Math + Design: Collaborative Posters

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Abstract

Undergraduate students majoring in fine arts with a concentration in graphic design collaborated with undergraduate students majoring in mathematics in order to create posters about famous mathematicians. The project addressed the communication skills, creative skills, and collaboration skills of both majors. The activities were incorporated into a senior graphic design class for fine arts students and into a capstone mathematics project class for students majoring in mathematics. Nine posters were selected for detailed descriptions.

Introduction

In this project, undergraduate students in a graphic design class were paired with undergraduate students in a capstone mathematics project class in order to create math posters about famous mathematicians and their achievements. Due to space limitation, we chose nine of the 20 posters to present here. They are displayed in Figure 1. Our choice of the nine posters was based on aesthetics, design concepts, mathematical content, and, last but not least, how easy it was to explain the poster with a few sentences. The rest of the posters can be found without any description in Figure 2 of the Supplementary Materials.

In each of the student pairs, the mathematics student chose two famous mathematicians on their own, making sure that there was no duplication among the students, and they wrote a two-page essay about them. Each graphic design student chose one of the two mathematicians, and they wrote a short summary about them independently from the mathematics student. After the research phase, students compared notes, chose the most famous mathematical result, and the design students started to sketch ideas. Students had to try to concentrate on the single most important accomplishment of the selected mathematician as much as possible in order to keep their design clean, simple, and not overwhelming. Generating a great concept and a unique visual design are important and challenging parts of the graphic design process, and they take time. The students used traditional methods of graphic design – drawing thumbnails on paper and listing ”key words” (word associations) – to come up with a conceptual idea. Art design students shared their sketches and discussed their ideas with the student of mathematics before starting the creation of the actual poster design. At least two meetings were required. The art design students also evaluated their ideas via peer evaluation (critique) in their class, during which they selected one design. After the graphic design instructor's approval, students started creating the digital version of the poster. Following another class critique, students were required to revise their design before the final submission of the project.

The project was challenging for the art students because it was hard to understand most of the mathematical concepts. Even for the undergraduate math students, it was difficult to understand the mathematical results, with the additional difficulty of explaining them to the fine arts students. Another difficulty was the selection of the single most important mathematical result, since most famous mathematicians have many famous results, and sometimes the mathematical concept was too hard to understand for the students. This project also served in part as an assessment of the critical thinking, communication, and collaboration skills of both fine arts and mathematics students. Some kind of poster project is always part of the graphics

design class, and for this reason, it was easy to incorporate it as an experiential learning assignment. The coordination with the mathematics capstone project class was also relatively easy, as mathematics students worked more in an advisory capacity instead of as active participants. From a graphic design point of view, designing these posters was quite different from a typical mathematics poster that usually tries to include every single piece of mathematical information. Students in both classes were excited about this collaborative project and its poster results.

Poster Designs: Visual Exploration of Famous Mathematicians and Their Discoveries

In this section, we present nine of the 20 posters with our brief explanations of both the posters and the processes that the students went through.

Poster: Paul Erdős, by Monica Lugo and Andres Salgado. See Figure 1a.

Paul Erdős (1913–1996) was a Hungarian mathematician. For the poster about him, both the graphic design student and the mathematics student had difficulty singling out, understanding, and visualizing one mathematical idea. What fascinated the students and what they chose to conceptualize was the idea of the Erdős Number. The poster uses the famous Erdős quote "My brain is open" and shows the names of other famous mathematicians with various Erdős numbers.

Poster: Bertrand Russell, by Mariana Zapata and Kareem Wahid. See Figure 1b.

Bertrand Russell (1872–1970) was a British mathematician and philosopher. The poster about him shows boxes inside boxes, with several different formulations of Russell's famous paradox written on the inside of the boxes. Naturally, it is impossible to visualize a paradox in a mathematically correct way. The design using boxes containing boxes symbolizes sets containing sets.

Poster: Kurt Reidemeister, by Jacqueline Maldonado and Jose Gonzalez. See Figure 1c.

Kurt Reidemeister (1893–1971) was a German mathematician. The poster about him playfully writes the mathematician's first name using collections of knots, called link diagrams. Knots are closed curves. The draft version of the poster used open curves; luckily, the math student caught the mistake. Under the name, the three types of "Reidemeister moves" are depicted that can be used to create all knot deformations. Including the faces of the mathematicians was optional. Faces create more interest, and people will remember artworks with faces better. In this case, only the eyeglasses and the eyes are depicted in order to fill some space while avoiding distraction from the knots.

