Geometrical Object Making for Design Thinking

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Abstract

GOMYAP workshops are focusing on the development of creative and critical thinking through design. The tool use for the workshop is a paper toy named GOM (Geometrical Object Making), created by Gizem Aytaç in order to emphasize the collaboration between geometry and the design process. The Design profession as architecture acts like a bridge between math and art. Participants will learn to fold GOM modules by creating polyhedral objects in order to be introduced to the collaboration between geometry and everyday objects. This open-ended workshop lasts for 90 minutes and ends with the designing and making of participants' dream models.

Introduction

This paper draws on my experience of working with 1850 kids in 62 workshops within 3 years. In this paper, GOM's interdisciplinary playfully educational capacity will be presented and the outcomes will be put on public display. The material world is infinitely malleable. You wake up to a world of things designed by mankind. Geometry is the study of spatial order through measurements and relationships of forms. The symmetry of platonic solids has fascinated architects, designers and artists throughout the ages. GOMYAP workshops aim to teach creative design thinking by linking geometry with everyday objects to facilitate the realization of the connection between the two.

Plato considered geometry as the most reduced therefore the ideal Philosophical language. Plato wrote on the door of the Plato Academy "Let no one ignorant of geometry enter''. According to him, a philosophy student was not able to function as a person of logic if the student did not know geometry. Starting from this point of view we built our system on analytical and three-dimensional thinking. GOM's slogan "Wise up to Geometry" takes its reference from his sayings. We want to share the power of creativity through geometry and design.

Since this is an interdisciplinary activity, I will try to point out the related topics which influenced me as a designer. These topics could be put in order as design & architecture, math & geometry, arts & crafts, learning experiences, learning spaces, and recycling.

Paper has a memory for actions. Once you fold it, the mark remains on it. This characteristic creates a learning advantage. Learning from our mistakes is usually an underrated activity at schools. The school system and tests want perfect answers to questions. How about making mistakes and trying to learn from them creatively? Paper is a very flexible material and can be shaped easily. While making a GOM, you can make mistakes and choose to correct them or you can try to solve the problem and create something new out of it. GOM gives opportunities for structural forms, organic forms as well as artistic forms. This experience helps the children not to worry about making mistakes and lets them think in a solution-oriented way which is a closer perspective to real life. Flexible material leads to flexible thinking. GOM is an organic paper toy. It has a very low carbon footprint of production. It is easy to recycle. The important thing is the process of making, designing and thinking. Usually students love taking models home to share with their parents. There have been some schools that use GOM models for papermaking activities.

We wake up every day and see at least 400 objects that man has created. Your surrounding objects and places make you feel different emotions. Design is a responsible act of making. You change the lives of many people and shape the world accordingly. A good design has basic principles. "It has to look aesthetically pleasing as well as be practical and ergonomic. It has to solve a problem with a global and

cultural moral. It has to explore functional, economical, meaningful, organizational and constructive relationships" [2]. To create something out of an idea is not an easy task for someone whose understanding of the world comes from the standard educational system. Innovative thinking starts when we begin to think out of the box. You need to let go of what you know, start from nothing, and begin a new process from there. The Design Thinking Process has 5 stages including: empathizing, defining, ideating, prototyping and testing. "Design Thinking is a design methodology that provides a solution-based approach to solve problems. It's extremely useful in tackling complex problems that are ill-defined or unknown, by understanding the human needs involved, by reframing the problem in human-centric ways, by creating many ideas in brainstorming sessions, and by adopting a hands-on approach in prototyping and testing. Understanding these five stages of Design Thinking will empower anyone to apply the Design Thinking methods in order to solve the complex problems that occur around us — in our companies, our countries, and even our planet." [5]. GOM uses design thinking both for the creation of the GOM brand and also by teaching the method to children at an early age through GOMYAP workshops. During design education learning forms and shapes starts with polyhedral. Every building, object or space that is designed must fulfill a geometrical and therefore an aesthetical knowledge and understanding.

What is GOM?

