

Creating the “Discover the Art of Math” Exhibit

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Abstract

This paper describes the creation of an interactive, hands-on geometry exhibition “Discover the Art of Math.” The exhibition was created by a team of science center and university specialists from Nordic and Baltic countries in 2012. It became a traveling exhibition accompanied by a 4D Frame workshop. On the basis of this exhibition and workshop, Helsinki University studied the effects informal education has on motivation to study and attitudes towards science.

Creating the Concept

To create an interactive, hands-on science exhibition on the complicated subject of math is always a challenge. The team of partners from Estonia (Energy Discovery Center), Latvia (Science Center Zinoo), Sweden (Innovatum Science Center, Tekniska Museet) and Finland (Helsinki University) created an exhibition on geometry supplemented by 4DFrame geometry workshop for the partner science centers. Helsinki University Teacher Department carried out a research on study motivation on the basis of the exhibition project.

We wanted the visitors to learn the basics of descriptive geometry by experiential methods (i.e. by hands-on experiences). The 4DFrame workshop was created in order to strengthen the new knowledge children got from the exhibition. 4DFrame is a construction system for teaching and learning math by creating geometrical objects. We believed that studying in this form would raise the level of intrinsic motivation of children and that it would make studying math easier as well as influence their overall attitudes towards math and science.



Figure 1 and 2: “Discover the Art of Math” exhibit in Cesis, Latvia and 4DFrame workshop for Latvian teachers.

We started creating the exhibition by asking ourselves (the Discovery Center employees) how much math is in these activities we do every day. It appeared that our hobbies were mostly about math –

women could knit or sew, men could do handicrafts etc. By discussion we realized that for instance knitting a sock with different color threads, with four knitting rods and with a pattern would be very complicated 4D modeling math that girls can do at rather early age. They do not need to know the formulas for the activity. They learn it by experience. The same logic applies with the handicrafts work that the men in our team could do – creating furniture etc. The exhibition stemmed from the wish to visualize these ideas on our exhibition. To create the exhibition design we carried out a design competition amongst the Master students of Estonian Academy of Art.

The 4DFrame workshop with the geometry tools was created with the help of the Innovatum Science Center teachers from Trollhättan. The workshop included modeling 3D objects to 2D objects by drawing them through a shadow, learning symmetry by making a snowflake and studying Euler's formula.



Figure 3, 4, 5 and 6: 4DFrame geometry workshop in Cesis.

Exhibits

Six exhibits were created for the exhibition as described below.

Tangram puzzle is an exhibit demonstrating geometrical shapes and simple connectivity. There are colorful, semi-transparent geometric objects on a light table. Combining those objects, visitors are creating different multiple angle shapes. Also, there is possibility to combine two or more similar objects together to obtain sets of other forms. Tangram puzzle is well suited for playing and teaching. Shapes of birds, animals or other common objects can be put together from simple elements. Combining/playing with those objects gives possibility to sorting and arranging objects by color, form.



Figure 7: *The light tables of the exhibition.*



Figure 8: *Tangram puzzle at Cesis exhibition.*

Matrix is an exhibit that explains coordinate geometry. Numbers have value that can be expressed as points on the XY-axis table. These points can be connected with elastic rope to form line graphs. The example on the table shows exact hour-by-hour temperature changes in town.



Figure 9: *Matrix and visitors at Zinoo.*



Figure 10: *Kaleidoscope.*

The exhibit *Kaleidoscope* describes aspects of geometrical optics such as law of reflection.

Multiple images can be seen due the repeated reflections in flat mirrors, placed at the 60 degree angles to each other. Different objects can be used to show this phenomena.

The curved wooden blocks are covered with plastic mirrors. Two types of mirrors are on the table: concave and convex. The visitor can pick an object (cube or a prism, etc.), put it near the mirror and look, how the relative locations of mirror and object affect reflected images.

The exhibit *String sculpture* is a monumental, dynamic string-surface model. Its artistic value will be enhanced by lighting and dynamic deformation. Exhibit shows the transformation of the triangle into a circle. Also the base disk can be rotated horizontally up to 180 degrees to show the further transformations.



Figure 11 and 12: *Our string sculpture at the exhibition in Jyväskylä and in Cesis*

Slices is an exhibit where visitors put 3D objects like pyramids, cubes, etc. under laser beams. The laser plane are projected vertically in the “black box”. To eliminate the dangerous reflections, we use less than 1mW laser pointers. In descriptive geometry the slices have very important place and find practical use in everyday life in architecture and medicine (fMRI).

The exhibit *Rotating bodies* demonstrates how simple 3D geometrical shapes emerge to the human eye through fast rotation of half line, circular arch or broken line.



Figure 13 and 14: *Exhibits Slices and Rotating bodies at the exhibition in Cesis and in Jyväskylä.*

Conclusions

The exhibition has been exhibited with great popularity in several Baltic and Nordic countries - in Innovatum Science Center in Trollhättan Sweden, in Tekniska Museet in Stockholm Sweden, in Science Center Zinoo in Cesis, Latvia and at Energy Discovery Center in Tallinn, Estonia. More than 55 000 have visited the exhibition and experienced the innovative teaching of math. 1200 pupils participated in the research.

The visitors have especially liked the combination of the exhibition and the 4DFrame workshop that has helped to make studying math fun and simple.

The exhibition was selected to serve as the main warm-up event for Bridges Finland 2016 at the University of Jyväskylä (exhibited in Jyväskylä University Science Museum) and it has been visited also by thousands of schoolchildren from the wider Jyväskylä-area.