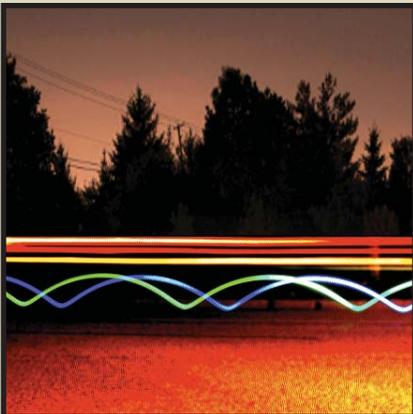
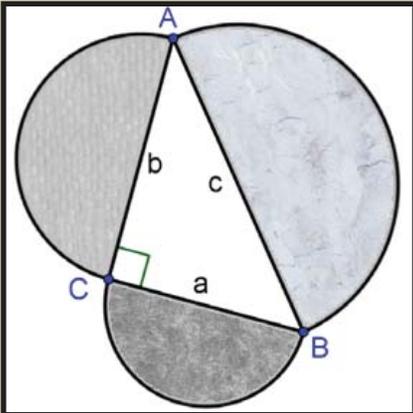
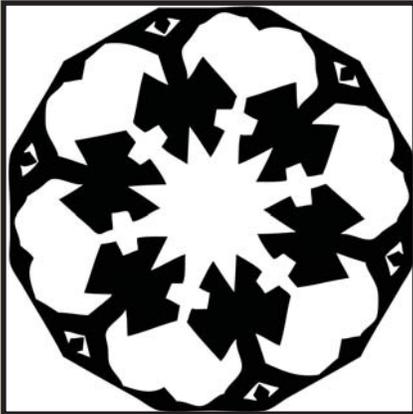


Ohio Journal of School Mathematics

Number 64
Fall 2011

Building an Energetic Community of
Ohio Mathematics Educators



A publication of the Ohio Council of Teachers of Mathematics
www.ohioctm.org

Ohio Journal of School Mathematics

Fall 2011



Number 64

A Publication of the Ohio Council of Teachers of Mathematics

Ohio Journal of School Mathematics Call for Manuscripts

The *Ohio Journal of School Mathematics* is the journal of the Ohio Council of Teachers of Mathematics. It is intended to be a medium for teachers from elementary to college level to present their ideas and beliefs about the teaching and learning of mathematics. Mathematics educators at all levels are encouraged to submit manuscripts for upcoming issues of the Journal.

Although research studies are not emphasized in the *Journal*, practical application of research implications is appropriate.

GUIDELINES FOR MANUSCRIPTS and ACTIVITIES

Manuscripts should be double-spaced with one-inch margins, 11 point Times New Roman font, and a maximum of 8 pages. References should be listed at the end of the manuscript in APA style. Please include appropriate information such as author, journal or book title, publisher, date, and pages.

Original figures, tables, and graphs should appear embedded in the document – both in the electronic and hard copy forms. Please do not use text boxes, footnotes, or head-notes.

One hard copy and an electronic copy are required. The electronic copy may be in Word. The electronic copy should be submitted via an email attachment to elaughba@math.ohio-state.edu. Author name, work address, telephone number, fax, and email address must appear on the cover sheet. No author identification should appear on manuscripts after the cover sheet. (The editors of the *Ohio Journal of School Mathematics* use a blind review process for manuscripts. Classroom activities are not peer-reviewed but undergo a rigorous revision process in consultation with the editors).

Submit manuscripts to *Ohio Journal of School Mathematics*, Journal Editors.



Ed Laughbaum
Department of Mathematics
The Ohio State University
231 West 18th Avenue
Columbus, OH 43210
elaughba@math.ohio-state.edu

Michael Todd Edwards
Department of Teacher Education
401 McGuffey Hall
Miami University
Oxford, OH 45056
m.todd.edwards@muohio.edu



The article content of the *Ohio Journal of School Mathematics* does not necessarily represent the views of the Ohio Council, and all opinions expressed therein are those of the authors.

About the Cover:

Image of cycloid graph, courtesy of Ali Chidester, a student at Upper Arlington Community High School. Snowflake design generated by Make-a-Flake by Barkley (<http://snowflakes.barkleyus.com>), courtesy of Dylan Michael Edwards. The “Tree of Mathematics” is used courtesy of Cassady Rhyan Edwards. Individuals interested in contributing cover art for future issues of the *Journal* are encouraged to submit graphics (.png or .tiff formats are preferable) to Michael Todd Edwards at m.todd.edwards@muohio.edu.

