

Scientific REPORT

Numb3d by numb3rs?

(Diamo i numeri!)

Few people have any idea how much mathematics lies behind the artifacts and accoutrements of modern life. Nothing we use on a daily basis — houses, automobiles, bicycles, furniture, not to mention cell phones, computers, and Palm Pilots — would be possible without mathematics. Neither would our economy nor our democracy: national defense, Social Security, disaster relief, as well as political campaigns and voting, all depend on mathematical models and quantitative habits of mind.

Lynn Arthur Steen, Mathematics and Democracy, 2001

The theory of probability is at bottom nothing but common sense reduced to calculus

Pierre Simon Laplace, Théorie analytique des probabilités, 1812

Neglect of mathematics work injury to all knowledge, since he who is ignorant of it cannot know the other sciences or things of this world.

Roger Bacon, Opus Majus, 1267



Leaflet front, Numb3d by Numb3rs? exhibition

I. Description of the activities

Numb3d by numb3rs? offered visitors an occasion to increase their knowledge about numbers and sharpen skills that are useful when dealing with today's reality where uncertainty, percentages and data are increasingly present. The main objective of *Numb3d by numb3rs?* was to create an interactive scientific exhibition about numbers, from their origin through the theory of probability, and ultimately the role of numbers in the dynamic fields of statistical analysis and Data Science. The project ran for two years from 01.07.2014 – 30.06.2016 and emphasized themes that invited visitors to dig deeper, drawing their attention to concepts like probability, uncertainty, and chance, all of which are overlooked at school and in everyday life, but are fundamental to best interpret our reality.

As indicated in the project proposal, the exhibition was made up of three sections: DIGITS, DICE and DATA, a sort of 3D trip through games, puzzles brain-teasers, simulations and intriguing stories about numbers. The project did not in any way substitute classroom learning. Instead, it promoted an informal way of approaching mathematics where the visitor's experience, pleasure and emotions came into play as they entered the fascinating world of numbers. The presence of families on weekends, the length of visits, the enthusiasm of the public and comments provided in the evaluation questionnaires suggest that it is possible to arouse interest in topics that normally the generic public does not consider exciting.

The creation and setup of the exhibition at the two project premises (Ascona and Lugano) was implemented as planned, although the opening took place first in Ascona and then in Lugano instead of the reverse, as proposed, because of logistic constraints. The project was postponed by 3 months due in part to a delay in the availability of *L'ideatorio's* new exhibition premises in Villa Saroli, Lugano, and to the necessity of coordinating with other important science communication events (Science Festival "Ricerca Live!"). However, the main objectives of the project were achieved and the milestones stated in the proposal were reached:

1. 01.07.2014 – 02.03.2015: Exhibition design, construction and promotion; setting up school visits;
2. 02.03.2015 – 26.04.2015: Exhibition open at Casa Serodine, Ascona - 7 weeks including weekends;
3. 21.09.2015 – 19.02.2016: Exhibition open at Villa Saroli, Lugano - 13 weeks including 9 weekends; the exhibition was extended until 26.02.2016 and a survey conducted.
4. 17.06.2016 – 30.08.2016: Statistical analysis of the data collected to study the impact of *Numb3d by numb3rs?*; drafting the Final Report.

After the exhibition closed in Ascona, advertising was launched in Lugano and school groups started reserving their visits. In addition, two evaluation questionnaires were created for visitors, one for teachers and one for the general public. The Società Matematica della Svizzera Italiana (SMASI) supervised by Prof. Antonietta Mira and Federica Bianchi, a doctoral student at USI and with the help of *L'ideatorio*, conceived and created two booklets of learning materials to be distributed to teachers during their visits to the exhibition. Between the Ascona and Lugano exhibitions, the booklets were checked and refined in readiness for school visits in Lugano. In addition, a new exhibition was organized at the Scuola Cantonale di Commercio, in Bellinzona, from 07.05.2016 until 17.06.2016 – 6 weeks, reserved for high schools. This final exhibition was not foreseen in the initial project proposal (see Annex 1).

The exhibition, including the unanticipated opening in Bellinzona, was active for 27 weeks over two years. In addition, the exhibition in Lugano was extended due to an official request from the Dipartimento Educazione Cultura e Sport (DECS) to allow those school groups who were not able to participate by the established closure date to experience the exhibition. The closure was therefore postponed from 19.02.2016 to 26.02.2016, so that overall, the exhibition lasted 28 weeks including 16 weekends.

2014						2015												2016								
07	08	09	10	11	12	01	02	03	04	05	06	07	08	09	10	11	12	01	02	03	04	05	06			
								Ascona							Lugano											Bellinzona

Exhibition opening months

During the exhibition, several free collateral events were organized and open to the public (see section II).

