The Magic of Anamorphosis in Elementary and Middle School

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Abstract

This workshop will introduce the art and math behind cylindrical anamorphic images to K-9 students. Some of the mathematical concepts related to anamorphic images will be explored. We will also explore ways in which mathematics curriculum can be complemented with creative artistic activities. Workshop participants will have the hands-on opportunity to produce their own anamorphic images, which will be theirs to keep and re-use post-workshop. There will be opportunity to discuss how different activities related to anamorphic images could be implemented and extended to accommodate students of different abilities and interests. All materials needed for the workshop will be provided.

Introduction

Anamorphisis is a unique form of perspective art that obeys mathematical perspective laws. An anamorphic picture or sculpture appears distorted, but when the image is viewed from a certain position (perspective point) or through an optical device, such as a curved mirror, it becomes recognizable. There are two common anamorphic techniques: perspective or oblique anamorphosis, and mirror or catopric anamorphosis. The type of anamorphic technique used typically depends on the creative intentions of the artist.

Anamorphic techniques have been in art from as early as the fifteenth century. However, various kinds of anamorphic art continue to amaze and inspire creativity today. Contemporary artists include Jonty Hurwitz, who creates anamorphic sculptures whose propose form are revealed through cylindrical mirrors; Andrew Compton, who creates art viewed through a conical mirror; and Panya Clark Espinal, who creates simple drawings that bring anamorphic effects to the streets. These artists and many others continue to fascinate adults and children with anamorphic art. More recently, anamorphic art has been integrated into K-12 classrooms by educators interested in cross-curriculum activities that combine mathematics, art and science. In Scotland, elementary students have used anamorphic mirrors to learn about concepts in science, math and art (https://blogs.glowscotland.org.uk/wl/P7J/2012/10/17/p7j-get-smart/). In another school in Hong Kong (http://dhanara.aishk.edu.hk/2015/06/secondary/anamorphic-art-in-year-8-mathematics/), grade 8 students used a large polar grid on a floor to create anamorphic art that could be seen using a large cylindrical mirror.

The mathematics that underlie the varied anamorphic transformation techniques differ, and can be difficult to teach to a K-12 audience. Hunt [5] discusses the mathematics behind the anamorphic transformation to the surface of a cone and a pyramid, which involves geometry and algebraic calculation that is beyond high school level. Raush [7] describes the mathematical formulas that are used to produce printable grids that are used for cylinder anamorphosis images. She, too, shows that the mathematics is above high school level. However, some of the concepts and ideas behind anamorphic projections can be easily explored by K-12 students in a variety of ways. In 2015, Fenyvesi and Hahkioniemi [3] offered a workshop at the Bridges Conference which included activities involving anamorphosis suited for school-age children. Iavorski and Saito [6] also described how they used the cylindrical transformation in elementary and junior high math classes. In recent years, a number of accessible online videos that describe the technique of anamorphosis have become popular, and have provided educators with a means to introduce perspective techniques in art classes.

This workshop focusses on anamorphic images that can be identified through a cylindrical mirror. Participants will have hands-on experiences developing anamorphic art, and opportunity to share ideas on how to replicate the activities of interest to them in the classroom. Practical instructions and guidelines related to the introduction of anamorphic art and the development of cross-curriculum activities involving anamorphic art will be provided.

Why Use Anamorphosis in Math and Art Class?

Studies have shown that "at all levels, students benefit from working with a variety of materials, tools and contexts when constructing meaning about new mathematical ideas." [2]. Offering students a variety of pedagogical approaches and links among concrete, pictorial and symbolic representations of mathematical concepts, helps them develop spatial reasoning skills. Artists, architects, and engineers, among others, need a highly developed capacity to mentally build and manipulate structures and objects. Activities that include concepts related to anamorphosis offer a unique and engaging opportunity for students to learn and apply mathematical concepts often presented in more abstract form, such as reflections, stretches and translations.