JOURNAL EDITOR

Ed Laughbaum
 Department of Mathematics
 The Ohio State University
 231 West 18th Avenue
 Columbus, OH 43210
 eloughba@math.ohio-state.edu

JOURNAL EDITOR

Michael Todd Edwards
 Department of Teacher Education
 401 McGuffey Hall
 Miami University
 Oxford, OH 45056
 m.todd.edwards@muohio.edu
 mathtech.ning.com

EDITORIAL ASSISTANT

Kelly M. Costner
 Richard W. Riley College of Education
 Winthrop University
 204 Withers/WTS
 Rock Hill, SC 29733
 costnerk@winthrop.edu

2011-2013 BOARD OFFICERS

Past President, Kim Yoak
 1819 Graham Rd.
 Stow, OH 44224
 kjoak@gmail.com
 Stow-Munroe Falls City
 Schools

President, Mark Jaffee
 26 North Cedar St.
 Oberlin, OH 44074-1530
 markjaffee@oberlin.net
 Mathematics Teacher, Lorain
 Admiral King High School

Secretary, Rebecca Maggard
 P.O. Box 448
 Eaton, OH 45320
 rmaggard@woh.rr.com
 Mathematics Teacher,
 Brookville High School

Treasurer, Ruth Hubbard
 5155 Miami Road
 Cincinnati, OH 45243-3915
 rhu Hubbard1@cinci.rr.com
 Mathematics Teacher, ret.

**Affiliate Services,
 Laura Anfang**
 lanf@roadrunner.com
 Adjunct Professor,
 Ursuline College

**Executive Director,
 Dave Kullman**
 kullmade@muohio.edu
 Professor Emeritus,
 Mathematics
 Miami University

**Vice President Elementary,
 Anne Hambrick**
 2821 Ridgewood Ave.
 Cincinnati, OH 45213
 hambricka@olv-school.org
 Our Lady of Victory School

**Vice President Secondary
 Caroline Borrow**
 19600 North Park Blvd.
 Shaker Heights, OH 44122
 cborrow@hb.edu
 Hathaway Brown School

**Vice President College,
 Patti Brosnan**
 brosnan.1@osu.edu
 Associate Professor,
 Mathematics Education
 The Ohio State University

At-Large, Kevin Dael
 kdael@alexanderschools.org
 Mathematics Teacher,
 Alexander Middle School
 Albany, OH 45710

OCTM DISTRICT DIRECTORS

East, David Spohn
 spohnd@hudson.edu
 Mathematics Teacher,
 Hudson High School,
 Hudson, OH 44236

Southeast, Kevin Dael
 kdael@alexanderschools.org
 Mathematics Teacher,
 Alexander Middle School
 Albany, OH 45710

South, Rena Allen
 142 Private Dr. 10467
 Ironton OH 45669
 allenr@ohio.edu

Southwest, Jeffrey Wanko
 401 McGuffey Hall
 Oxford, OH 45056
 wankojj@muohio.edu
 Associate Professor, Teacher
 Education, Miami University

West, Peggy Kelly
 2414 Oakbrook Blvd.
 Beavercreek, OH 45434
 peggy.kelly@wright.edu
 Instructor, Wright State
 University

Central, Jody Bailey
 jodie_bailey@hboe.org
 Elementary Teacher,
 Hilliard City Schools

**Northeast, Annemarie
 Mockler**
 mockler@sel.k12.oh.us
 Mathematics Specialist
 South Euclid-Lyndhurst
 City Schools

**Northwest,
 Karma Vince**
 kvince@sev.org
 Mathematics Teacher,
 Sylvania City Schools

At-Large, Al Cote (on leave)
 cote@ohio.edu
 Director, Southeast Ohio
 Center for Excellence in
 Mathematics and Science

At-Large, Ann Farrell
 ann.farrell@wright.edu
 Professor,
 Mathematics Education
 Wright State University

OTHER COUNCIL POSITIONS

**Membership, Sister Mary
 Theresa Sharp, SND**
 13000 Auburn Road
 Chardon, OH 44024-9330
 tsharp@ndec.org
 Lecturer, Kent State Univ.

**Historian,
 Duane Bollenbacher**
 329 S. Main Street
 Bluffton, OH 45817
 bollenbacherd@bluffton.edu
 Instructor, Bluffton Univ.

**Memorial Committee
 Bonnie Beach**
 1216 Sunbury Road
 Columbus, OH 43219
 beachb@ohiodominican.edu
 Ohio Dominican University

**Memorial Committee
 Rebecca Maggard**
 P.O. Box 448
 Eaton, OH 45320
 rmaggard@woh.rr.com
 Brookville High School

**Newsletter Editor
 Chris Bolognese**
 cbolognese@uaschools.org
 Mathematics Teacher,
 Upper Arlington High
 School

**Website Editor
 Steve Phelps**
 sphelps@
 madeiracityschools.org
 Mathematics Teacher,
 Madeira High School

**2011 Annual Meeting
 Contact
 Dan Brahier**
 530 Oak Knoll Dr.
 Perrysburg, OH 43551
 brahier@bgsu.edu

**2012 Annual Meeting Con-
 tact, Patti Brosnan**
 brosnan.1@osu.edu
 Associate Professor,
 Mathematics Education
 The Ohio State University

**Contest Coordinator
 Michael Flick**
 Xavier University
 3800 Victory Parkway
 Cincinnati, OH 45207
 flick@xu.edu

**OHMIO Director
 Nancy McDaniel**
 6688 Apache Way
 West Chester, OH 45069
 nlmcdaniel@juno.com

**Advocacy Coordinator
 Katie Hendrickson**
 1604 McCoy Avenue
 Albany, OH 45710
 KH232602@ohio.edu
 Instructor, Ohio University