Overall, the project involved a greater number of school groups than was foreseen in the proposal: instead of 210 groups, a total of 232 groups were hosted in Lugano and Ascona, plus 49 high school groups in Bellinzona. Considering the academic theme of the exhibition, the participation of the general public was also very good and in line with participation in other *L'ideatorio* exhibitions.

The exhibition was built according to the steps outlined in the proposal. The themes and the interactivity involved in the exhibits required the presence of a great number of scientific explainers, which represented the greatest cost to the project, but also the most added value. School groups were always guided by the expert scientific explainers from *L'ideatorio*, sometimes assisted by graduate students from USI. The scientific explainers also accompanied and assisted the general public during weekends. In addition, six high school students were selected as junior scientific explainers through a specific call and shadowed the scientific explainers on days when the exhibition was open to the public. The junior explainers provided support in interacting with the public, while getting an educational experience themselves. Having young scientific explainers conveyed a view of mathematics as something warm and fun. In addition, the variety of content and different types of interaction offered by *Numb3d by Numb3rs?* proved to be flexible with cues for different kinds of visitors, satisfying the curiosity of children and inexpert visitors, but also intriguing colleagues at the Università della Svizzera Italiana (who had the chance to visit the exhibition with their families at a reduced price) and graduate students (for whom two evening events were organized at the exhibition). The exhibits were built with natural materials (mostly wood and cardboard) using a simple graphic design and primary colors (intentionally warm and light), which gave the exhibition a welcoming and playful atmosphere, while ensuring the set-up could adapt to different spaces. Moreover, the low cost and easy availability of the basic materials (wood and cardboard) was a benefit, since timely restorations were required due to the great interactivity of the exhibits and the fragility of cardboard.

SCNAT, the Swiss Academy of Sciences, celebrated its 200-year anniversary in 2015. Because *Numb3d by Numb3rs?* coincided with the period dedicated to the celebrations of the Academy, it became one of the key events of the Science Festival "Ricerca Live!" which was organized for the occasion in the Italian part of Switzerland (www.scienzenaturali.ch/service/leisure/37608-diamo-i-numeri-). The Ascona exhibition was also included in the program of the festival *Asconoscienza* (www.asconoscienza.ch).

To assess the impact of the exhibition in Lugano, an online questionnaire was given to teachers and the general public received evaluation questionnaires in hard copy. Questionnaires were completed anonymously. The data analysis is presented in Section III.



II. The main results and products

Project results are in line with what was foreseen in the proposal. Overall, the three exhibitions involved 284 classes of all school types and grades (each group participated in a 1h30'– 2h visit, guided by a scientific explainer), 5340 students, 367 teachers, plus 2072 visitors from the general public who were hosted during the weekends in Lugano and Ascona. A total of 7779 people visited the exhibition.

The table below reports details concerning the school that visited:

Classes of schools visiting the Exhibition										
Elementary		Secondary		High school		SSPSS*	Specialty School	CPE**	Pre-Training	CAS DFA °
	n°		n°		n°	n°	n°	n°	n°	n°
I	31	I	25	I	16	2	1	1	4	1
II	32	II	21	II	18					
III	36	III	12	III	17					
IV	33	IV	9	IV	3					
V	22									

* Professional School for Medical and Social Services (Scuola Specializzata per le Professioni Sanitarie e Sociali, SSPSS)

** Psycho-educational Center

° Certificate of Advanced Studies — Department of Teaching and Learning SUPSI (15 pre-school and elementary school trainee teachers. Trainer prof. Silvia Sbaragli)

The project produced the following items:

1. Exhibition *Numb3d by Numb3rs?* (n° 27 interactive exhibits)

n° 3 openings:

- a. Ascona – Casa Serodine
- b. Lugano – Villa Saroli
- c. Bellinzona – Scuola Cantonale di Commercio, SCC

2. n° 1 video *Numb3d by Numb3rs'* at CSCS

Video (length: 7') created by the Swiss National Supercomputing Centre on research studies, carried out using supercomputers.

3. n° 3 interactive videogames with simulations

These videogames, created by the startup company 'Immpres – Immersive presentation' in collaboration with *L'ideatorio*, allow players to move in a 3D graphic environment, through interaction with a specific sensor, and make simulations relating to probability. The videogames are entitled: "The die is cast", "Roulette", and "Random steps" ("Il dado è tratto", "La roulette", "4 passi a caso"). The games, presented within the exhibition, can also be used standalone, and were made available to schools that expressed interest.

4. www.diamoinumeri.ch

The website, created by 'Immpres – Immersive presentation', presents the exhibition themes and general information about the project in a playful and interactive way. In addition, visitors to the site can download teaching material by signing in to a reserved area.



Homepage screenshot of exhibition website

5. 'Digits, Dice, Data' graphic design

The logo, the graphic design of the exhibition and the website design were created by Teresa Sdravich (www.teresasdravich.net).

Below are three examples of the images that were created for the exhibition all of which effectively promoted a coherent, engaging, and readily communicable graphic concept.