GOM is a kit of organic paper modules that can be used to design and construct an unlimited number of 3D shapes. GOM is a modular system that is made out of paper circles. The folding of circles into triangles, squares and cornices. GOM is model making is a toy that explores structural, geometrical or artistic forms and their intersections. The kit is intended to stimulate creative self-expression. Its creativity has no boundaries and you can design an unlimited number of shapes. Anyone who believes in the power of play from 5 years and older can play. While developing fine motor skills, it teaches patience and commitment. GOM also teaches cooperation, concentration, non-verbal communication, and reinforces responsibility and self-confidence. The design toy also improves communication skills with constructive criticism and it aims to popularize the universal language of mathematics and geometry. [4]

As a product in the market, the GOM package has 10 sheets of organic colorful papers, each sheet includes 14 pieces, 40 modules, and 140 pieces in total with 6 pages of instructions in English and Turkish with drawings. (Figure 1)

Figure 1: *GOM packaging as a product*

At the GOMYAP workshops, we work with the modules. The schedule and content of the workshop defines the number of modules that is being used. Each module has 3 pieces; 2 unit circles and a circular region. The circular region with an equilateral triangle in the middle is called mini delta. (Figure 2) As a manufacturer, we are always in the quest for the scale factor. The outer circumscribing circle is scalable. The radius of the modules can be changed according to the projects but the design stays the same. GOM's design patent includes all sizes of the drawing in the AutoCAD file. (Figure 2)

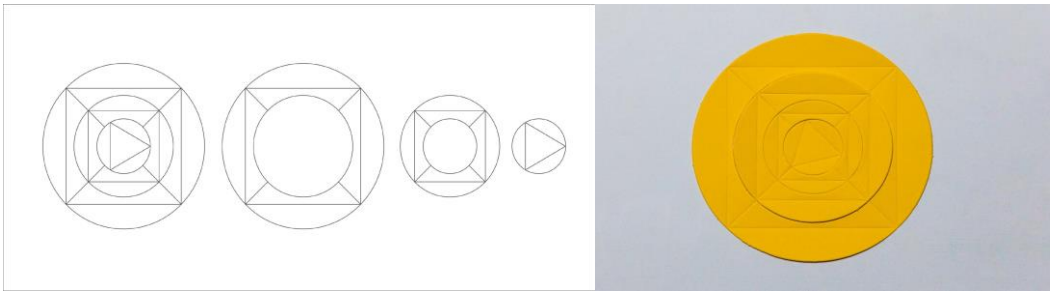

Figure 2: *The first draft of GOM drawn by Autocad (left) the prototype (right)*

Content and Execution of Gomyap Workshop

GOMYAP workshops are usually held with minimum of 15, and maximum of 30 participants. They last for 90 minutes. The needed equipment, (GOM modules and solvent free adhesives) are provided by the GOM team members. As the workshop starts with questions and answers, the workshop room needs to have good acoustics. Large spaces with a poor acoustical performance are problematic since the tutor and the participants often engage in constant conservation throughout the workshop.

Figure 3: *GOMYAP Workshop held for Kadıköy Municipality*

As shown in (Figure 3) we place the tables in circular or rectangular format so that the participants can see each other face to face and there is no hierarchy. We try to create an equal personal space for the participants. Running in the class, talking, dancing, and singing are allowed since we are only playing. The participants are free to leave the tables and sit on the floor or take a walk around and/or ask questions. [8]

We start with the question "What is design?" After hearing the participants' answers, we define design and try to show that we live in a world designed by mankind. The answers are quite fun to listen to. They usually know that the design process is related to drawings, drafts and prototypes. The workshop continues with the introduction of GOM and the rules of play. These basic rules are: 1.Carefully separate pieces to avoid tearing. 2. Work with clean hands on a flat surface. 3. Separate the rings carefully. 4. Fold accurately on the scored lines towards the inside. 5. Align the pieces carefully. 6. After gluing, squeeze the joints together and press firmly. 7. Allow time for the pieces to dry.

The first piece we define is the mini delta. It is a circle with an equilateral triangle shaped line scored on paper. The tutor asks "What is a pyramid and how many sides does it have?" When they have the answer 4, the tutor asks them to make 4 triangles out of mini delta. (Figure 4) This is a Montessori [7] like object counting math activity. The younger kids (4-5 years old) especially adore this activity of counting modules. Then application of glue is demonstrated to the classroom. In the beginning of the workshop, which lasts about 20 minutes, the compelling part for the children is to learn the basic rules of GOM. We use this time for motivation building. When the first pyramid appears out of plain paper they are amused and come to understand how the paper pieces work. Circles folded up into triangles, squares & cornices.