**ORC Representative
 Michael Mikusa**
 1036 Jessie Ave.
 Kent, OH 44240
 mmikusa@kent.edu

**Constitution Committee
 Chair, Janet Herrelko**
 janet.herrelko
 @notes.udayton.edu
 Associate Professor,
 Mathematics Education
 University of Dayton

**Tournament Director
 Cathy Stoffer**
 Mathematics Department
 Ashland University
 401 College Avenue
 Ashland, OH 44805

**Tournament Director
 Carol Botzner**
 elizabeth.botzner@lakotaon-
 line.com

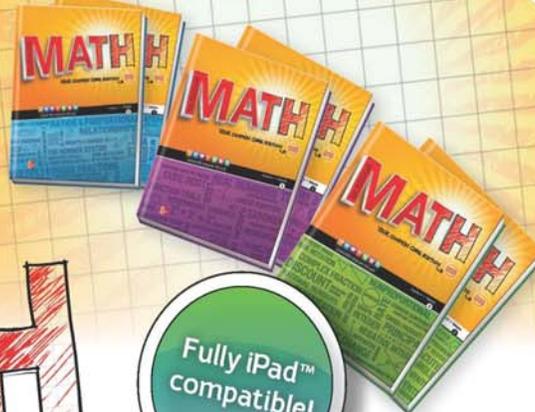
For more information regarding affiliate chapters and state mathematics consultants, please visit the OCTM website (ohioctm.org)

Permission to copy is granted to teachers for instructional use when the material is to be distributed free of charge or at cost only, to librarians who wish to place a limited number of copies on reserve, and to other professional journals. In all such instances, due credit must be given to the author(s) and to the *Ohio Journal of School Mathematics*. A copy of the document using *Journal* materials must be sent to the OCTM editor. Commercial use is prohibited. Copyright © 2011, the Ohio Council of Teachers of Mathematics.

Success Your Way

with

GLENCOE MATH



Your exciting new middle school math program built around the Common Core State Standards

A brand new day is dawning for middle school math teachers and students. It's your day, so find your way to get students excited about math class. It's a day when students are found outside of school watching math videos and playing math games. It's a day where teachers can find resources, customize presentations, create leveled homework sheets, and prepare a chapter test easily in one convenient online location. It's a day powered by *Glencoe Math*.

Glencoe Math is a unique, new middle school program that presents math in real and relevant ways to students and provides a robust toolkit to teachers. It's just what you've been looking for to engage students and energize teachers.

Uniquely Interactive

- iPad™ compatible lessons, games, apps, videos, and virtual manipulatives connect with today's digital natives.
- Students work problems, tear out pages, take notes, and complete homework sheets right in the book.

Highly Customizable

- ALL planning and assessment resources are in one online portal.
- Exclusive access to ConnectED offers customizable resources, such as lesson presentations and editable worksheets.

Built to the new Common Core State Standards

- Lessons, assessments, and activities ease student and teacher transition to the new standards.
- Point-of-use common core curriculum simplifies planning.

Teach **Your** way... in **Their** world.

With *Glencoe Math*, you engage students by teaching math in real, relevant ways. And robust resources let you incorporate the latest

Preview a sample!

Scan the barcode below with your smartphone.



Alternately, direct your browser to <https://www.mhonline.com/glencoe/math/> or contact your sales representative for more information

**Mc
Graw
Hill** Education

Ohio Journal of School Mathematics

Fall 2011

Number 64

- 6 *Discovery: A Squaring Pattern for Two-Digit Numbers and Beyond*
Sam Biederman and Diane Borton Kahle, Upper Arlington High School
- 11 *Connecting the Art of Navajo Weavings to Secondary Education*
Mary Kay Kirchner, Dulaney High School, and Reza Sarhangi, Towson University
- 19 *Mersenne Primes*
Joseph Fryer and Casey Detro, Miami University
- 23 *Integrating Response to Intervention in an Inquiry-Based Math Classroom*
Lisa Douglass, Ohio Dominican University, and Alissa Horstman, North Fork Schools
- 31 *Exploring the Rhind Papyrus*
Dana Hartnett and Lauren Koepfle, Miami University
- 36 *A Mathematical Origami Puzzle*
Patrick S. Dukes, Clemson University, and Joseph P. Rusinko, Winthrop University
- 43 *Estimation Using Whole Numbers*
Michael Krach, Towson University
- 46 *Corn & Tractor Price Comparisons*
Steve Lifer, Lexington High School
- 53 *Getting Active with Angles!*
Kimberle Kembitzky, Hilliard Davidson High School, Catherine Victor, Arapahoe High School, and Lauren Flanagan, Hilliard Davidson High School
- 59 *Problems to Ponder while on a Car-Trip*
Stephanie Buckenmeyer, Wayne Junior High School, and Joe Gerhardinger, Notre Dame Academy
- 64 *Problem Solving is About Seeing Relationships*
Debbie Kuchey and Michael Flick, Xavier University

Connecting the Art of Navajo Weavings to Secondary Education

Mary Kay Kirchner, Dulaney High School, and
Reza Sarhangi, Towson University

The Navajo Nation is well-known for its exceptional artistry with respect to the weaving of rugs, blankets, and other textiles. This article will discuss the culture of the Navajo, their weavings, and how this art form can be used to teach and extend mathematics concepts in secondary education. The patterns within the Navajo weavings will be used to illustrate examples of the four isometries and the seven frieze groups. These patterns will also be used to determine the fundamental region, as well as to study the fractal concept of iteration and its impact on area and perimeter.