The creation of anamorphic art in cross-curricular activities involves the mental manipulation of images and objects, which is a fundamental skill to the understanding of mathematics, especially geometry. These activities stimulate thinking and planning, requiring students to mentally anticipate the mirrored images given a drawing. In activity 3, for instance, participants (or students) will be challenged to predict how the Cartesian grid has to be changed in order to solve the deformation problem. For example, introductory Calculus courses are often preceded by and introduction to functions and graph transformations. The practice of predicting results from a geometrical transformation using critical reasoning skills is an essential step towards the development of abstract thought. An important aspect of learning mathematics is the ability to make connections between "real world" observations and their mathematical representation. Diagrams, physical models, and mathematical symbols are useful tools for communicating information and understanding in mathematics [8], and activities involving anamorphosis provide students with the opportunity to learn to use these tools.

Finally, but perhaps most importantly, anamorphic images stimulate students' curiosity, engaging them to explore new art techniques, new points of view of artistic representations and different painting styles. The integration of math and art creates the potential for complementary learning in both disciplines.

Activities

In this section we briefly describe the activities that will be offered in the workshop, and some possible modifications to accommodate different learners. Detailed information, students' handouts, and other ideas will be discussed during the workshop.

Warm-up and Introduction. We will share examples of anamorphic artwork through a brief slide show to stimulate discussion about anamorphic art. We will begin the discussion by asking questions such as: Is it possible to determine what the pictures or sculptures are depict? Is there a way we might be able to view these images in a "normal" form? Do you think that if we "untwist" the images we can determine what each of them represents? We will distribute several printed images so participants can use them later to discover what they represent. The objective of this activity is to raise the participants' awareness about how we may be misled when our senses provide conflicting information, especially in the case of optical illusion. The activity generates discussion about artistic styles and techniques that artists may use to captivate an audience. Possible classroom modifications include: (a) the use of children's cartoons or pictures of movie characters, which younger students may be more excited to work with; (b) the use of photos that depict instructors or celebrities to invoke an element of surprise.

Build the cylindrical mirror. Participants will build a cylindrical mirror from a piece of flat/flexible mirror and use it to discover the apparently hidden images. They will experiment with the flexible piece of mirror, bending it in different directions to develop ideas about geometrical transformation. Participants are encourage to experiment with their own reflection in addition to the images provided. As a group, we will develop conjectures about how the mirror transforms an image.

Discovering properties. In this activity participants will draw parallel and perpendicular lines and observe how they are transformed by the mirror (Fig. 1). Participants will be challenged to predict the transformation of objects (or drawings of lines and objects) through a mirror and the actual object (or original picture) from a transformed image. This activity provides an excellent opportunity to discuss parallel and perpendicular lines and properties of geometrical shapes. For younger students, possible classroom modifications include: (a) providing students with grids that already contain pictures and comparing the differences between the original and mirrored objects; (b) having students color squares in empty grids, and observe the differences. Advanced math students can be challenged to create their own polar grid using a compass to make concentric circles and radial lines.

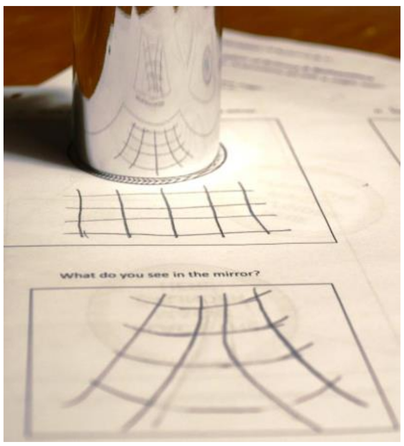

Figure 1: D*iscovering properties drawing parallel and perpendicular lines.*

Figure 2: *A drawing from a rectangular grid was mapped onto a polar coordinate system; the distorted drawing is transformed into a recognizable image by reflection in a cylindrical mirror.*

