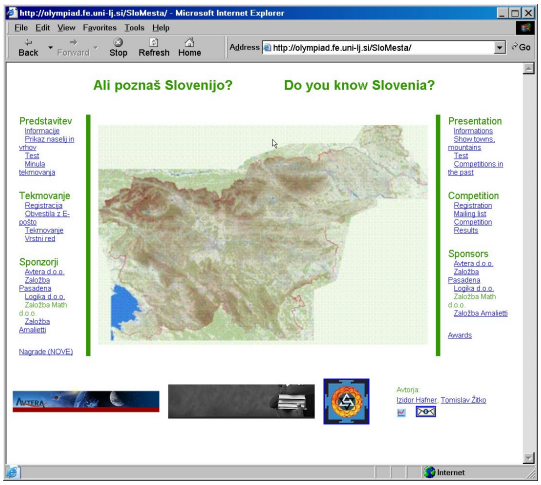

Figure 4, Competition in recognition of Slovenian settlements and mountain peaks

2. International Space Visualisation Olympiad

In the note [3] we presented two types of problems on polyhedral nets. Such problems were used on *National competition in recreational mathematics* [2] and were intended for gifted pupils and high school students. To test spatial abilities of an average student more basic type of problems should be used. For a polyhedron net this means that student should indicate which sides of the net should be glued together to form the polyhedron. So the task is to present this well known problem in an attractive form. The problems shown bellow are also available as Java applets and we are planing to make a standard space visualisation test from them.

A polyhedron net is a polygon whose sides should be glued in pairs to get an edge of the polyhedron. So the basic problem is to find all pairs of corresponding sides (Fig 5). Of course at the same time we glue vertices of the polygon into vertices of the polyhedron. So the second problem is to indicate vertices that belong to the same solid vertex.

At the first problem the faces of the polyhedron are subdivided into isosceles triangles having edges as base lines and the centre as a vertex. Since each edge is the base of two triangles both will be coloured by the same colour. So the number of colours equals the number of edges. On the net only one triangle of each pair will be coloured. The task is to colour the other triangle.

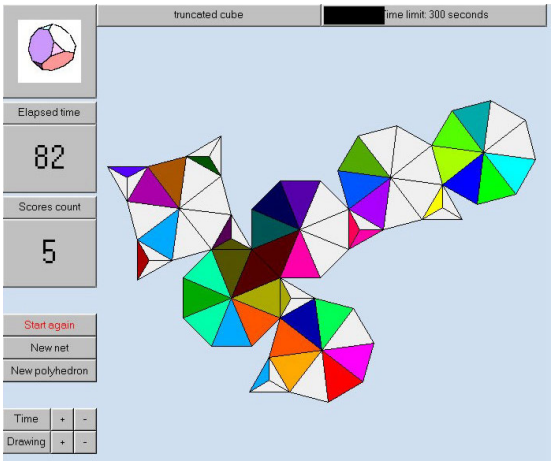

Figure 5, Colouring edges

Coloured solids - instructions: The faces of a solid are coloured by different colours. The faces of the solid are then divided on smaller polygons and the "new" solid is developed into a net (Fig 6). The colour of only one polygon of each face is given. The task is to

colour all parts of a face with the same colour. This is accomplished by click on coloured part first and then on yet uncoloured part (or parts) of the same face. There is a penalty of 10 seconds for each wrong guess.

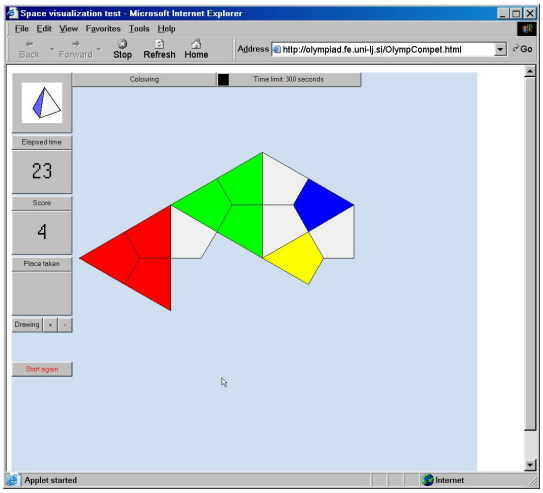

Figure 6, Colouring faces

The task is to solve as many labyrinths on a set of random polyhedral nets as possible in 5 minutes (Fig. 7). There is no limit on the number of entrances. Each labyrinth is an exercise to find the path from the black to the red spot on a given random net of selected polyhedron. The available move is to proceed from current face (designated by green point) to adjacent face on polyhedron. But such a face must not be connected with current face by dark line. In case you find yourself on wrong path, you should go back (by clicking backward without making a mistake). The last clicking point is the red one. The penalty for each wrong guess is 10 seconds.