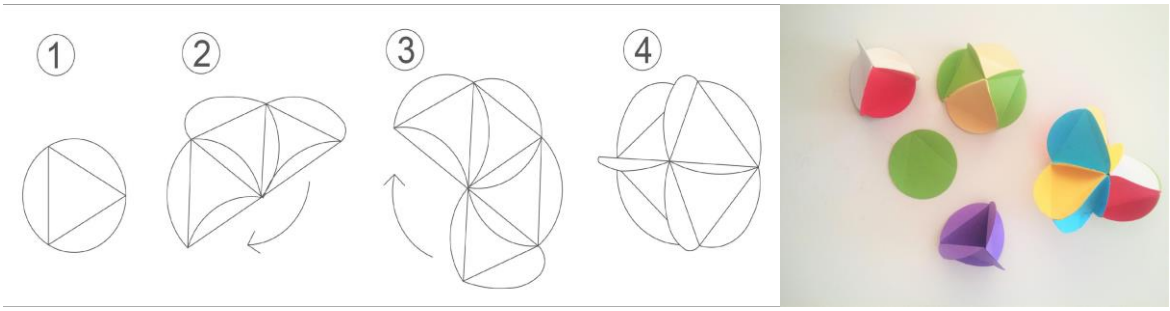

Figure 4: *(1) mini delta, (2) tetrahedron, (3 and 4) octahedron*

The activity continues with questions & answers for the corresponding shapes of tetrahedrons and octahedrons. (Figure 4) First we start by making a tetrahedron with 4 pieces and then closing the bottom of the paper model. Sometimes the students use 4 GOM pieces to make a square pyramid (half of an octahedron) and do not close the bottom. In this case the tutor talks about the octahedron and helps them to make one, while giving information about the square pyramid to the classroom. For the example of a pyramid we use the pyramid of Egypt and for the octahedron we tell them about the Louvre Museum. This continues with hexahedron, and icosahedron and rhombi cuboctahedron. At the end of 70 minutes, the participants are asked to design their own dream objects.

The point here is not to tell the students that they did anything wrong with the pieces, but instead to teach them and help them understand the polyhedron that they are about to make. We never try to change the designs they make in concentration but instead we try to show them the way.

Creative Act and Learning Activity

The Creative act is a very important skill for the 21st century. The world is changing rapidly and education is one of the most powerful instruments of change. Creativity is an ability to take two or more concepts and put them together in something new that is novel, and useful. To improve the brain's ability to find different pieces of information seemed irrelevant in the past. Designing is about structures, and their coming together

accurately. Geometry is used in order to calculate angles, proportions, and how structures do and do not work. DYI projects like GOM, hands on activities and new applications taught at early ages will guide children to creative and analytical thinking. [6]

As Dr. Howard Gardner stated in his theory of multiple intelligences, there are 8 different intelligence types: logical/mathematical, verbal/linguistic, interpersonal, body/kinesthetic, musical, visual/spatial, intrapersonal, and naturalistic. [3] While designing the curriculum for the GOMYAP workshop, I tried to include the formative capacity of multiple intelligences. The workshop includes mathematical improvement as it is a geometrical and problem-solving activity. Verbally, we teach kids new words and try to tell stories about objects. When children talk to each other during the workshop it helps them to improve their interpersonel (people smart) skills in relationships. The hands-on nature of the activity improves their fine motor skills and motivates them to use their hands and fingers more. Designing geometrical objects helps improving their visual/spatial intelligence as they create things by visualizing them with their minds' eye. They continuously achieve goals during the 90 minutes for intrapersonel (self-smart) skills.