Introduction

The Navajos, or Diné, as they call themselves, have a philosophy that values beauty and harmony, which can be seen in their weavings (Iverson, 2002). Understanding the geometry behind Navajo weavings requires learning more about the culture, history, and values of the Navajo Nation. For example, “a splendid Navajo rug represents ...their worldview [of beauty and harmony within their universe] in an appropriately beautiful and lasting form.”

(McManis & Jeffries, 2009, p.9). This beauty and harmony, common to all Navajo weavings, is exemplified in the raised outline rug shown in Figure 1.

Bringing the art of Navajo weavings to the secondary curriculum offers educators an opportunity to connect mathematics, art, literature, and history. Cultural concepts can be explored, while noting the history of the Navajo Nation and how weaving became an intricate part of their economy and art. The fictional accounts of the Navajo Nation



Photograph courtesy of National Museum the American Indian, Smithsonian Institution [Catalog Number: 29/4375]

Fig 1 Larry Yazzie, Diné (Navajo) detail of Raised Outline Rug (1994)

Police can educate students on the cultural values and traditions of the Navajo Nation (Hillerman, 1990; Thurlo & Thurlo, 2006). Students can also study the unbreakable code of the Navajo Code Talkers during World War II (Kawano, Gorman, & Frank, 1990).

The Geometry of Navajo Weavings

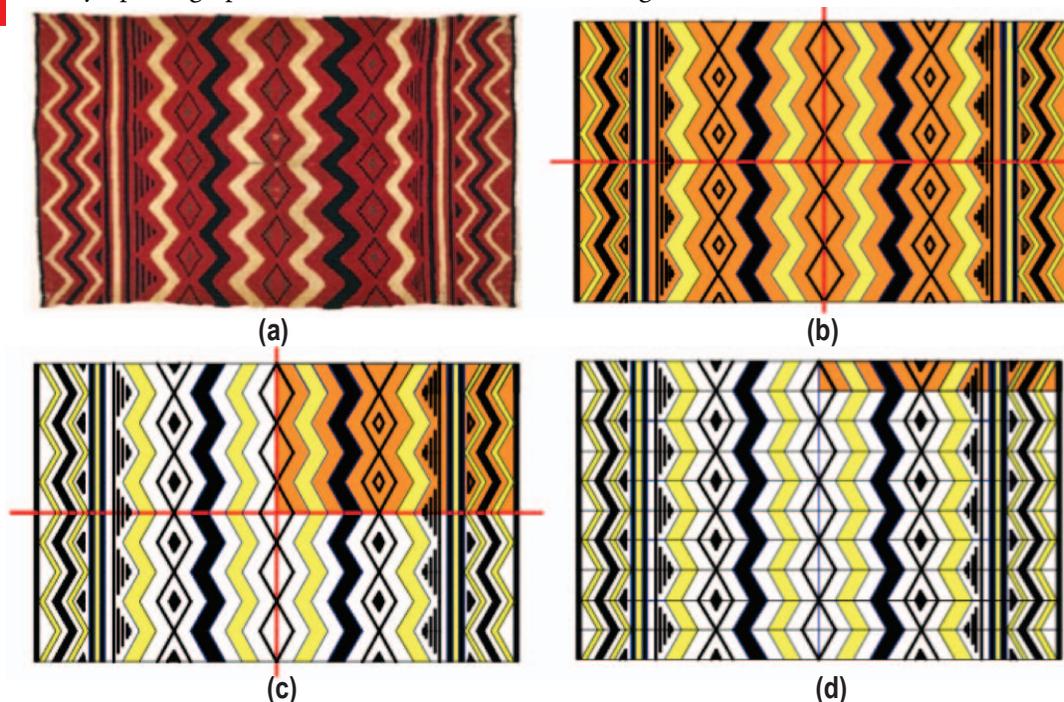
Students can explore the geometry of Navajo weavings, using information in a transformational geometry unit and searching on the Internet for Navajo weavings. A transformational geometry unit typically includes a study of the four isometries: translations, rotations, reflections, and glide reflections. Students may identify isometries used to generate patterns in Navajo weavings.

The National Museum of the American Indian (NMAI) of the Smithsonian Institution is a great place to start. For students living within driving distance of Washington, D.C., a visit to the NMAI is highly recommended. If an actual visit is not possible, a visit to their website (Smithsonian Institution 2010) provides students with many photographs that demonstrate the

geometry, the symmetry, and the beauty of Navajo weavings.

Figures 1, 2, and 3 are Navajo weavings from the 1820s to the 1990s. It is interesting to note the changes in colors and styles, over time. All three weavings may be used to explore and extend the students' knowledge of transformational geometry. Students could study the weaving pattern of the Navajo Poncho in Figure 2a and determine the smallest region possible that can be used to generate the entire pattern, which is often referred to as the "fundamental region" (Washburn & Crowe, 1988, p. 53). Many students immediately notice horizontal and vertical lines of symmetry (Figure 2b). They might decide that $1/2$ or $1/4$ of the weaving is the smallest region possible to generate the entire pattern (Figure 2c). The pattern can be printed onto paper or copied into Geometer's Sketchpad, allowing students to further explore this concept, by sketching lines directly onto the pattern and searching for the fundamental region. Ultimately, the students will discover that the fundamental region is only $1/20$ of the entire weaving (Figure 2d).

