USING PHOTOGRAPHY INSERTED INTO GEOGEBRA TO TEACH MATHEMATICS TO LEARNERS IN A MEANINGFUL WAY

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Abstract:

The paper shares how to use photography inserted into the GeoGebra software to teach mathematics to learners in a meaningful way so students are more successful in learning math. By using technology and photographs, our young learners will become excited to construct and investigate math ideas and learn math while using GeoGebra software and seeing math in the world around them when using photography. By liking and enjoying math more by way of photography and the software GeoGebra student achievement may increase. The author hopes students will see and appreciate the world around them better and maybe turn them on to the STEM fields which are so critical today while also seeing the math in the photography and world around them while employing critical emerging technology like GeoGebra.

Keywords: GeoGebra, Photography, Math Content, Technology, Standards, Real-world

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Introduction

> *"A photograph never grows old. You and I change, people change all through the months and years but a photograph always remains the same. How nice to look at a photograph of mother or father taken many years ago. You see them as you remember them. But as people live on, they change completely. That is why I think a photograph can be kind."*
>
> -Albert Einstein 1879-1955

By using photography and GeoGebra, we can better reach our students and show them how math is all around us. In today's technologically-oriented world, students need to be proficient in Science, Technology, Engineering, and Mathematics (STEM) fields. As endorsed by the National Council of Teachers of Mathematics (NCTM, 2000) and stressed in the new Common Core State Standards (CCSS) in Mathematics, it is critical that we teach math using technology, address attitudes and anxiety toward math, and make the math that students are learning relevant and meaningful. Often, it may be best to start teaching young people geometry first as opposed to numbers which are considered to be more abstract and difficult to learn. Geometry is one of the most concrete branches of mathematics and focusing on this first can benefit students' whole view of mathematics and their attitudes towards learning it (Furner, 2021: Furner and Marinas, 2020). Chehlarova & Chehlarova (2014) found that using such software like GeoGebra with photography was motivational for the learner in turning them on to learning mathematics. Motivation is critical today in teaching mathematics and as Albert Einstein says above, "photography can be kind."

This paper looks at ideas for teaching mathematics with the use of technology and photography using the free dynamic mathematics software, GeoGebra, to help teachers develop mathematically confident young people. GeoGebra is 20 years old now! Over the years, many educators and researcher have developed ggb files to develop many creative and imaginative ideas using GeoGebra. GeoGebra offers many teacher resources on their website to use in the classroom to teach mathematics (Furner and Marinas, 2020). GeoGebra examples will be shown as well as available websites to find interactive files that show how GeoGebra can be used to cover many math concepts K-12 with photography (Furner, 2021). Ancochea & Cárdenas (2020) contend that making the learning of math real-world using photography and GeoGebra can help students see value in math and also be more successful in learning it when it is made more relevant. Furner and Marinas 2020) have shown in their work over the years how easy it is to insert photographs into GeoGebra and make math relevant as you teach it to young people. Bakar, Yunus, Mohamed, & Karim (2020) found using photography and representational models used in GeoGebra software helped students better understand the math they were learning with such models/graphics. The goal of this presentation/paper is to show educators how to insert photography into the GeoGebra software and use the tools to help cover many of the Common Core Mathematics Standards for teaching grades K-12 mathematics today.

