Citizen Art – Collective Mathematical Art to Raise the Public Awareness of Mathematics

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Abstract

The project *Polytopia – Adopt a Polyhedron* aims to raise awareness of mathematics in the general public. The participants are invited to adopt a polyhedron, give it a name and build a model. The individual polyhedra are displayed on a website, where we provide a crafting sheet for each polyhedron. Furthermore, we encourage the participants to build a creative model of the polyhedron from materials of their choice. Pictures of these models are uploaded to the website and thus a gallery of polyhedra emerges. In this paper we show results of the project. More than 1400 polyhedra have been adopted and 230 models were built.

Citizen Art

A paradigm of contemporary science communication is to engage the public in an eye-level dialogue about the subject instead of a hierarchal communication that hands down knowledge from experts [9]. Active participation and not just being a receiver of information is a key to form self-motivation to delve into the presented topics. The concept of citizen science invites the participants to actively join the research process. Examples are the collection of bird observation data [1] or catching mosquitos and sending them to a lab in order to map the location of different species [2]. The contributors of citizen science projects feel contented by playing an active part in the data collection, and studies hint at a rise of awareness, understanding and even literacy in the respective scientific fields [4]. We wanted to apply a similar concept in our project but also add an artistic and creative element. Therefore, the idea of *citizen art* was born [6]. Every participant would be able to attend to a fraction of the variety of polyhedra and thus be able to imprint a personal note by adopting, naming and building a creative model of a single specimen.

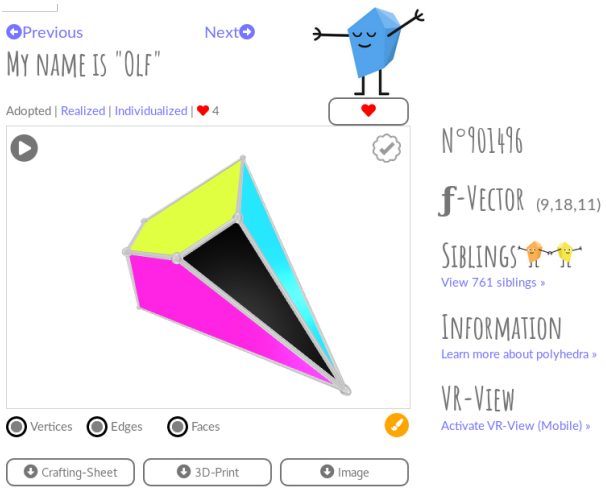


Figure 1: *Screenshot of the website www.polytopia.eu of an adopted polyhedron [3].*

Project Description

Polyhedra

There are many different definitions of convex polyhedra. In this paper we only give a very intuitive one: three-dimensional convex polyhedra consist of outward-pointing vertices, straight edges and flat surfaces and do not contain any holes or indentations. The ancient Greek scholars Plato and Euclid described them and they have been investigated ever since. Dürer, Kepler and da Vinci have emphasized the aesthetically pleasing qualities of polyhedra in various artworks. The symmetry and regularity of polyhedra have fascinated many mathematicians and laymen to this day [5].

Adoption and Realization

In our project *Adopt a Polyhedron* we illuminate the multiplicity and wealth of variety of polyhedra for the public. On our website all 2907 combinatorial types of polyhedra with up to nine vertices are on display [3]. The user can choose a polyhedron and by giving it a name, adopt it, see Figure 1. For each polyhedron a crafting sheet to build the model can be downloaded. We also encourage the users to make another creative and *individual* model of their object. Pictures of the models can be uploaded and piece by piece a collective gallery of all 2907 polyhedra with up to nine vertices may emerge. Figure 2 shows a mosaic of all 230 models that are in the gallery so far.

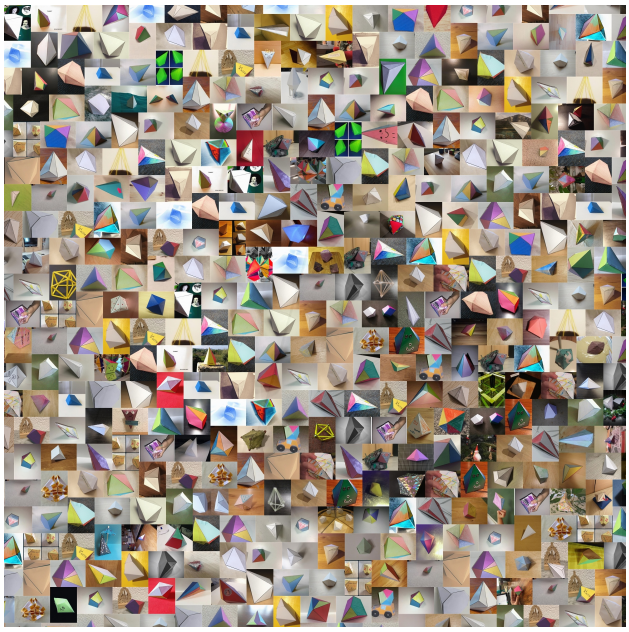
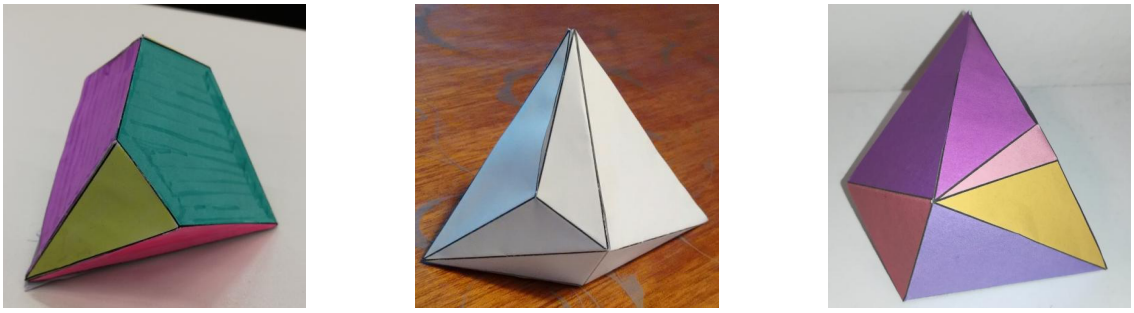