Students can explore the geometry of Navajo weavings, using information in a transformational geometry unit



Photograph (a) courtesy of National Museum of the American Indian, Smithsonian Institution [Catalog Number: 9/1912].

Fig 2 Diné (Navajo) detail of poncho (1825-1860)

The Navajo Double Saddle Blanket in Figure 3a provides another opportunity for students to further explore the concept of the fundamental region. Following a cursory study, students who are asked to find the fundamental region and lines of reflection may quickly decide by using a horizontal line, that the fundamental region is $1/2$ of the weaving (Figure 3b). Some students will insist, however, that through the use of an added vertical line of reflection, the fundamental region is actually $1/4$ of the weaving. This response will be incorrect, because of the yellow and red triangles at the top and bottom of the weaving.

In response to these findings, the teacher could then ask the students what changes could be made to add a vertical line of reflection. The answer is change the interior color of the three triangles at the top and the bottom of the weaving, from yellow to red or from red to yellow (Figure 3c). This will add the vertical line of reflection and in fact changes the fundamental region from $1/2$ of the weaving to $1/16$ (Figure 3d). Regardless of the number of transformations used, the simplicity of line, color, and symmetry, turns the textile into a beautiful weaving that has a sense of balance and harmony, reflecting the predominant values in Navajo culture.

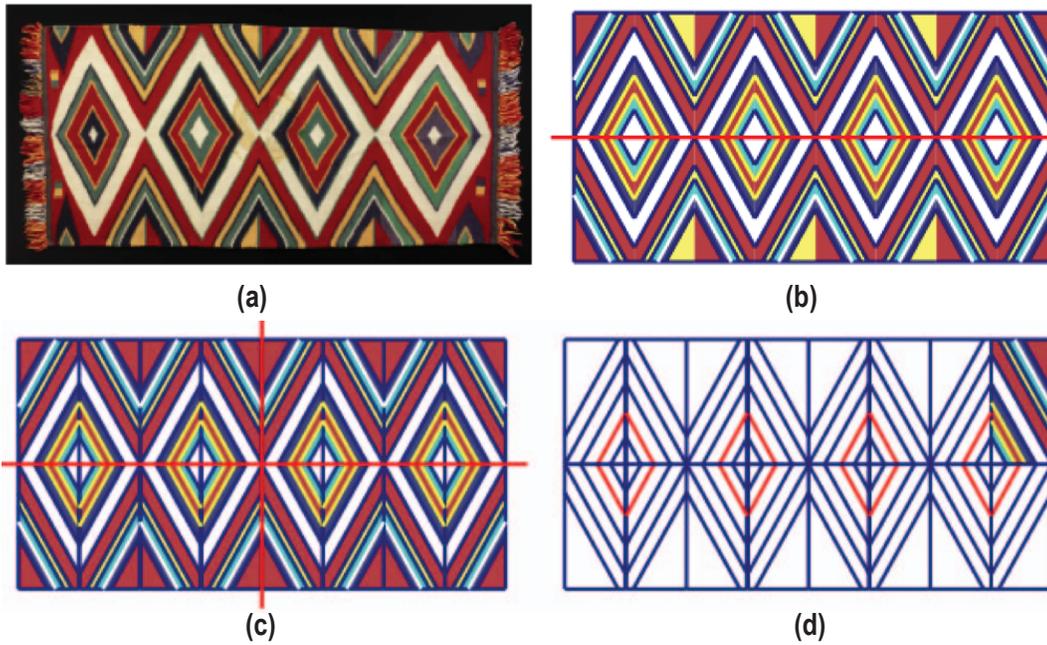


Fig 3 Diné (Navajo) detail of Double Saddle Blanket (circa 1880)

Photograph (a) courtesy of National Museum of the American Indian, Smithsonian Institution [Catalog Number:15/9869].

students will enjoy creating geometric designs, inspired by their research of Navajo textiles, their knowledge of the four isometries, and a study of the seven frieze groups.

Using the Seven Frieze Groups to Create Patterns

Students can use their knowledge of the four isometries to discover the seven frieze groups and create new patterns. This portion may be done using graph paper and colored pencils. Too often, we rely heavily on technology, forgetting the discovery power of pencil and paper, but of course technology can

be a great tool for mathematical exploration. Many students love the thrill of creating designs using geometry software, such as the Geometer's Sketchpad (Sarhangi, 2009). Regardless of the methodology, students will enjoy creating geometric designs, inspired by their research of Navajo textiles, their knowledge of the four isometries, and a study of the seven frieze groups.