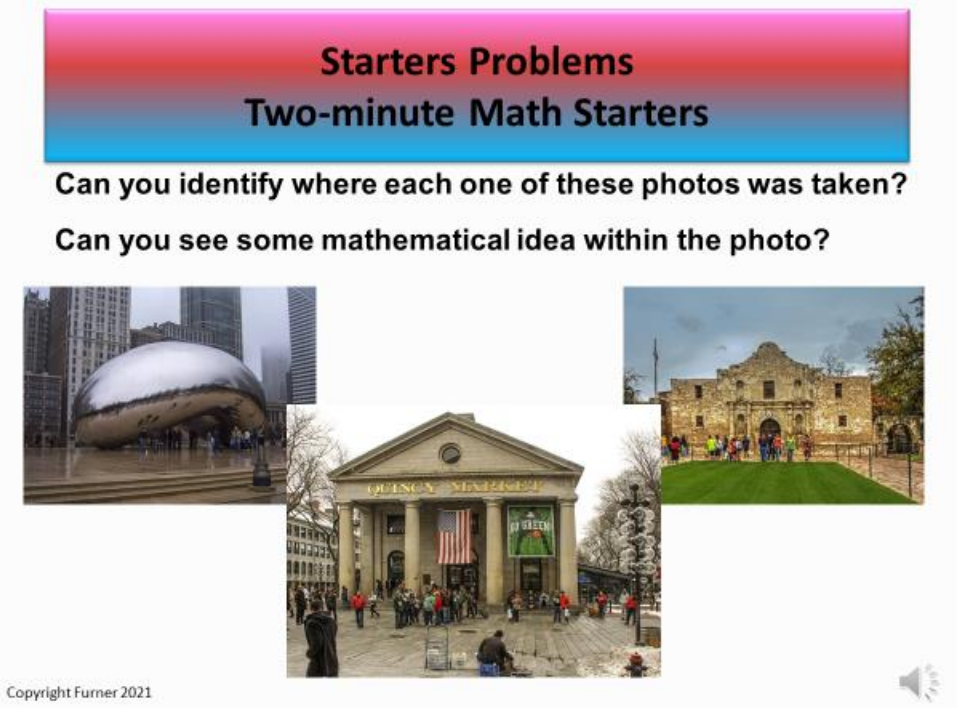

Figure 1. Do You Recognize Each ICTCM Conference City for Each Photo?

Today it is critical to make important connections while teaching math showing students math in the real world. Students are often motivated and excited by photography. This session will show how mathematics teachers can use photos inserted into GeoGebra Software and then explore the relevant math in the photograph, i.e. shapes, symmetry, measurement, fractions, parabolas, etc. By using software like GeoGebra and photography of the real world, many of the new Common Core Math Standards are met while also helping students to see the math in the world around them (Furner and Marinas, 2020).

Munakata and Vaidya (2012) in their research found that students do not consider mathematics and science to be creative endeavors, though the traditional artistic disciplines rank high in this regard. To address this problem in perception, the authors used photography as a means to encourage students to find the deep-rooted connections between science and mathematics and the arts. The photography project was used in a formal classroom setting as well as an outside activity, i.e. in a more informal setting. The project found student interest and motivation were peaked when photography was part of the instructional strategies to teach new material while making meaningful connections to the math using the photography.

This paper promotes using emerging technologies like GeoGebra and show how photos are inserted into GeoGebra and used to relate the math ideas in the photos based on research to better engage young learners. Students see an appreciation for math around us and in everyday life (Gorriz & Vilches 2019). When using visuals, students are often highly

motivated by using photos that appeal to their senses while exploring the mathematics within them (Furner and Marinas, 2020). Antje, Hannula, & Toivanen (2018) found that when using outdoor photography when teaching math that it had a positive impression on students' and their learning of mathematics. Hall & Lingefjärd (2016) surmise that using GeoGebra and creating such mathematical models is critical for student learning and understanding today.

GeoGebra

GeoGebra is free and multi-platform dynamic mathematics software for all levels of education that joins geometry, algebra, tables, graphing, statistics and calculus in one easy-to-use package found at: http://www.geogebra.org.

GeoGebra is a multi-platform dynamic mathematics software for all levels of education from elementary through university that joins dynamically geometry, algebra, tables, graphing, spreadsheets, statistics and calculus in one easy-to-use package (Hewson, 2009; Hohenwarter, Hohenwarter, & Lavicza, 2009). This open-source dynamic mathematics software can be downloaded for free or used online. Since there are no licensing issues, students and teachers have the freedom to use it both within the classroom and at home. GeoGebra has a large international user and developer community with users from 190 countries is currently translated into 55 languages. This session will share how to use GeoGebra and also how to insert photograph and use the tools of GeoGebra to investigate important math concepts in grades K-12.