Poster: Alan Turing, by Diana Chong and Kareem Wahid. See Figure 1d.

Alan Turing (1912–1954) was an English mathematician and computer scientist. Ones and zeros form the background for the poster of Alan Turing. The colored, rotating drums depicted at the top and bottom of the picture formed the "bombe," an electro-mechanical device that was designed by Turing during World War II to break the German ciphers.

Poster: David Hilbert, by Ruben Elizalde and Andres Salgado. See Figure 1e.

David Hilber (1862–1943) was a German mathematician. The poster about him uses a variant of Hilbert's space-filling curves. The curve can be constructed iteratively as the limit of piecewise linear curves. It is a continuous fractal with Hausdorff dimension 2. While the typical mathematical depiction of the curve is to show several iterations side-by-side, the students decided to use two iterations connected to each other. The curves are also connected to a depiction of Hilbert's face.

Poster: Leonardo Fibonacci, by Rodolfo Mendez and Violeta Castaneda. See Figure 1f.

Leonardo Fibonacci (1170–1240) was an Italian mathematician. The Fibonacci numbers are well-known both in mathematics and in the fine arts. This poster combines several aspects of the sequence. The beginning of the sequence forms the background of the poster. Fibonacci's image is placed inside the Fibonacci spiral and the Fibonacci tiling. It is perhaps less well known that Fibonacci created this sequence to describe the growth of an idealized rabbit population. Pairs of rabbits produce new pairs in two time periods: one for mating and another for gestating. As a consequence of this staggering, in any period n, the population F_n is the sum of the populations from the previous two periods: $F_n = F_{n-2} + F_{n-1}$. Increasing shapes of rabbits are placed on the Fibonacci curve.

Poster: Isaac Newton, by Melissa Alatore and Elizabeth Terry. See Figure 1g.

Isaac Newton (1642–1727) was an English mathematician and natural philosopher. The falling apple is a popular story of what inspired Newton to formulate the theory and mathematical description of universal gravitation. In addition to the apple and instead of the equation for universal gravitation, the students decided to include representations of Newton's second law of motion, $F = ma$, and Newton's third law of motion, $F_A = -F_B$. Only part of Newton's first law of motion is included. From "if the net force on an object is zero, then that object will have zero acceleration," the "if" part is depicted as $\Sigma F = 0$.

Poster: Emmy Noether, by Alondra Andrade and Pricilla Mendez. See Figure 1h.

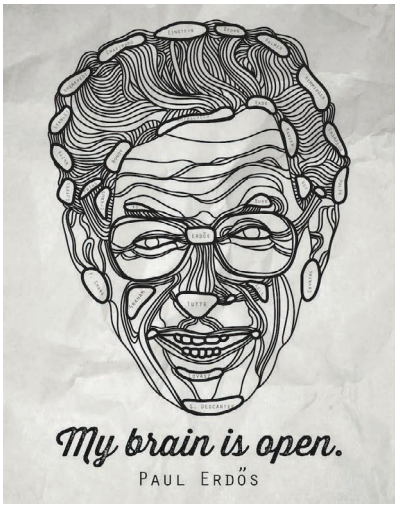
Amalie Emmy Noether (1882–1935)) was a German mathematician. The poster refers to Noether's First and Second Theorems by connecting the expressions "conservation laws" and "symmetries in nature" with geometric objects. As a special, simple case of her First Theorem, the Euler–Lagrange equation is also depicted. The dark background with the white dots represents the night sky and refers to the connection of her results to general relativity.

Poster: Euclid, by Cesar Perez and Daniel Leal. See Figure 1i.

Euclid (325–265 BC) was a Greek mathematician. He is considered to be the father of geometry. The poster about him grabs concepts from his most famous work, the 13 books of the mathematical treatise "The Elements." The name Euclid is displayed using stylized line segments and curves. Angles (book 1) are formed using circles (book 3) and the top and bottom of the letter I. The triangles and parallelograms are contained in Book 6. The most prominent object on the poster is the icosahedron, which is one of the five Platonic solids discussed in Book 13 of The Elements.