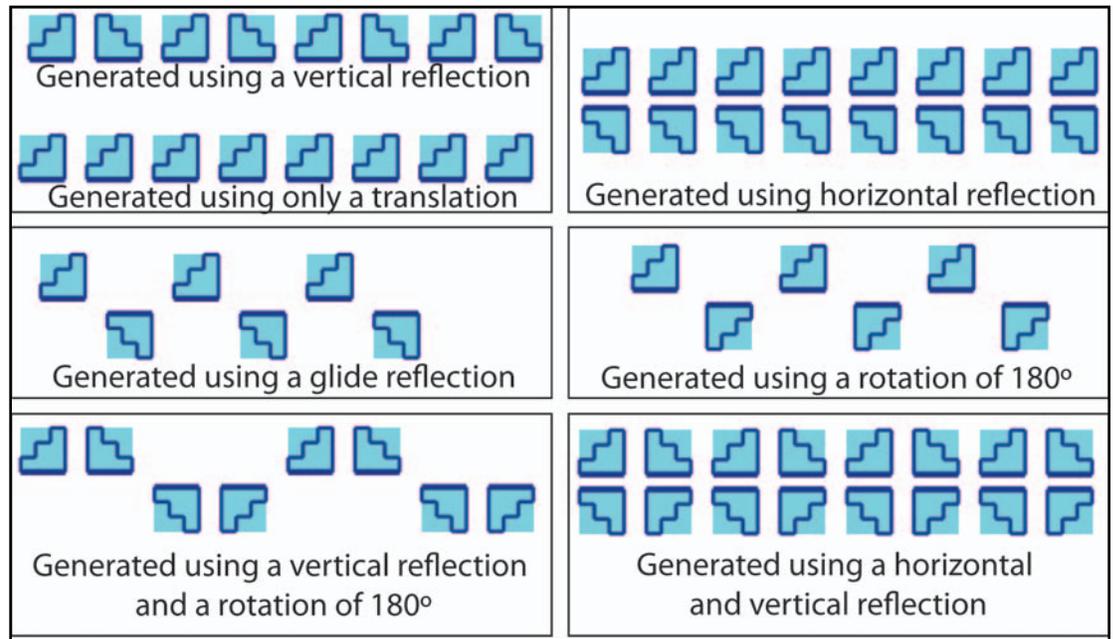


Fig 4 The seven frieze groups

While most high school geometry students should be proficient at identifying the four isometries, they are probably unfamiliar with the seven frieze groups. “The number of geometrically different patterns for friezes is infinite. Nevertheless, based on their symmetries, all can be classified into seven groups” (Sarhangi, 2000, p. 199). The raised outline rug shown in Figure 1 can be used as a motivational tool, introducing students to the concept of frieze groups. Students could be asked to study the rug and find the three friezes (i.e., the frieze on the left, generated by a translation of a feather, the frieze on the right, produced by a vertical reflection, and a third frieze in the middle, on a diagonal) gracefully balanced between the two right triangles. Students should also notice that this Navajo rug has a sense of balance, achieved by the use of rotating a large, right triangle, but changing the objects in the interior of the triangle.

In an exploration activity, the teacher could guide the students, using either technology or graph paper, to discover the seven frieze groups. Washburn and Crowe (1988, p. 83) developed a flow chart with a

series of questions that are used to identify a particular frieze group. These questions could be modified so that the students discover the frieze groups for themselves, by taking an existing polygon and applying vertical and horizontal reflections, glide reflections, 180° rotations, and translations along a line. Figure 4 shows the possible outcomes.

Using Fractal Geometry Concepts to Study Area and Perimeter

The geometric patterns from Navajo weavings can be used to explore fractal geometry concepts, by using a sketch from a section of a traditional Navajo rug. The students could be asked to produce a series of iterations from the sketch of the section, measure each new stage and compare the areas, thus affording the opportunity to study series and sequences in a very concrete way.

Students could explore a wide variety of Navajo weaving styles through the website of the Hubbell Trading Post, a National Historic Site of the National Park Service (2010). For students traveling near Ganado, Arizona, the Hubbell Trading Post is well worth the visit.

The geometric patterns from Navajo weavings can be used to explore fractal geometry concepts

For those unable to actually visit this historic site, a virtual visit on their website, will provide excellent photographs, demonstrating a wide variety of regional weaving styles. The website also can provide a student with a wealth of information regarding the past and the present of the Navajo nation.

Figure 6 is an adaptation of a pattern, from a section of the Ganado style rug, shown in Figure 5. With each iteration, the shape is growing based on a fractal geometry algorithm, and demonstrates an example of

the fractal property of self-similarity, where an object is similar to itself, but in miniature (Sarhangi, 2009).

Suppose that the first shape (on the left) in Figure 6 is comprised of two triangles of 1 square unit each, then the first step has an area of $2(1)$ square units. After the second step, the area is now $2(1 + 3)$ square units, with a pattern forming, so that the subsequent iterations are $2(1 + 3 + 5)$, then $2(1 + 3 + 5 + 7)$ or 2, 8, 18, 32, ... as shown in Figure 7.