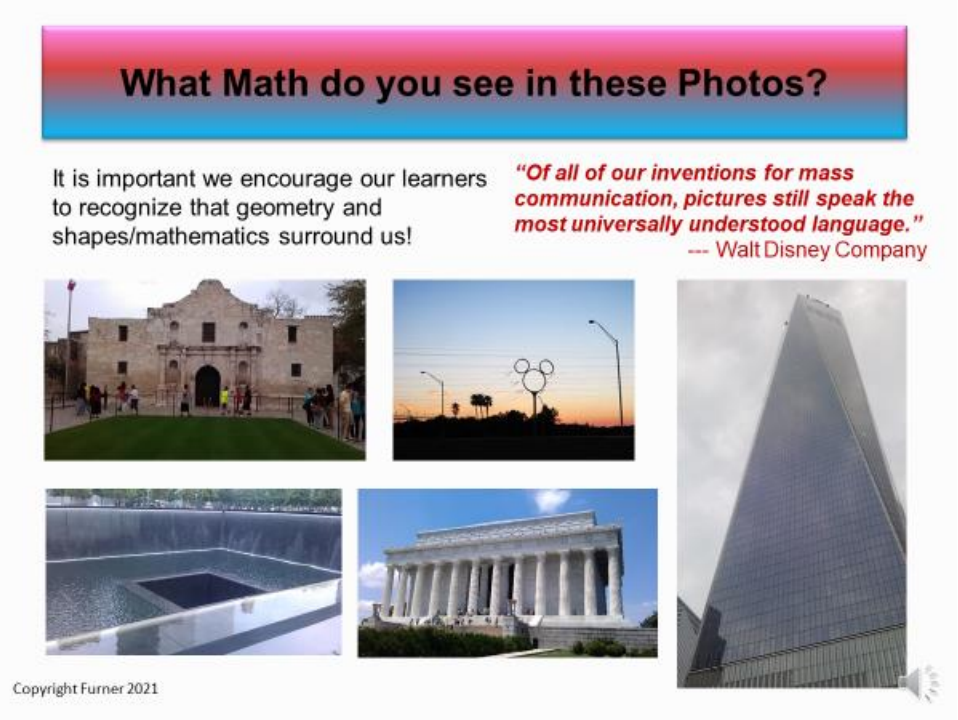

Figure 2. Math Surrounds Us in Photographs/Disney Quote

Making Connections While Teaching Mathematics

Connections need to be made when we teach mathematics (Zengin, 2019). Munakata and Vaidya (2012) based on their research found that students do not consider mathematics and science to be creative endeavors, although the traditional artistic disciplines rank high in this regard. To address this problem in perception, the authors used photography as a means to encourage students to find the deep-rooted connections between science and mathematics and the arts. The photography project was used in a formal classroom setting as well as an outside activity, i.e. in a more informal setting. The project found student interest and motivation were peaked when photography was part of the instructional strategies to teach new material while making meaningful connections to the math using the photography. Jones (2012) also in her book, *Visualizing Mathematics*, discusses how teachers need to help students visualize and create representations of their math understanding in order to become excited about the subject. Arranz, Losada, Mora, & Sada (2009) also support using such realities as photography in GeoGebra to teach mathematics seeing the representations for understanding of the subject. Rizzo, del Río, & Manceñido (2019) and Rizzo, Laura, Manceñido, Lavicza, & Houghton (2019) in their research found that it is important to link photography with GeoGebra software when teaching mathematics to make it more meaningful to learners.

Covering the Common Core Math Standards in Classrooms Today

Today teachers are challenged to cover many math standards. GeoGebra lends itself to teaching in a meaningful way incorporating technology while using photography and the dynamic tools of the GeoGebra, teachers can cover many of the Common Core Math Standards. In the Figures 3-12, each show examples of how to teach many of the common math concepts and standards listed below by the Common Core with examples below with the examples in Figures 3-12 of such concepts.

CCSS.MATH.CONTENT.K.G.A.2
Correctly name shapes regardless of their orientations or overall size.
CCSS.MATH.CONTENT.2.G.A.1
Recognize and draw shapes having specified attributes, such as a given number of angles or a given number of equal faces.1 Identify triangles, quadrilaterals, pentagons, hexagons, and cubes.
CCSS.MATH.CONTENT.4.G.A.1
Draw points, lines, line segments, rays, angles (right, acute, obtuse), and perpendicular and parallel lines. Identify these in two-dimensional figures.
CCSS.MATH.CONTENT.6.G.A.3
Draw polygons in the coordinate plane given coordinates for the vertices; use coordinates to find the length of a side joining points with the same first coordinate or the same second coordinate. Apply these techniques in the context of solving real-world and mathematical problems.

CCSS.MATH.CONTENT.8.G.B.7
Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.
CCSS.MATH.CONTENT.HSG.CO.A.1
Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.

