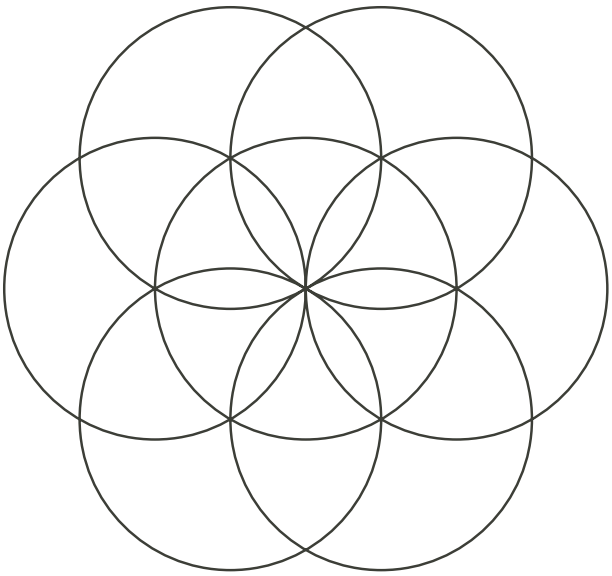
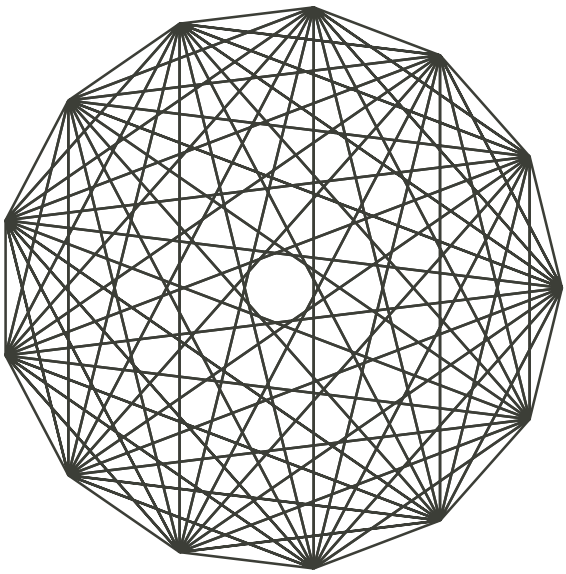


• Bridges for Teachers •
• Teachers for Bridges •



Mathematics Investigations in Art-Based Environments

Mara Alagic
Wichita State University, USA
mara.alagic@wichita.edu

Paul Gailiunas
Gosforth High School, Newcastle, UK
p-gailiunas@argonet.co.uk

Abstract

This paper presents two sources of information about mathematics and art integration. The first source is a brief outline of concepts that will be introduced through the workshop series at this conference. The second source is a collection of insights and resources about mathematics and art integration provided by a group of elementary education teacher candidates.

Introduction

Today's mathematics teachers face many challenges in their efforts to meet requirements of standards-based teaching and high-stakes assessments. They need ongoing support from their professional communities. An emphasis on standards-based teaching, although it appears somewhat limiting, provides formal guidance for developing both conceptual and procedural understandings of mathematical concepts. Educational objectives are focusing more and more on innovative ideas for teaching for understanding [6] which includes integration across curricula, conceptual understanding via multiple representations, contextual learning, and problem-based learning approaches [4, 5]. Teachers need creative ways of accomplishing such demands; they need and like ideas for mathematics education which integrates the arts. In addition to innovative ideas for mathematics education via the arts, teachers need high quality guidance and resources that would model for them how to explicate mathematical concepts that are more or less implicit in art-based contexts. Furthermore, art-based assessments and application of these concepts in new environments may take learning even deeper.

We learn and retain the most from thinking in critical and creative ways. To design an effective, creative, and critical mathematics learning environment teachers must begin with an understanding that students' learning is dependent on the way information is presented. Perception-based representations preserve much of the structure of the original perceptual experience. Meaning-based representations are abstracted from the perceptual details, incorporating the meaning of the experience [2]. Mindfulness in learning requires students to (a) think in meaningful ways to represent what they know and (b) actively engage to create knowledge that reflects their understanding of mathematical ideas [3, 7]. When students represent what they know in their own way, through their own representations, they deepen their understanding of mathematical ideas, expanding their repertoire of representations. Only when individuals can go back and forth between various representations of mathematical concepts (for example, the visual and the analytic) does mathematical understanding occur [1].