Photograph courtesy of Hubbell Trading Post National Historic Site

Fig 5 Detail of a round rug with Ganado style

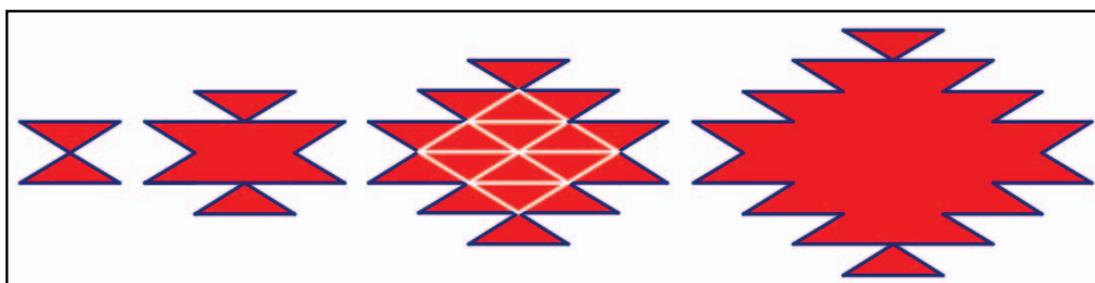


Fig 6 Adaptation of a pattern from the Ganado style rug

With each iteration, the shape is growing based on a fractal geometry algorithm, and demonstrates an example of the fractal property of self-similarity

First Step, A_1	Second Step, A_2	Third Step, A_3		nth step, A_n
$2(1)$	$2(1 + 3)$	$2(1 + 3 + 5)$	→	$2(1 + 3 + \dots + (2n - 1))$
2	8	18	→	?

Fig 7 The area of the growing pattern

Using Figure 7 and the formula for the sum of the first n terms of an arithmetic progression, students will discover that $Area = 2(1 + 3 + \dots + (2n - 1)) = 2 \frac{n[(2n-1)+1]}{2} = 2n^2$.

We can also use Figure 6 to find another sequence based upon perimeter. Using one of the isosceles triangles, if we let the base equal a units and one of the legs equal b units, then the perimeter in the first step is $2a + 4b$ units. The second step would have a perimeter of $6a + 8b$

units, with the third step having a perimeter of $10a + 12b$ units, and ultimately, a pattern emerges, as shown in Figure 8. Developing the formula for the numerical coefficients in the A_n step is a great opportunity for students to use their knowledge of arithmetic sequences.

First Step, A_1	Second Step, A_2	Third Step, A_3		n th step, A_n
$2a + 4b$	$6a + 8b$	$10a + 12b$	\rightarrow	$(4n - 2)a + (4n)b$

Fig 8 The perimeter of the growing pattern

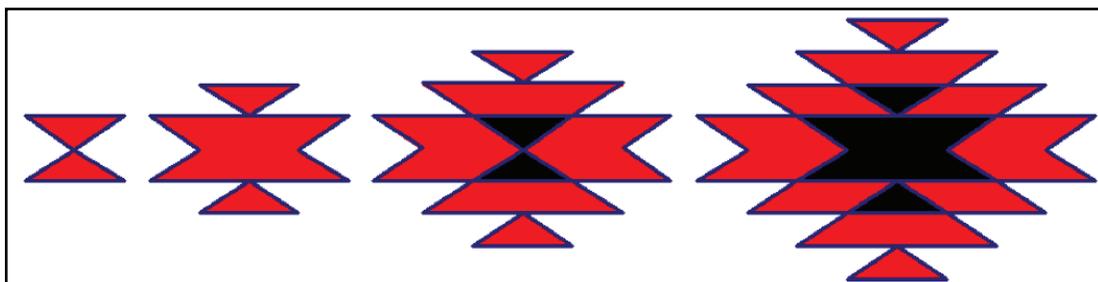


Fig 9 New pattern produced by a color change

By introducing an internal change of design, this same pattern can be analyzed in a different way to produce a different sequence. Referring back to the actual rug as shown in Figure 5, we see that there is a pattern embedded within the main pattern, demonstrating again the property of fractal geometry. Analyzing the red areas, in the stages shown in Figure 9, a related but new sequence emerges as follows. First step: $2(1)$, second step: $2(1 + 3)$, third step: $2(1 + 3 + 5) - 2(1)$. fourth step: $2(1 + 3 + 5 + 7) - 2(1 + 3)$ and continue so that the sequence becomes: $2n^2 - 2(n - 2)^2$, for $n \geq 2$ or more simply as $2(1), 2(4), 2(8), \dots, 2(4n - 4), \dots$ or $2, 8, 16, \dots, 8(n - 1), \dots$ for $n \geq 2$ as shown in Figure 10.

First Step, A_1	Second Step, A_2	Third Step, A_3		n th step, A_n
$2(1)$	$2(1 + 3)$	$2(1 + 3 + 5) - 2(1)$	\rightarrow	$2n^2 - 2(n - 2)^2$
$2(1)$	$2(4)$	$2(8)$	\rightarrow	$2(4n - 4)$
2	8	16	\rightarrow	$8(n - 1)$

Fig 10 The red area of the growing pattern, with the color change

Conclusion

Navajo weavings in rugs and textiles offer an exciting opportunity in secondary education for students to understand abstract geometric concepts by using concrete hands-on approaches. Navajo weavings provide an inspiration for our students to recognize the beauty of mathematics as well foster a better understanding of the Navajo Nation.

