

From a new teaching method to a museum: the Galleria di Matematica in Casalina

Emanuela Ughi

Galleria di Matematica, Polo museale universitario di Casalina, CAMS, Centro di Ateneo per i Musei Scientifici, Dipartimento di Matematica e Informatica, Università degli Studi di Perugia, Manifattura ex tabacchi, Via del Risorgimento. I-06053 Casalina (Deruta, PG). E-mail: emanuela.ughi@unipg.it

ABSTRACT

The Galleria di Matematica (University of Perugia) collects exhibits made for teaching purposes, and allows an hands-on approach to many mathematical theorems and ideas.

Key words:

hands-on, teaching, mathematics, geometry.

RIASSUNTO

Da un nuovo metodo d'insegnamento ad un museo: la Galleria di Matematica di Casalina.

La Galleria di Matematica (Università di Perugia) raccoglie exhibit costruiti per fini didattici, e permette un approccio hands-on a numerosi teoremi e questioni matematiche.

Parole chiave:

manipolazione, insegnamento, matematica, geometria.

Paul Gauguin said "Je ferme les yeux afin de mieux voir"; and very often indeed mathematicians work by covering their eyes, not to be distracted by the reality around them.

But visualization skills are not common, at every level, even the University students often are not able to imagine three-dimensional shapes, and mentally manipulate them, so that it is not easy to share mental images related to mathematical topics.

So, in 1998, I started to make mathematical objects, in order to show those mathematical shapes, theorems, ideas I was not able to transmit simply by drawing. My exhibits are usually made using simple and poor material, as wood, heavy paper, plexiglass, wool threads. They usually require that the visitor touches or manipulates some drawing, or puzzle, or moves something, in order to meet the mathematical idea I am trying to transmit.

I started to organize mathematical exhibitions, and the reaction of people has been positive and interested. In particular, teachers of all levels planned to use these objects to introduce new mathematical ideas, even since this different teaching method seemed promising in involving also some students usually having low performances.

This hands-on approach encourages in trying to face new mathematical questions, and often allows people to feel they are able to understand – even those people that already completely gave up understanding mathematics.

From then, the creation of new objects (and of related mathematical teaching proposals) continued

(and still continues), so producing a large collection of exhibits of many different kinds and sizes. Even my University students have been involved in this project, often explaining their thesis by some model. There is no special rule or plan to choose a new mathematical object to realize. I choose upon my curiosity and pleasure, being mostly interested on the mathematical teaching potential of the object, or on its beauty.

First of all, indeed, as a teacher, I know that many people think that math is hard. So I work in translating some obscure drawing in something that can be seen and manipulated, often searching the simplest case to use as an example, according the quote: "The art of doing mathematics consists in finding that special case which contains all the germs of generality" (attributed to David Hilbert).



Fig. 1. Leonardo's Ycocedron Abscisus Vacuus.



Fig. 2. A cardboard great rhombicosidodecahedron.

So through my work, I make visual representations of mathematical images difficult to describe by words alone, so helping people to grasp a mathematical concept through the medium of a mathematical object.

Secondly, as a Geometry scholar, I love geometrical shapes, and would like to inspire the same love in others. Some between my objects are not only mathematically meaningful, but also very beautiful: for example, the logo of the Galleria is an Ycocedron Abscisus Vacuus I realized in heavy cardboard as a copy of one of the polyhedra Leonardo da Vinci draw for the Divina Proportione of Luca Pacioli. A copy of the same exhibit has been donated to the Biblioteca Ambrosiana in Milan, to be displayed together in the same case with Pacioli's original book - hanging directly over da Vinci's drawing (fig. 1).

Finally, in 2014, the collection had its own place in the Polo Museale of the University of Perugia, in Casalina, and a partial setting has been exposed in the "Galleria di Matematica". The main arguments of the exhibition are the mathematical theory of perspective, polyhedra and tessellations (fig. 2), algebraic and transcendent curves, and geometric effects by mirrors.



Fig. 3. The Graph Table: the map of Königsberg in 1652.

The Galleria rooms cover about 100 square meters, and most of the objects are simply put over tables, to be used and touched. All the tables are painted by a blackboard paint, so that children can even draw directly over them; for example, the "graph" table shows a map of Königsberg in 1652, with an island inside the river, and seven bridges; at that time Euler faced the problem of planning a walk passing over every bridge just once: the visitor can directly try to draw such a walk over the table by chalk, before being guided to understand the Euler's answer through the theory of graphs (fig. 3).

The visitors are usually guided (and strongly required) to accept to be involved in some between the offered activities. Also, they can learn how to make at home a copy of some exhibit: for example, a copy of the Ycocedron can be made by the materials in the book "Il poliedro di Leonardo" (Edizionicorsare) (Ughi, 2013); the cardboard beehive can be made by following the directions described in a video tutorial in the website of the European Project MiMa (AA.VV., 2015a; AA.VV., 2015b; see web site n.1) (fig. 4).

Outdoor, at the entrance of the Galleria, a long number line painted on the sidewalk allows to organize games on numerical problems - at several levels, from simple multiplication tables to more complex questions (fig. 5).

A small part of the collection concerns those exhibits that have been planned and made for special needs students and visitors. In particular, the part of the exhibition on perspective has also been translated in several small haptic exhibits, to be explored in a tactile way by blind visitors, in order to to surrogate those visual experiences they miss.

Several exhibitions share a similar "from concrete to abstract" approach, so offering concrete mathematical experiences through manipulatives. In Italy, they are mostly connected with Universities or University professors: il Giardino di Archimede in Florence, the



Fig. 4. The MiMa cardboard beehive.



Fig. 5. The Outdoor Number Line.

exhibitions of the group of Maria Dedò in Milan and Trento, the Macchine Matematiche in Modena. Abroad, the Mathematikum in Giessen is one of the most popular museums in Germany.

Anyway, it is not easy to compare the Galleria di Matematica with similar museums, since it has been realized with almost no funds, and has no dedicated staff. So, the openings are not continuous, but organized - often on request - according my availability (and that of my students) to guide a visit and to explain the hidden mathematics of the objects. So, for example, during last year, there were about a dozen of visiting groups (mostly classes from primary school to University), but, during the event AmareMatica, in October 2015, there were about 1000 visitors in 2 days.

All ages were involved, since each object can be used and understood at several levels, from the simpler way of observing "what is happening" to deeper ways to discover the mathematical reasons or possibile generalizations.

REFERENCES

- AA.VV., 2015a. *MiMa - Mathematics in the Making - The Project*. Sheffield Hallam University, Sheffield, 27 pp.
- AA.VV., 2015b. *MiMa - Mathematics in the Making - The Toolkit*. Universidade Nova de Lisboa, Lisboa, 41 pp. also available at http://www.mathematicsinthemaking.eu/fileadmin/media/Output/Toolkit_-_publications/MIMA_ebook_EN_VFinal_compact.pdf, accessed 21.06.2016)
- UGHI E., 2013. *Il Poliedro di Leonardo*. Edizioni Corsare, Perugia, 22 pp.

Web Site (accessed 21.06.2016)

MiMa project
<http://mathematicsinthemaking.eu/>

Submitted: June 21st, 2016 - Accepted: October 11th, 2016
 Published: December 16th, 2016