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SCIENCE ON STAGE SWITZERLAND

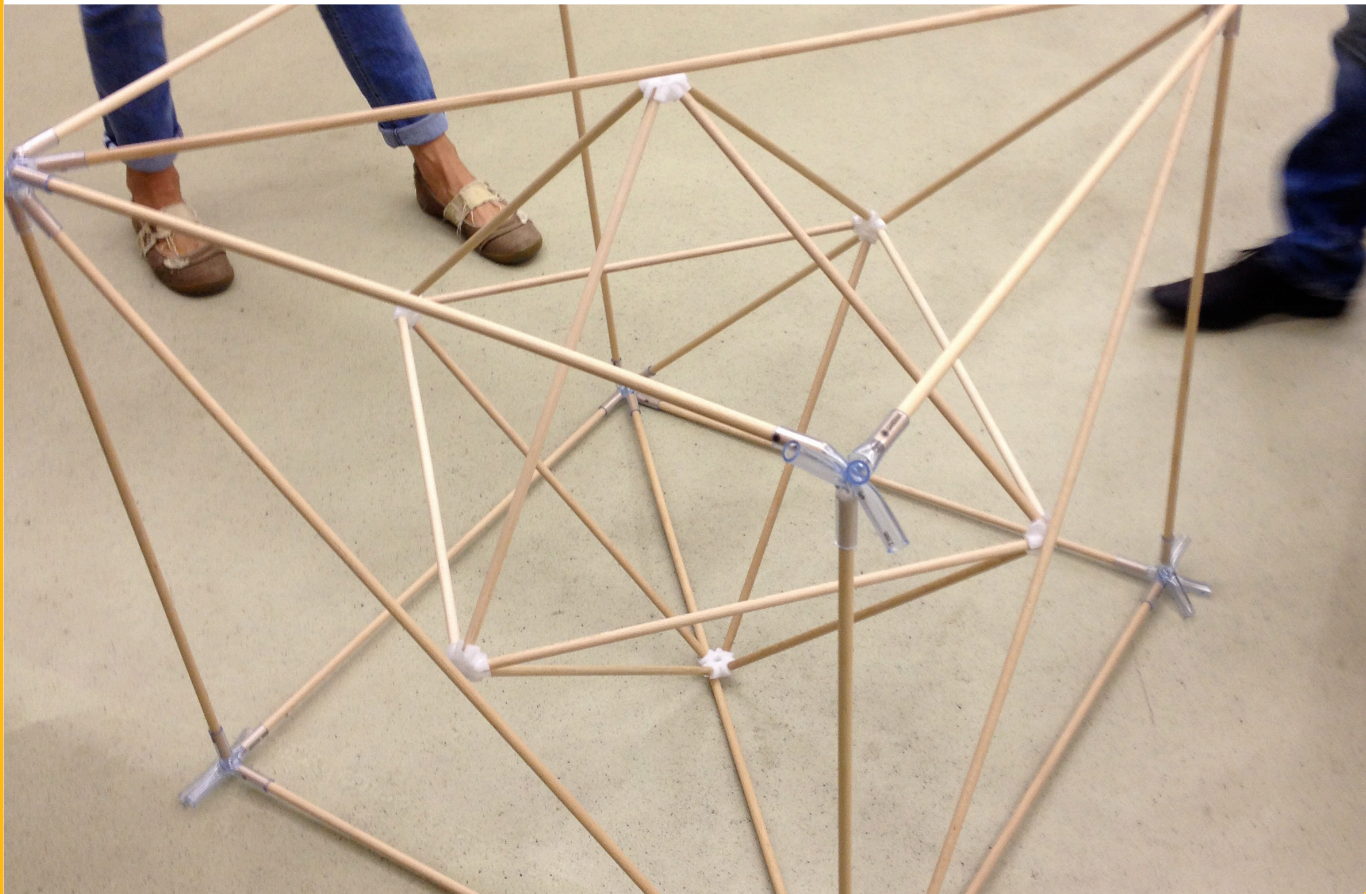
Learning by doing in mathematics

Tactile mathematics: How to help students develop a spacial understanding for complicated geometric structures

Keywords: polyhedra, manipulate, mathematics, experiment, geometry

Discipline: mathematics

Age level of students: primary to secondary schools, it depends how you use the materials



Conceptual introduction

Who was not intimidated by solid geometry? Drawing three dimensional objects on paper with all their geometrical characteristics is often a challenge for students. However with simple materials from a DIY store (Do It Yourself store) and the instructions which you will find in this teaching unit, you will find that geometry becomes more intuitive.