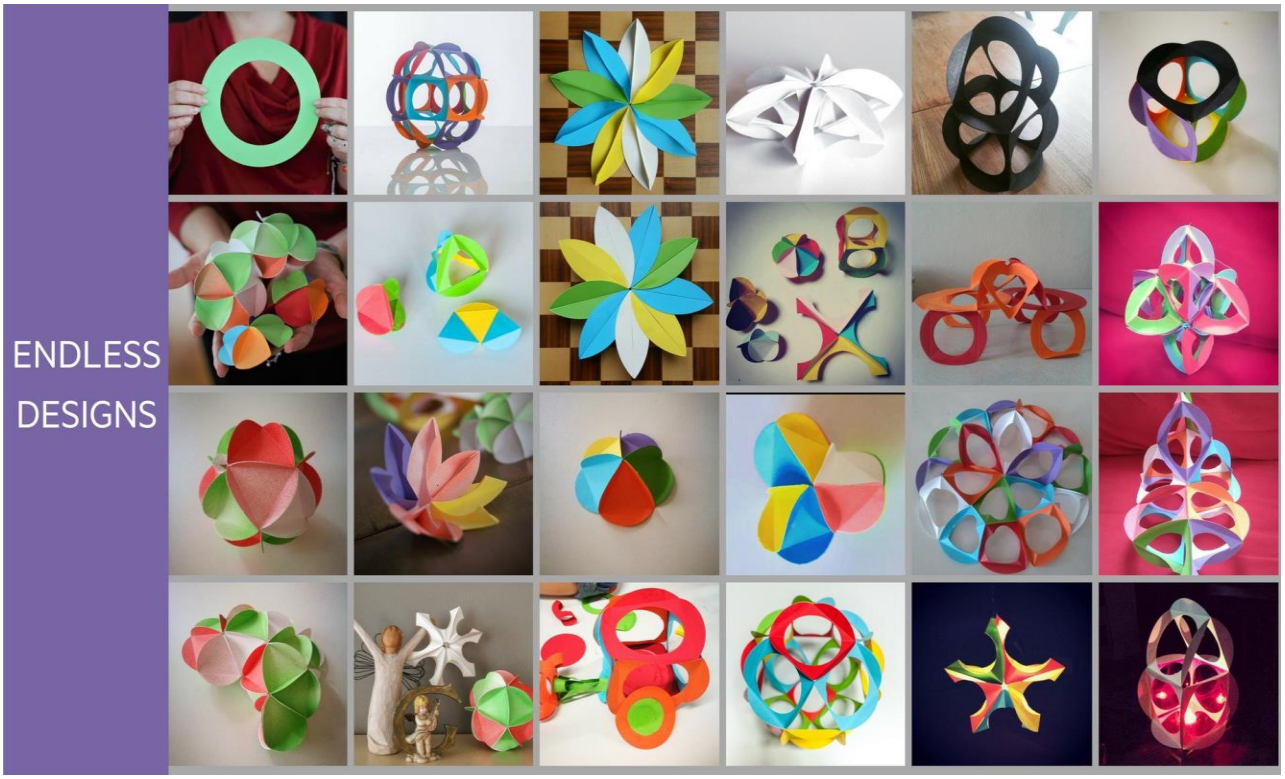

Figure 5: *Examples of GOM designs*

Conclusion

At the end of this workshop the children share the joy of making. They learn about geometry while playing and improving their mathematical and problem-solving skills. "The language of Math is also the language of empathy. 2+2 equals to 4 but so does 1+3. Both sides of the equation look different but the solution is same." [1] During the design process empathy is the main starting point of a problem. We need to see the problem from both sides just like the equal equations in math. When a designer starts to see the world with empathy, he becomes better at responsible tasks both moral and ethical. We start to question and criticize. GOM is still on progress as a learning tool. Currently we are working on quantifiable implications that can tell students about their strong skills and intelligences. We are searching survey techniques and applications for valuable feedback. The workshop that would be held for the Bridges participants would provide valuable

data for us from a mathematical point of view. I come from architectural background so the participant's mathematical background would add a valuable information for our mathematical point of view.

New Designs

GOM is still in progress as a learning tool. We just designed the pentagon and hexagon from paper. Our design research continues with the Buckyball which was patented by the architect Buckminster Fuller in 1961. The photographs are the interpretation of Buckyball with GOM. (Figure 6)

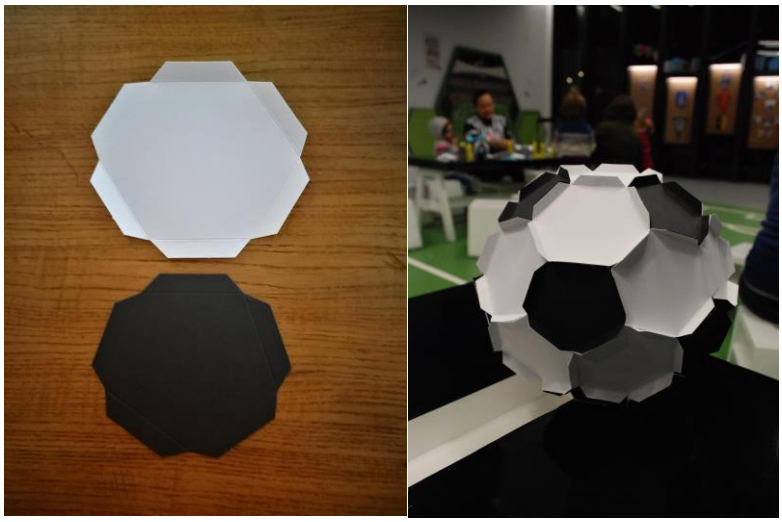

Figure 6: *The Paper Buckyball of Buckminster Fuller with GOM*

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