Figure 2: *Mosaic of pictures of polyhedra models.*

Goals

The objective of the project *Adopt a Polyhedron* is to raise the public awareness of mathematics and geometry. In adopting a polyhedron, the participant relates to a mathematical object on an individual level and by naming it and building a creative model they can add a personal and artistic element. This new approach emphasizes the one-on-one relationship between a mathematical object and the participant. By focusing on a single object, a huge field is easier to access and the participants are not overwhelmed by the complexity. They can add a personal touch and contribute to science. By putting the creative and relational aspect first we hope to foster an internal motivation to learn more about the object. We provide a detailed glossary on polyhedra

and related mathematical concepts on the website where a curious participant can quench their thirst for knowledge.



(a) **(b)** **(c)**

Figure 3: *Examples of realized polyhedra: (a) "Guggeli Knubbeleder", (b) "Anne Elisabet" and (c) "Juweloeder".*

School Materials

Pupils and students are a major focus group of the project. In order to make it easy for the teachers to implement the project in the math class, we developed school materials which link polyhedra to the content of the school curriculum. The learning journal *Polly's Journal* is based on the didactical principle of *dialogical learning* which enables the student to steer the direction and speed of their own learning process [8]. The journey starts with the construction of two-dimensional polygons and transfers the learner to building more complex three-dimensional polyhedra. Another focal point of the journal is to encourage the students to look at polyhedra with the eyes of a mathematical researcher and try to find their own research questions about polyhedra [7]. The goal is not to find a solution, but to find an interesting and difficult question. The process of finding questions and not answers reverses the usual process of the math class and we encourage the students to mail us their questions in order to engage in a direct dialogue. All school materials and the website are offered in English and German.

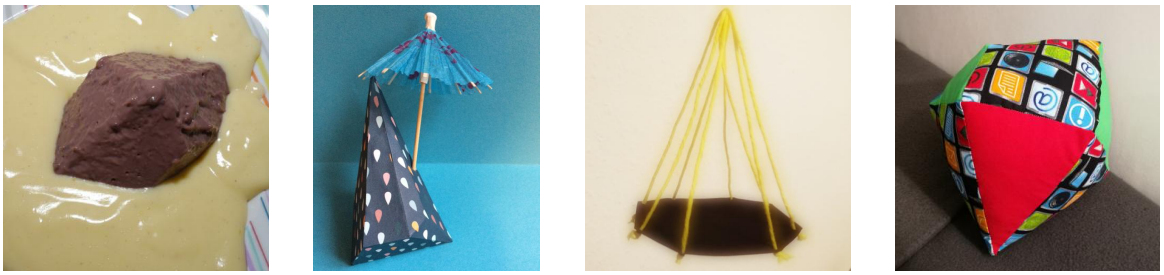
Results – Numbers and Pictures

Currently (2019-02-27) 1439 polyhedra have been adopted and pictures of 230 models have been uploaded. 183 of these models are paper models [3]. We call these polyhedra *realized*. Figure 3 shows three examples of realized polyhedra. The *individualized* polyhedra are the artistic and creative models that were created after the original paper models. The participants used a wide variety of different materials and Figure 4 illustrates four examples of the 47 individualized models.

From the user survey on the website we derive that 37% of the users are pupils (6 - 19 years old), whom are our main target group. An additional 10% are teachers, whom are important factors in reaching the children. 51% of the users saw in themselves a significant growth in their knowledge about polyhedra.

Conclusion

The idea to bring the intimate relationship between math and art into the realm of science communication by *citizen art* is well received by the participants of the project. Professional mathematicians often speak about creativity in their work that seems to be hidden to the laymen. It must be further investigated whether the *citizen art* approach to raise the public awareness of mathematics is able to convey this experience and if the stated gain in mathematical literacy is measurable and significant.



(a) **(b)** **(c)** **(d)**

Figure 4: *Examples of individualized polyhedra and their materials (a) "Puhlyeder" (chocolate icecream) (b) "Seems to be Piez" (cardboard, holding a paper umbrella), (c) "Octavius" (cardboard and string) and (d) "Flori" (soft toy, fabric and filling).*

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