In this project we present different and innovative situations to reveal many mathematical conceptions. The various activities are based on discussions between students and also develop their manipulative skills. The purpose of our mathematical activities is to promote both collaborative and experimental ways of learning.

We use the platonic polyhedra to make mathematics attractive with some games like: 3D-Puzzles, giant constructions and origami folding moving solids.

In Switzerland we are working with a plan to teach mathematics, the 'Plan d'études romand', https://www.plandetudes.ch/web/guest/MSN_25/.

One of the goals in mathematics is to represent natural, technical and social phenomena as mathematical situations.

What the students do

1. BIG CONSTRUCTIONS (PICTURE 1)

The pieces of wood that are used for the edges of the big solids of Platon are bought in a DIY market. They have a length of 1 m and a diameter of 1 cm.
A flexible connector consists of PVC pipe (which can be bought by the methre in a DIY market), of 3 pieces (10-11 cm of length and internal diameter of 1 cm) that we cut out in the middle with an awl. You just have then to insert a screw there (type M4, 25 mm for example) and a nut (M4) to hold three pieces of pipe. We can obviously increase or decrease the number of the pieces of PVC pipe according to needs. (picture 2)

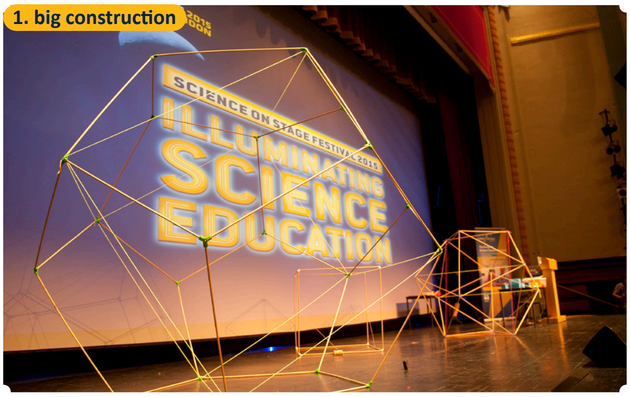
2. flexible connector

An alternative are stiff connectors made with a 3D printer. Our stiff connectors are files which are adapted to the diameter of 1 cm. It is necessary to increase however certainly the size of connectors (between 2 and 5%) at the time of launching the 3D printing, because the dilation of the filament when warming is to be taken into account. It depends on the type of used filament, on the precision of your 3D printer... It will be necessary for you to make trials to adjust them.

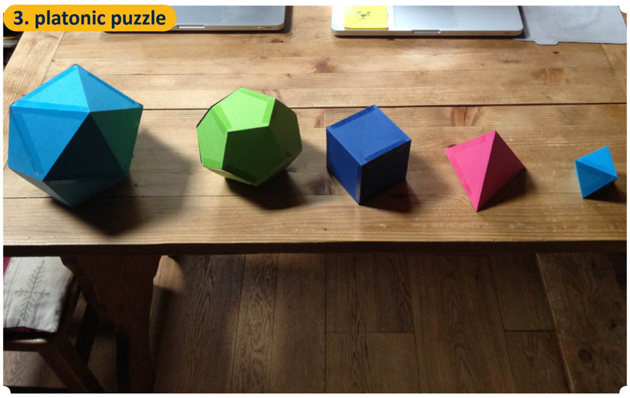
After that, you can do the five tasks in the pdf file (see under additional material: pdf file workshop learning by doing in mathematics). All the 3D files for rigid connectors are available for download.

2. PLATONIC PUZZLE (PICTURE 3)

Follow the step by step pdf file (see under 0-step by step) to construct the puzzle. All the files are available for download.



1. big construction

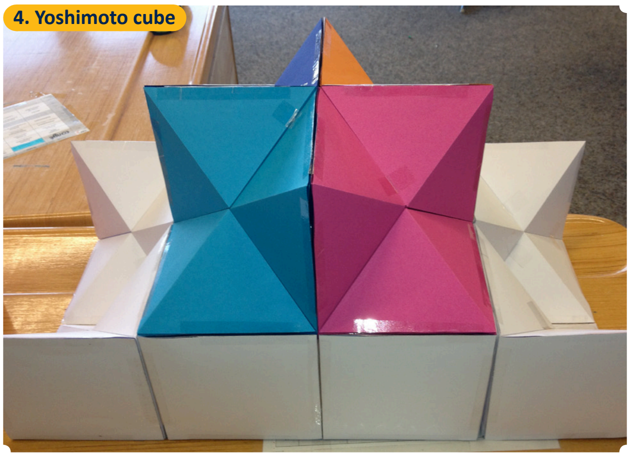

3. platonic puzzle

3. YOSHIMOTO, DOUBLE CUBIC BALL AND INFERNAL PYRAMID

For the infernal pyramid, it is enough to print the respective pdf file twice (see under Infernal pyramid.pdf) then build two half-pyramids. The objective is to make then a pyramid (tetrahedron) with those two identical parts.