Works Cited

- Hillerman, T. (1990). *Coyote waits*. New York: Harper Collins Publishers.
- Iverson, P. (2002). *Diné: a history of the Navajos*. Albuquerque: University of New Mexico Press.
- Kawano, K., Gorman, C., & Frank, B. M. (1990). *Warriors: Navajo code talkers*. Flagstaff: Northland Publishing.

McManis, K., & Jeffries, R. (2009). *Navajo weavings*. Tucson, AZ: Rio Nuevo Publishers.

National Park Service. (2010). *U. S. Department of the Interior. Hubbell Trading Post National Historic Site*. Retrieved from <http://www.nps.gov/hutr/index.htm>

Sarhangi, R. (2000). In search of symmetry. *Mosaic 2000 Conference proceedings* (pp. 195-202). Seattle:University of Washington Press.

Sarhangi, R. (2009, Fall). Fractal geometry designs on a dynamic geometry utility and their significance. *Ohio Journal of School Mathematics*, 35-42.

Smithsonian Institution. (2010). National Museum of the American Indian. Retrieved from <http://www.nmai.si.edu>

Thurlo, A., & Thurlo, D. (2006). *Mourning dove*. New York: Tom Doherty Associates, LLC

Washburn, D. K., & Crowe, D. W. (1988). Symmetries of culture. *Theory and practice of plane pattern analysis*. Seattle and London: University of Washington Press.



MARY KAY KIRCHNER, mkirchner@bcps.org, is a mathematics teacher at Dulaney High School, in Timonium, Maryland.

A classroom teacher of 37 years, she currently teaches advanced algebra, geometry, and calculus. She is the author of a Baltimore County Public Schools curriculum guide for Advanced Algebra.



REZA SARHANGI, rsarhangi@towson.edu, is a professor of mathematics and a mathematics educator at Towson University, in Maryland.

He is the director and the proceedings co-editor of the annual International Conference of Bridges: Mathematical Connections in Art, Music, and Science (www.BridgesMathArt.Org).

Wisdom of the Navajo

“You can’t wake a person who is pretending to be asleep.”

- Navajo proverb (in Kundtz, D. (2009). *Awakened Mind: One-Minute Wake Up Calls to a Bold and Mindful Life*. San Francisco, CA: Cornari Press, p. 7)

The Navajo Nation

“The Navajo of the Southwestern United States are the largest single federally recognized tribe of the United States of America. As of The Navajo Nation has over 300,000 enrolled tribal members.”

Donovan, B. (July 7, 2011) “Census: Navajo enrollment tops 300,000.” *Navajo Times*. Available on-line at <http://navajotimes.com/news/2011/0711/070711census.php>



GeoGebra Institute of Ohio

MIDWEST REGIONAL CONFERENCE • MIAMI UNIVERSITY, OXFORD OH • JUNE 11-12, 2012
 WWW.GGBMIDWEST.COM/CONFERENCE • WWW.GGBMIDWEST.COM/JOURNAL



Hands-on Exploration with FREE Software
Practical Teaching Resources Provided
New and experienced users welcome
FREE Conference - no Registration Costs
Professional Development for FREE!

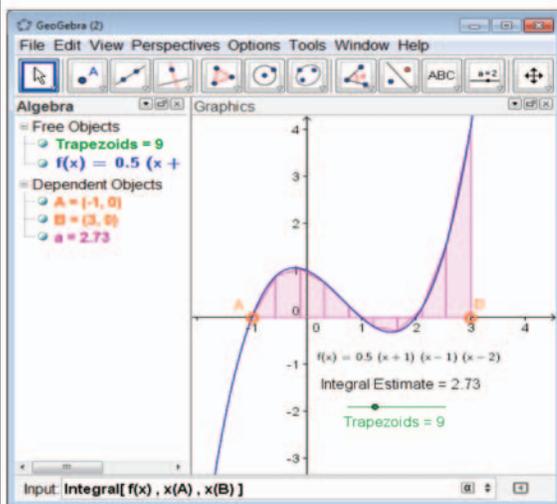


We offer three distinct types of sessions to meet different learning needs of our participants:

- Beginner Sessions** - Basic features and functionality
- Lesson Plan Sessions** - Sharing ready-to-use materials
- Research Sessions** - Content and pedagogical issues



The peer-reviewed Midwest GeoGebra Journal highlights ideas presented at the conference. Visit www.ggbmidwest.com/journal for more details.



"I learned . . . that geogebra can be used in ALL classes. It will help ALL students. I was reminded about all of the things beyond producing geometric drawings that GeoGebra can do."

**Kristen Rigby, Loveland City Schools
 Loveland, Ohio**

"I was impressed by the offerings at both the novice and advanced levels."

**Kathy Shafer, Ball State University
 Muncie, Indiana**

"I feel the conference was well organized and thought out. I highly recommend it to others!!! I feel confident in creating lessons and units."

**Trisha Murray, Northville Public Schools
 Wayne, Michigan**

The Relational Mind

"The human brain stores factual knowledge about the world in a relational manner. That is, an item is stored in relation to other items, and its meaning is derived from the items to which it is associated."

Buonomano, D. (2011). *Brain bugs: How the brain's flaws shape our lives*, 23. W. W. Norton & Company, NY.