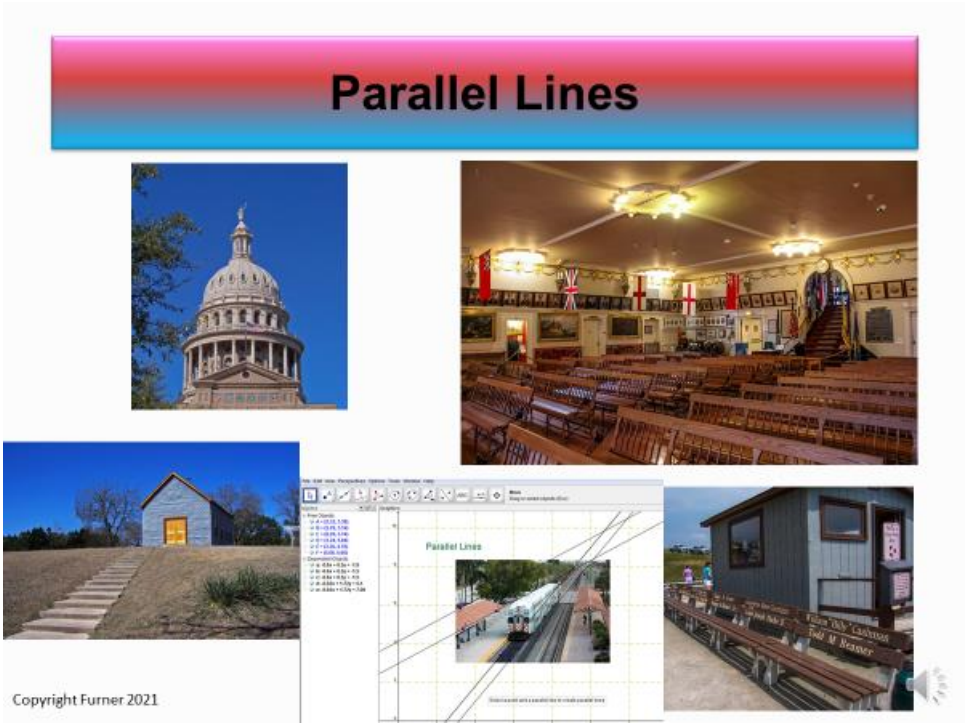

Figure 3. Parallel Lines in Photos and GeoGebra

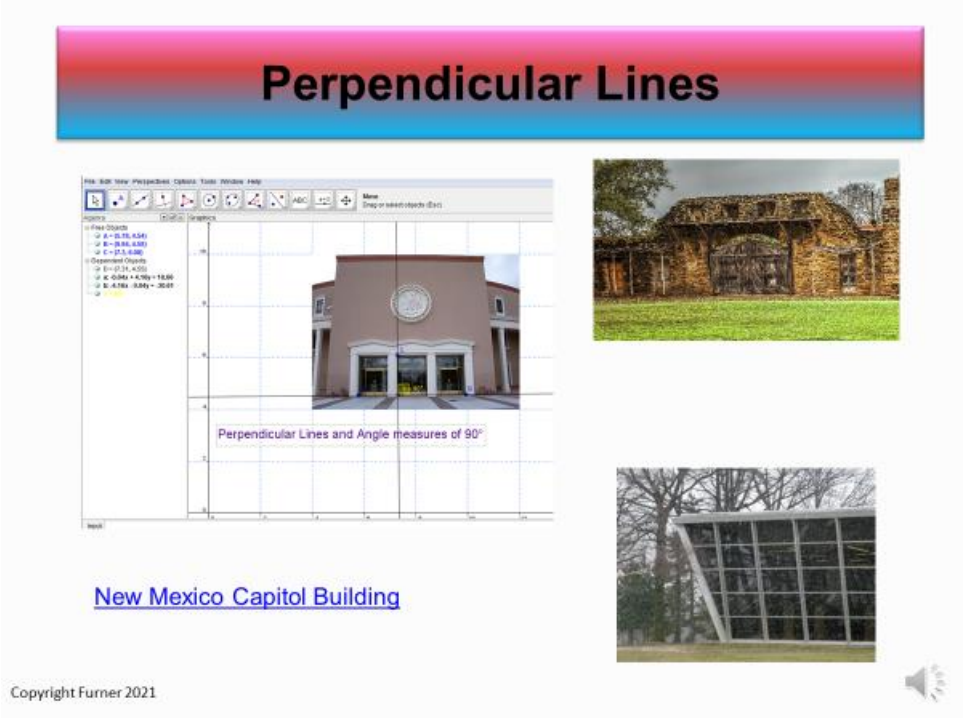

Figure 4. Perpendicular Lines in Photos and GeoGebra

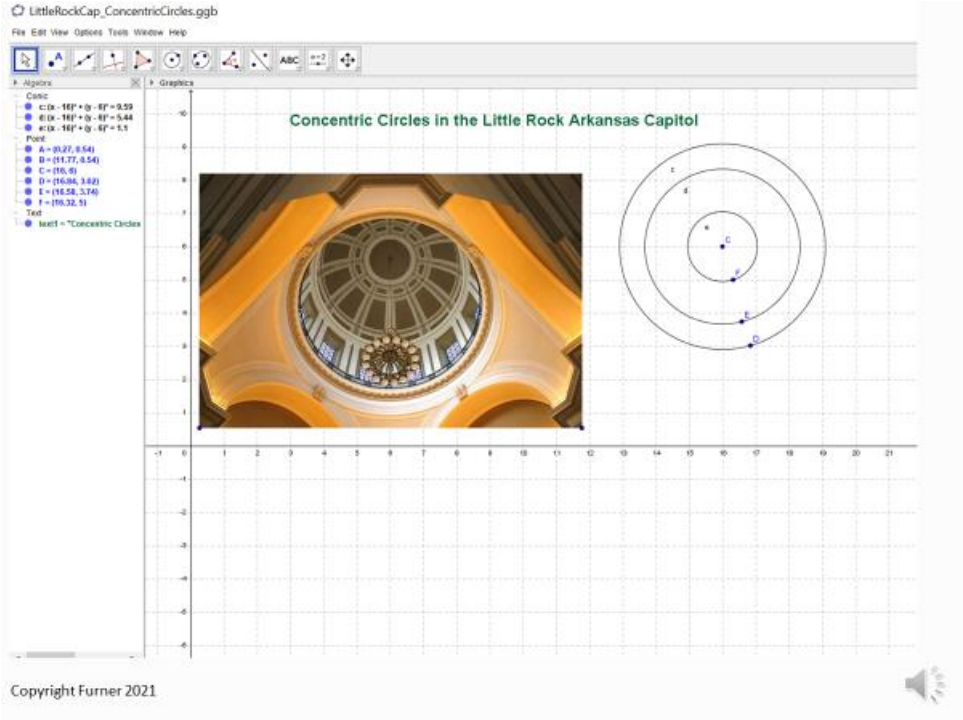

Figure 5. Concentric Circles in a Photo and in GeoGebra

Figure 6. Parabolas in Photos

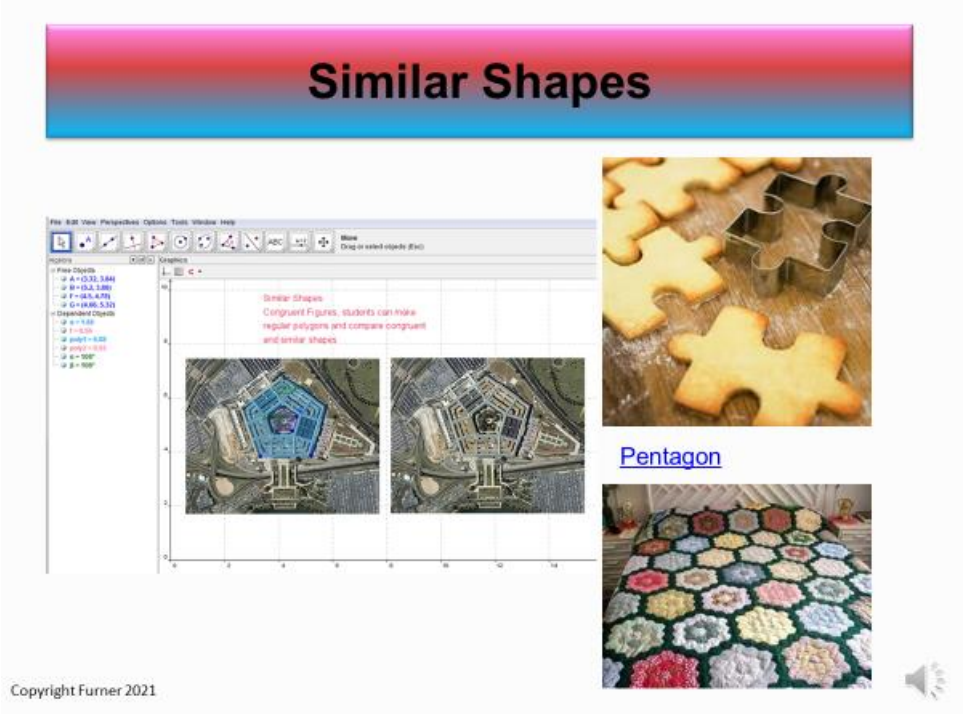

Figure 7, Similar Shapes in Photos and GeoGebra

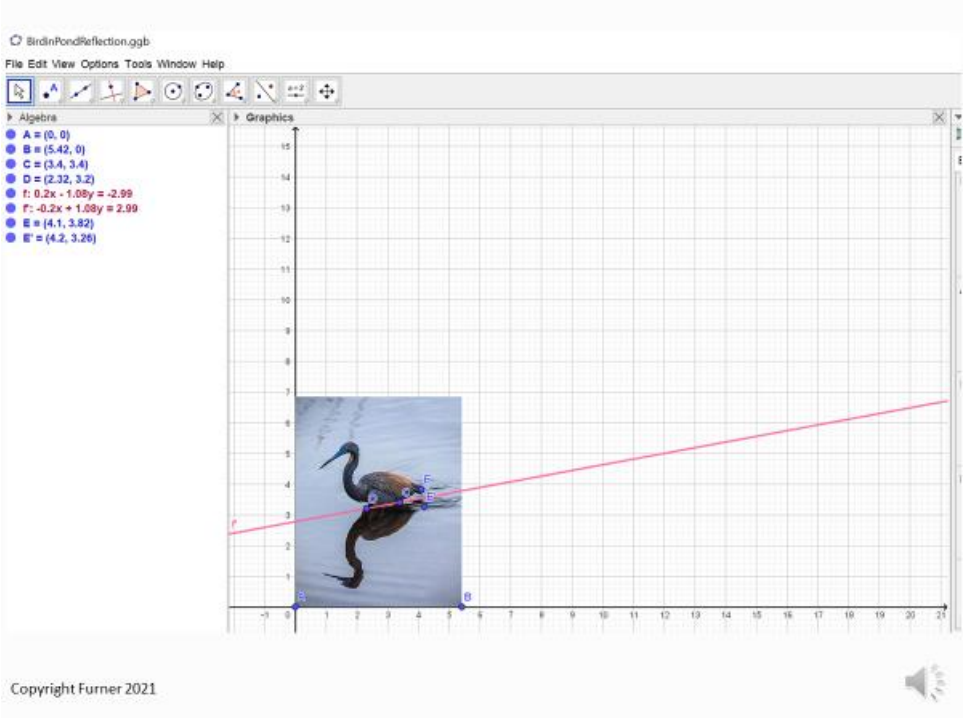