Both mathematics and art have their own language, structure, configuration, and means of expression. Creative problem-solving skills, facilitation of both informal and formal approaches, developing expertise in selecting appropriate tools, media and methods are common, in their own contexts, to both mathematics and art apprenticeship. The process and the product of creating and constructing pictures, applets, images, icons even symbols, in order to represent what we perceive to be relevant for an understanding and representing that understanding are in the heart of visualizing [8].

Bridges for Teachers, Teachers for Bridges

Teachers always need good integration ideas. The following is a brief clustering of mathematics and art integration concepts that will be presented at this conference.

- A Mandala is a complex circular design, intended to draw the eye inward to its center. Creating Mandalas provides fascinating bridges between mathematics, art, architecture, history, and science. Techniques used in creating mandalas can be used to demonstrate fractions, angles, trigonometric relations, and fractals. Further, these techniques have the potential to interest and motivate mathematics students (Stang).
- The historical context and reason-result relationship in the creation of dome tessellation by the architect Sinan - designing structures for a specific dimension - evaluating the usage of the dome structure in Sinan's mosques as the result of technology and material brings an understanding of mathematics and art connections in architecture (Sagdic, Vural, & Taygun).
- The creation of math art book forms provides an interesting interplay of 2D and 3D shapes. In the process of paper folding, these basic forms use elementary geometric knowledge, while letting students explore creative ways to use mathematical information in adding content to the pages or faces of these forms (Happersett).
- Hex Signs are circular discs with intricate geometric designs with specific meanings that were hung on barns in the "Pennsylvania Dutch" region of the United States. Construction of Hex Signs involves some interesting mathematics concepts. Common designs include: Rosettes, Birds, and Star Polygons and can be constructed using dynamic geometry tools (Evans).
- Line designs form a basis for mathematical understanding of geometric shapes and relationships of points, segments, and angles. Each of the line segments is really a tangent for each of the curves being formed; however, because of what we focus on, we often see the curves. The Arete of Line Designs explores the historical (including the George Boole connection), philosophical, and pedagogical nature of line designs (Round).
- The Plato Bead, a Bead Dodecahedron, is an example of a polyhedron and is another way to represent and learn the properties of regular and semi-regular solids. With a history dating back several hundred years in China, a bead polyhedron can be used with various sizes, colors, and types of beads (Shea).
- Sliceform models are three-dimensional objects created by slicing a solid many times in two directions. Modeling and physically constructing mathematical models may be accomplished using a computer, a printer, craft knife, glue, and paperboard (Luecking).
- A game called "zellij multipuzzle" is a set of 669 zellij-style tiles, of which one side is white and the other a different color so that each tile can be utilized in a positive or negative configuration. Designed by using the technique of laser cutting, this game is an introduction to the art of geometrical arabesque (Castera).

- Topological Mesh Modeling with hands-on experiments can be accomplished using topological modeler, TopMod. TopMod provides a wide variety of interactive techniques that allow the creation of unusual and interesting shapes by changing the topology of 2-manifold meshes (Akleman & Srinivasan).
- Paper Sculptures with Vertex Deflection are mathematically motivated developable surfaces (examples: sculptures by Ilhan Koman); a variety of shapes creating saddle, maxima, and minima using nip and tuck can be constructed and can provide an introduction to mathematical ideas, such as the Gauss-Bonet theorem. (Akleman, Koman, & Akgün).
- Stick models based on Platonic polyhedra convey some geometry concepts. These physical models are applicable to students from elementary school through graduate school, as with hands-on experiences, they build on their existing level of knowledge (McDermott)
- Reflecting on Vermeer's painting of The Music Lesson, the basic use of the RMS90 Modular Scale can be utilized to directly deduce all the elements of the scene in perspective, essentially recreating the perspective outline of the painting (García-Salgado).

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