The basic problem was to generate a large amount of geometrical solids, their nets and labyrinths. For this purpose we used *Mathematica* programming environment, especially the *Combinatorica* package. A typical problem is to find two most distant points in a labyrinth. This problem involve finding spanning tree in a graph. A geometric solid is represented by the graph of faces, where connection of faces means a common edge.

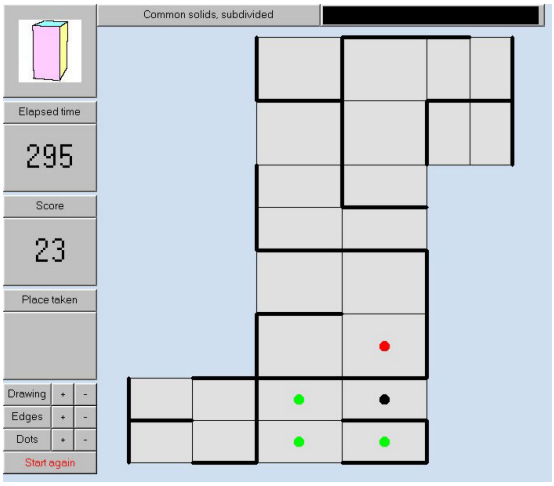

Figure 7, A labyrinth on a rectangular solid

3. International Olympiad in Mathematical Logic

The task is to find the truth value of up to 100 statements in randomly chosen world of figures in less than 7 minutes. The penalty for wrong answer is 20 seconds. Your answer must be correct to continue. Except for the first discipline there is a switch »hide world«, »show world«. If the world is shown, time runs two times faster. For answering you may use N and M on keyboard. Pressing »start again« stops the current trial and begins new one with no need to fill the form. The world of figures uses basic ideas of Tarski's World by J. Barwise and J. Etchemendy [1]. We use only two dimensional geometric figures: triangles, squares, pentagons... A figure is small, medium or large. So a medium triangle is larger than a small pentagon. A figure is either white or grey. A figure is to the left of the other figure if the column of the first is to the left of the column of the later. Similarly a figure is above (bellow) the other figure. A sentence of the form »Either A or B« is true iff (if and only if) truth values of A and B are different. Sentence »A or B« is true iff at least one of A, B is true. Sentence »A and B« is true if both A, B are true. Sentence »If A, then B« is false iff A is true and B is false. Sentence »A if and only if B« is true iff A and B are of the same value. For individual

variables we use x, y and z. Note that the same figure could be assigned to different variables.

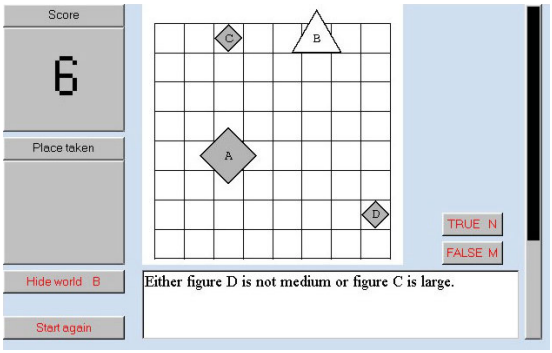

Figure 8, A world of figures

4. Competition in Symmetry Recognition

There are three disciplines: Recognition of Leonardo's group, recognition of frieze group and recognition of wallpaper group (plane crystallographics group) The task is to find the group of each of 20 randomly chosen figures in less than 5 minutes. The penalty for wrong answer is 20 seconds. Your answer must be correct to continue. Pressing »start again« stops the current trial and begins new one with no need to fill the form. Extra points are awarded if you finish before 5 minutes. Figures are generated by Mathematica notebook Plane Tiling by Xah Lee extended to cover Leonardo's and frieze groups. Here are some links that cover the content.