Figure 8. Reflections Using a Photo in GeoGebra

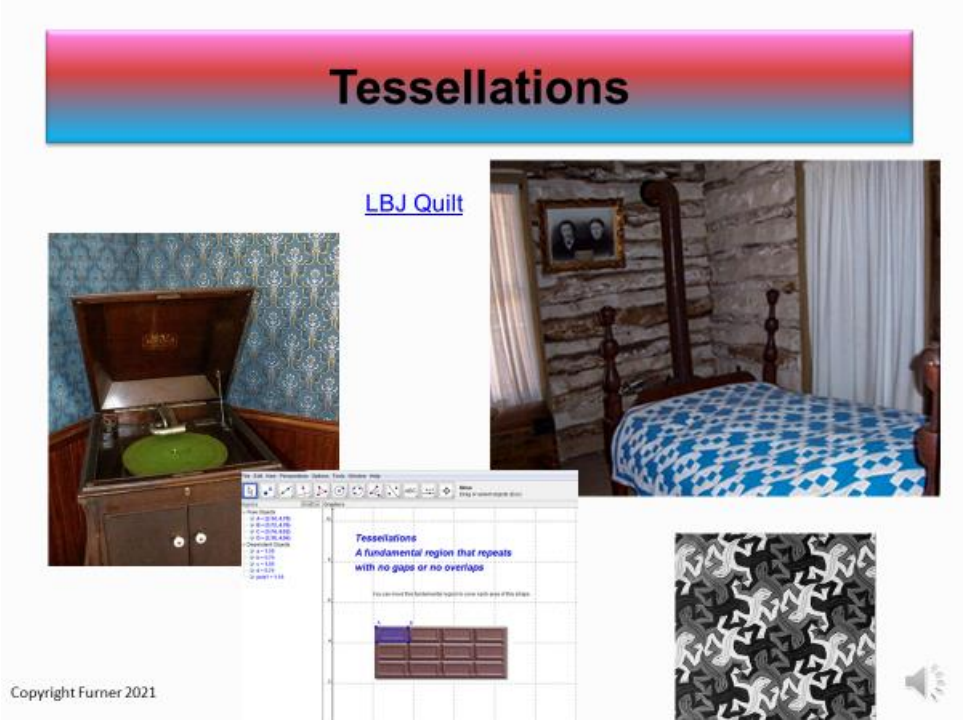

Figure 9. Tessellations in Photos and an Example in GeoGebra

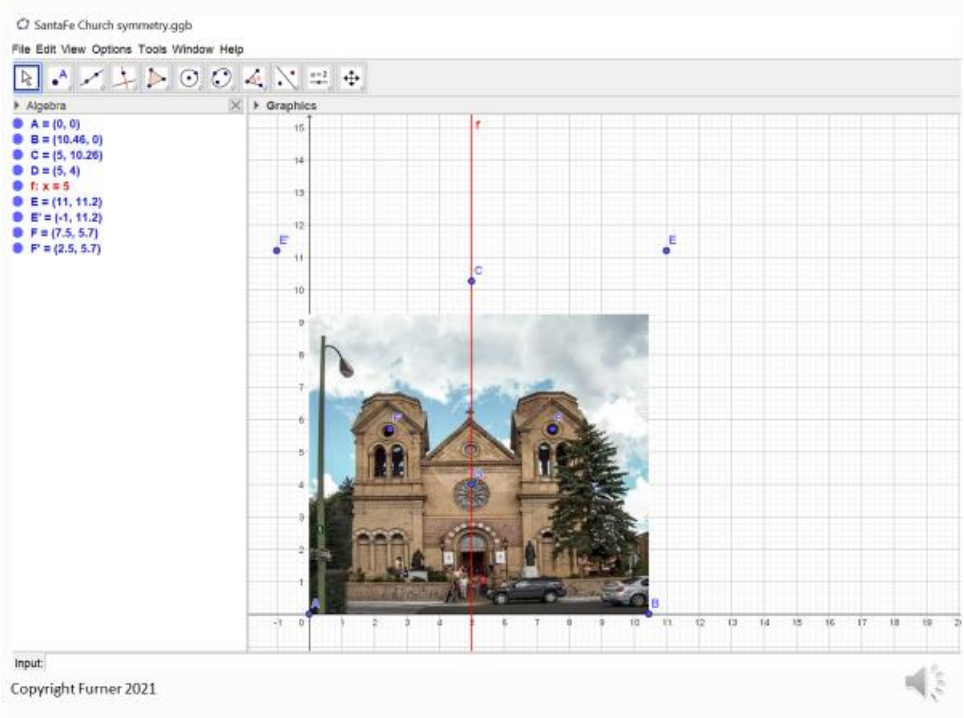

Figure 10. Line of Symmetry in Photo Imported into GeoGebra

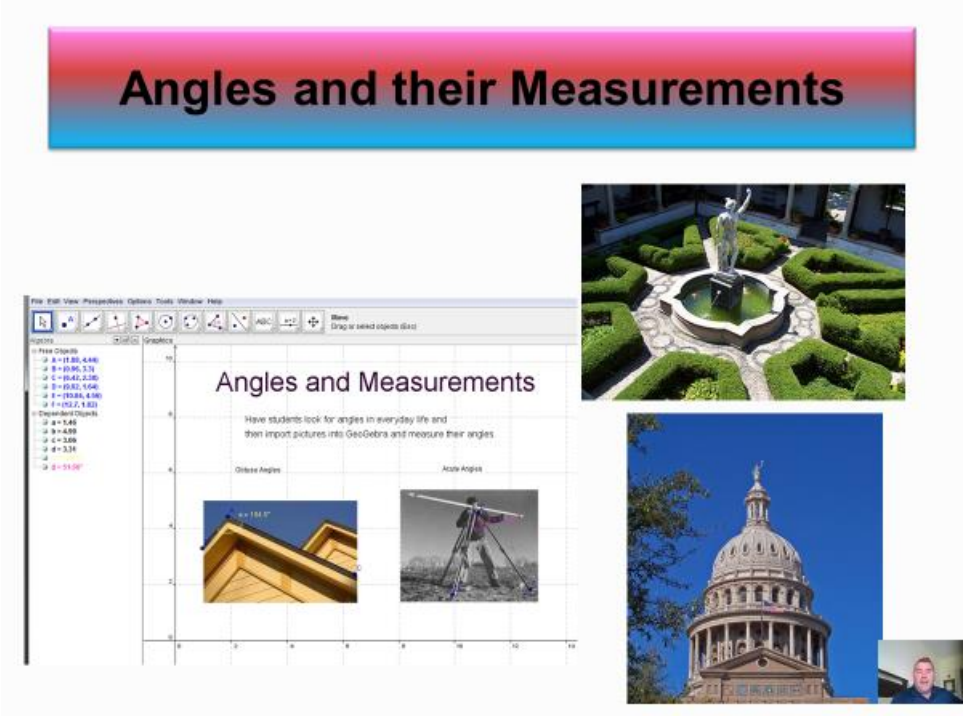

Figure 11. Angles and Measurement in Photos and GeoGebra

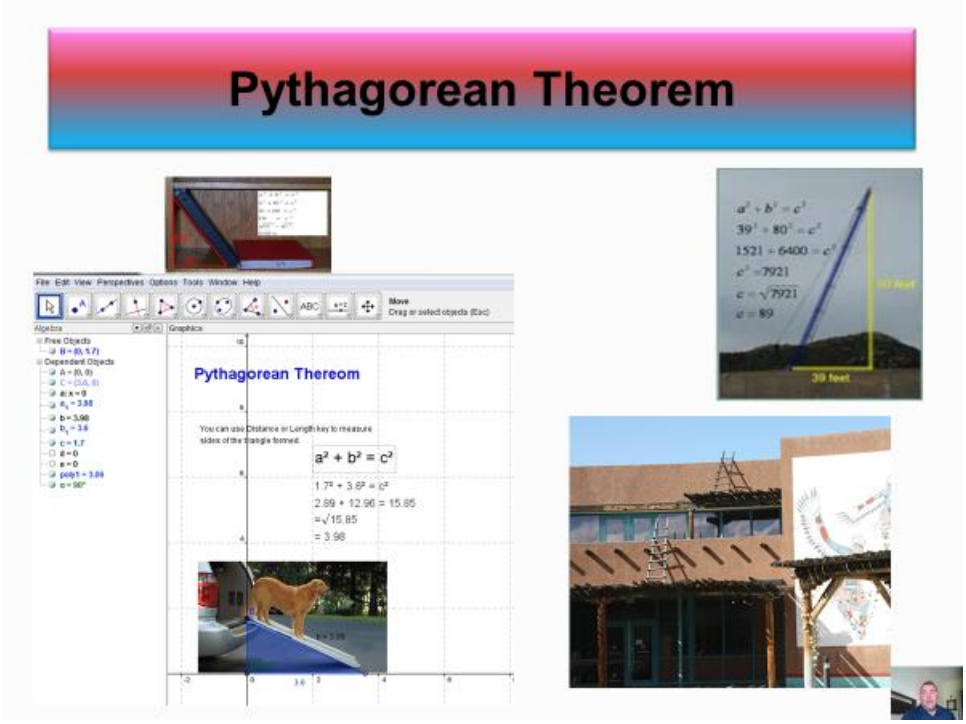

Figure 12. The Pythagorean Theorem Examples in Photos and in GeoGebra

Summary

"Every child is an artist. The problem is how to remain an artist once he grows up."
-Pablo Picasso 1881-1973

By using technology and photographs, our young learners will become excited to construct and investigate math ideas and learn as well to use technology like GeoGebra in the process to make many critical math connections. Today it is critical we help our young people grow up to be creative and artists as stated above by the quote from Pablo Picasso. By allowing students to see math all around us and using photography and emerging technologies like GeoGebra we can work toward allowing students to create, see, understand, and appreciate the beauty of mathematics all around us. By liking and enjoying math more by way of photography and the software GeoGebra, students can have more success with mathematics and the STEM fields in the future. The presenter hopes students will see and appreciate the world around them better and maybe turn them on to the STEM fields that are so critical today while also instilling a passion for photography, mathematics, and technology while learning.

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For all GeoGebra Files and other resources from the presentation please visit:

GeoGebra Files: http://matharoundus.com

Mathitudes: http://www.coe.fau.edu/centersandprograms/mathitudes

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