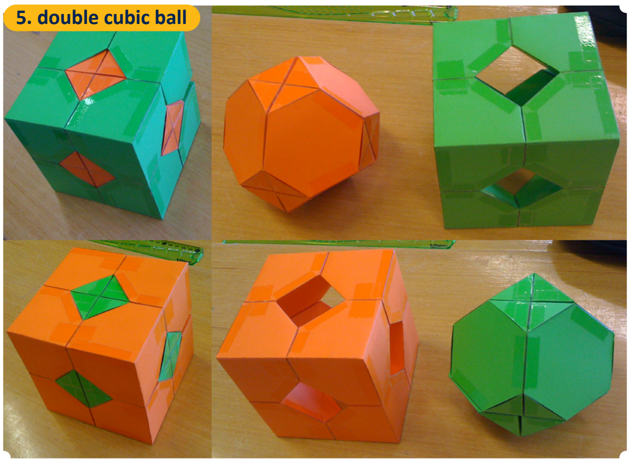
For the Yoshimoto cube, it is necessary to print the pdf Yoshimoto 16 times, eight times in one colour and 8 times in a second colour (see under Yoshimoto.pdf). It is then necessary to you to build 16 parts; they are half-cubes, then to assemble them 8 by 8 (picture 4).

4. Yoshimoto cube



For the double cubic ball, it is necessary to print 16 times the pdf of the double cubic ball, 8 times of a colour and 8 times the second colour (see under Double cubic ball.pdf). It is then necessary to build these 16 objects which are half-cubes with a regular hexagonal section. For the assembly by 8, it is necessary to refer to the cube of Yoshimoto and to tape in the same places, because hinges are placed in the same places as for the cube of Yoshimoto. (Picture 5)

5. double cubic ball



Conclusion

WHAT THE STUDENTS ARE EXPECTED TO GET OUT OF THIS

The students will be prompted to learning based on the scientific approach. Students' interest for science develops by playing with mathematical objects when using just simple and cheap equipment which is easy to implement in a classroom. The students will see those objects with another focus and develop the 3D view and capacities. The students have to cooperate to have success in the big constructions so while learning about mathematics they also get to experience the importance of team work.

PERSONAL EXPERIENCE - WHAT TO BE AWARE OF

The students can make everything easily, but this project takes time and students have to be patient and precise in constructing the objects. The more difficult constructions are the roofs of the dodecahedron and the roofs of the icosahedron in the platonic puzzle.

COOPERATION OPTION

The cooperation can be done with the big constructions. A class can imagine other polyhedra or polygons to insert in the 5 big platonic solids. Then a second class has to reproduce all of them.

All the pdf files are done by Thierry Dias and Jimmy Serment and available for free download at www.science-on-stage.eu. Credits for the Science on Stage Pictures "Mark Sammons Photography", all other pictures are made by Jimmy Serment and Thierry Dias.

ADDITIONAL MATERIALS

All additional materials such as the pdf files and the 3D files are available for download at www.science-on-stage.de/learning-by-doing-in-mathematics

Science on Stage Europe

ABOUT US

Science on Stage Europe brings together science teachers from across Europe to exchange best practice and teaching ideas and concepts with passionate colleagues from 29 countries. Science on Stage Europe believes that the best way to improve science teaching and to encourage more schoolchildren to consider a career in science or engineering is to motivate and inform their teachers. The non-profit organisation was founded in 2000 and reaches 100,000 teachers Europe-wide.

A network of national steering committees in the member countries provides the interface to their science teaching communities. They organise national activities for teachers and select the teachers who represent each country at the European Science on Stage festivals.

The festival, hosted every two years in a different country, is the culmination of national events in the participating countries. Following the festivals the ideas are cascaded throughout participating countries and participants have the opportunity to work together and develop their teaching skills.

ABOUT OUR TEACHING MATERIALS

With this new series Science on Stage Europe wants to further distribute innovative teaching ideas from teachers for teachers. The presented projects have been selected by an international expert panel based on criterias such as inquiry-based learning, feasibility in everyday school life and their potential to promote students interest in science. Many of these teaching concepts can be used to collaborate with colleagues from other countries.

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