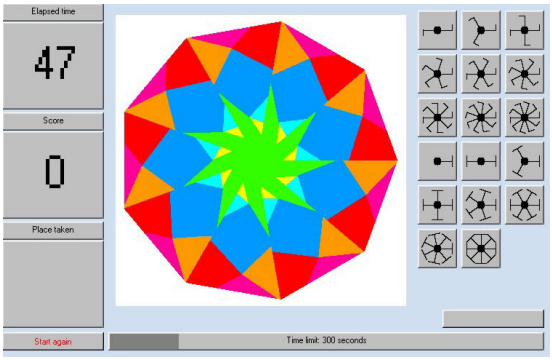

Figure 9, Leonardo's group

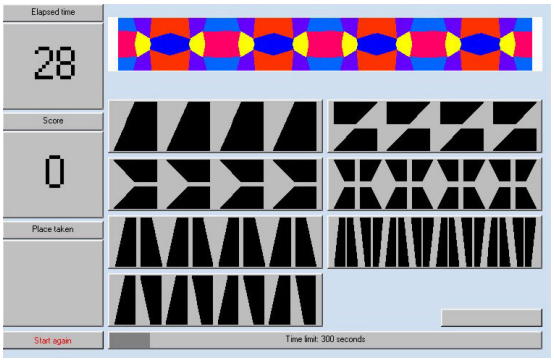

Figure 10, Frieze group

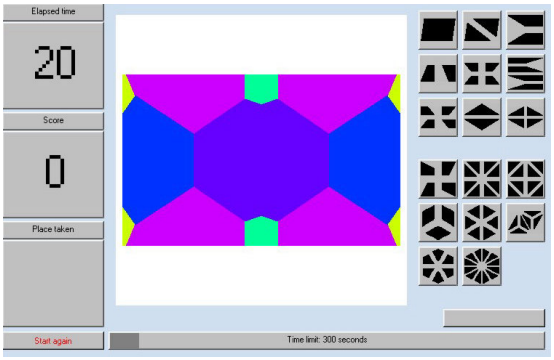

Figure 11, Wallpaper groups

We should mention that a discrete plane group is either Leonardo' s group, one of seven frieze groups or one of 17 wallpaper groups.

5. Competition in Recognition of Slovenian Settlements and mountain peaks

During 150 seconds names of 50 Slovenian towns or mountain peaks will be chosen in random order. You should click on the location of the town on the map. Each guess is awarded by 0 to 10 points. Best scores from towns and mountains are added together.

Data for this competition are scanned from existing maps. The same program could run a competition for any country if data are provided (A map, a list of place names with latitude and longitude).

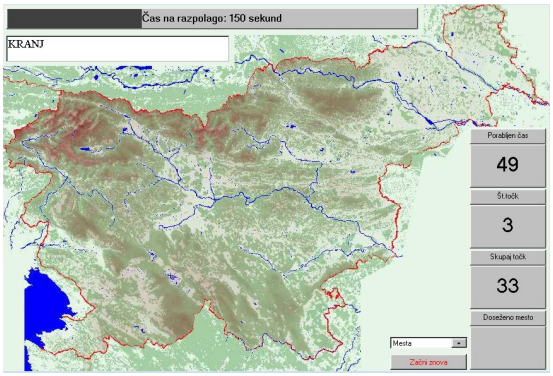

Figure 12, Slovenia

We also design a test for finding the world' s major towns. We use data from *Mathematica*.

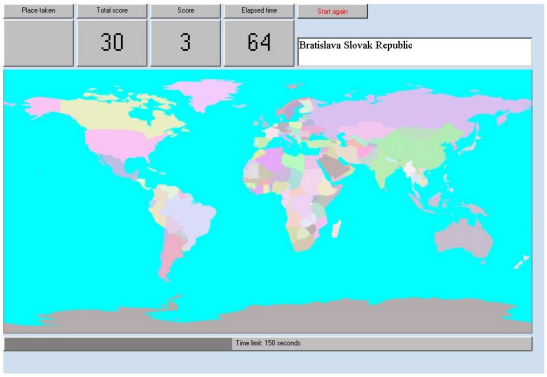

Figure 13, Positions of major world's cities

Our plan is to extend the competition to include rivers, cultural and natural attraction etc.

6. Conclusion

We presented four competitions via Internet from different parts of science. Our primary objective was to investigate possibility of organisation of such competitions. Although our initial target were skills such as common sense, geometrical insight, 3D-imagination, the ability of logical deduction, we found that other natural sciences (geography, biology) have even bigger potential to design an attractive Internet competition.

8. Acknowledgements

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9. References

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