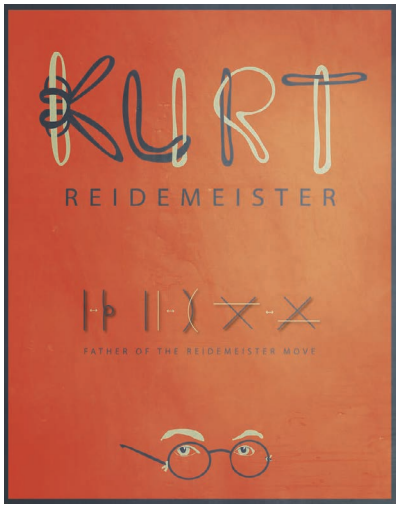
Summary

The main objective of this project was to create visually striking contemporary poster designs that represent the most recognized inventions of famous mathematicians. Successful visual communication is achieved through the application of basic design elements: lines, shapes, colors, typography, and symbolism. The collaboration provided an interesting way for design students to learn mathematics and create effective visual communication. Mathematics students learned how to communicate mathematics to non–mathematical audiences. They also learned that poster designs create interest by focusing on visuals based on images instead of lots of texts. The final design was not just aesthetically pleasing but also conceptual and engaging. Selected posters are now permanently displayed on the walls of the hallways in the mathematics building at UTRGV. Similar projects are planned for the sciences. While general science discoveries might be easier to understand and visualize, and might not require collaboration with scientists, instructors should make sure that all the information are correct on the posters.

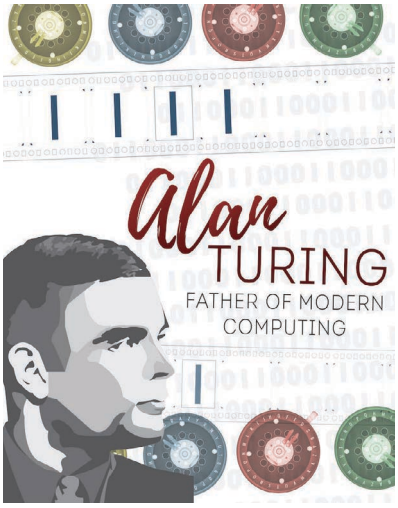


(a) *Paul Erdős*

(b) *Bertrand Russell*



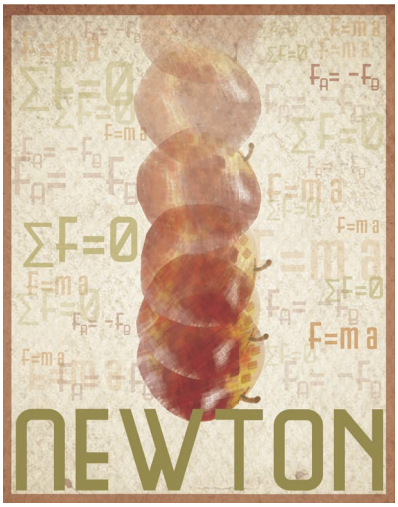
(c) *Kurt Reidemeister*



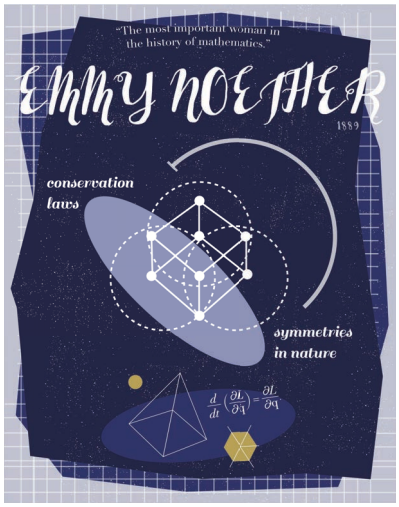
(d) *Alan Turing*

(e) *David Hilbert*

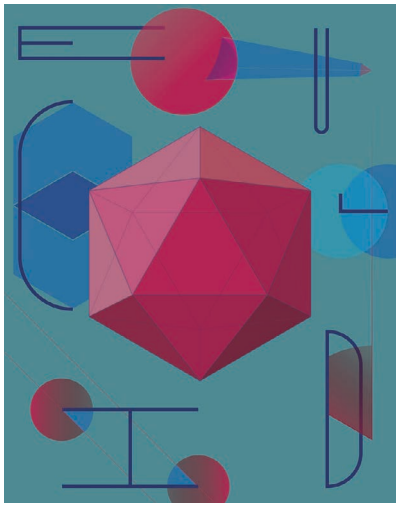
(f) *Leonardo Fibonacci*



(g) *Isaac Newton*



(h) *Emmy Noether*



(i) *Euclid*

Figure 1: *Poster Designs: Visual Exploration of Famous Mathematicians and Their Discoveries*