Make an anamorphic design. Participants will make their own picture in the Cartesian grid and transfer the design into a polar grid by mapping the points from one system of coordinates to the other (Fig. 2). The cylindrical mirror will then be used to view and enjoy the final art work. This activity introduces younger students to coordinate systems and motivates them to use coordinates to locate and reproduce images. From the artistic point of view this activity has a great potential to allow students express their artistic abilities through experimentation with color, effects, and materials. Depending on students abilities they can be asked to color pictures in the polar grid, transfer and color an (already drawn) image from a Cartesian grid to a polar grid, or in the case of artistically advanced students, hand-draw an image without the guidance of a grid.

Anamorph me! In this activity participants will find a photo (preferably online) of a personality and use the app *Anamorph me!* [1] to generate an anamorphic image of that person. They will share their anamorphic photos, and collectively guess the anamorphed personalities. Figure 3 shows the interface of the app Anamorph me!, and a printed anamorphic photo that is the result of the cylindrical transformation. In a classroom setting some possible modifications of this activity include anamorphing student photos using the app and having students guess the identities of the anamorphed students from print-outs of the transformed images. More advanced students may be able to take and anamorph photos of each other. The sillier the photos, the more fun and challenging it will be.

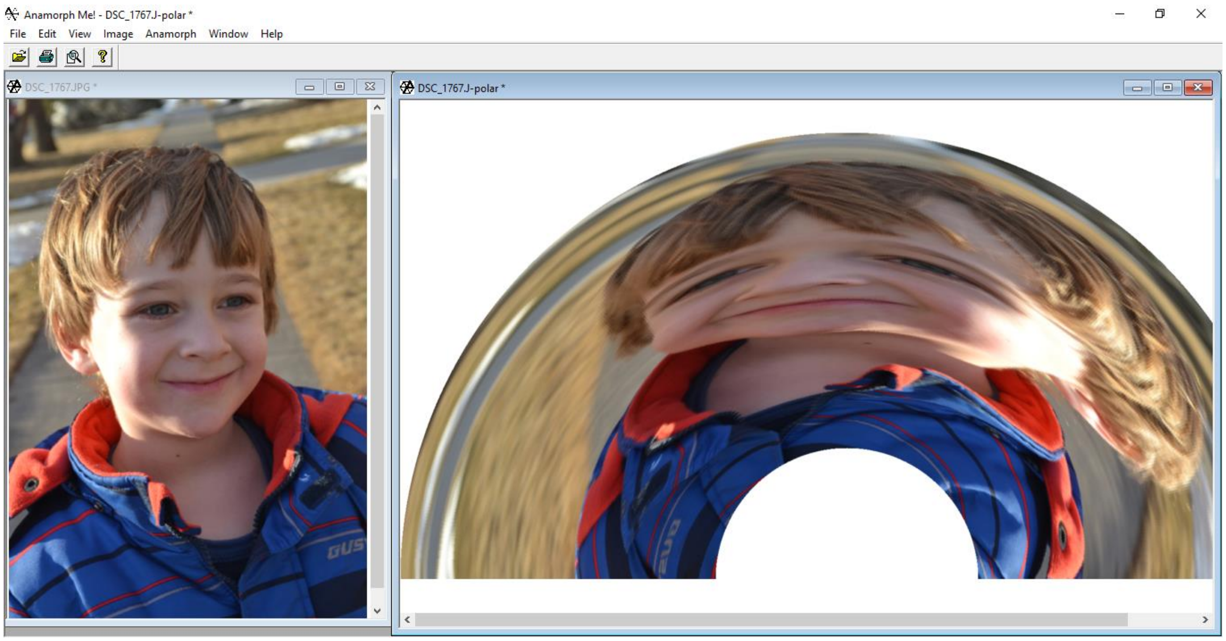

Figure 3: *Anamorph me! software interface. The transformation of a photo into a cylindrical anamorphic image.*

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