Students Teaching Students: Fun Group Activities and Creative Projects

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AMATYC’s IMPACT on “Engagement”

A. “Mathematical knowledge is now viewed as being socially __________, that is, mathematics is learned through a process of __________ within a _________ of learners” (p.45).

B. “Students should interact with each other often through meaningful discourse and ______________ activities for the purpose of sharing and refining ideas” (p.46)

C. “Designing a learning environment that fosters active student engagement in mathematical thinking, encourages student __________ and risk-taking … is a shared responsibility of students, faculty, institutions, and other stakeholders” (p. 43).
AMATYC’s IMPACT on “Engagement”

A. “Mathematical knowledge is now viewed as being socially constructed, that is, mathematics is learned through a process of communication within a community of learners” (p. 45).

B. “Students should interact with each other often through meaningful discourse and collaborative activities for the purpose of sharing and refining ideas” (p. 46).

C. “Designing a learning environment that fosters active student engagement in mathematical thinking, encourages student creativity and risk-taking … is a shared responsibility of students, faculty, institutions, and other stakeholders” (p. 43).
1. Why have Students Teaching Students?

“My students will learn much more when I turn their eyes from always looking at me and help them look at one another.” —Parker Palmer, *The Courage to Teach*

We should “encourage students to construct their own explanations, to reason, to draw conclusions, to act...Students become the actors in the learning process.” —Ken Bain, *What the Best College Teachers Do*
1. Why have Students Teaching Students?

“The best way to create an environment conducive to developing authority in our students is to place them in situations where they must assume it... The best way to gain a sense of authority is to practice it in meaningful content-rich contexts.”

—Paul Hanstedt, *Creating Wicked Students: Designing Courses for a Complex World*
2. Jigsaw Group Activity

Step 1: Move into “expert groups” (at least one person from each home group moves to the four corners of the room and middle) where you will study one proof of the Pythagorean Theorem with your new “expert group.”

Step 2: Working together, prepare to teach the main ideas of your topic to the others in your home group. (5 min.)

Step 3: After a few minutes, move from your “expert group” back to your home group, where each person in the home group is now an expert on a different topic. Take turns teaching what you have learned to the others in your home group. (5 min.)
3. Group Teaching Project

Step 1: Groups draw a random number and then have a “draft” to choose which topic they will teach the class.

Step 2: Groups meet with the professor about a week beforehand to discuss plans and get ideas.

Step 3: Groups meet outside of class to plan their lesson, including a handout, and a PowerPoint.

Step 4: Groups teach the lesson on the assigned date. Classmates give feedback.

Step 5: The professor assesses the design and presentation of the project.
THE GOLDEN RECTANGLE

by Megan, Nicki, and Lainie
Fashion Show

A.

B.

C.

D.

E.
Look around the room to find This Beautiful Rectangle
Check golden rectangles found

Measure them, are they actually golden?

How to find the ratio of a rectangle:

\[
\frac{\text{Length}}{\text{Width}}
\]

A golden Rectangle’s Length divided by its width will equal 1.618
Golden Rectangle in nature
Math is cool

What happens when you take squares out of Golden Rectangles?
Draw a Golden Rectangle

1. Draw a square using a Fibonacci number.

2. Find the midpoint of the square’s base.

3. Use a ruler to draw a diagonal line to the upper right corner of the square.

4. With the compass touch both the midpoint and upper right corner, swing compass down until it is on the same plane of the base.

5. Connect this point with the original square, then add lines connecting with the upper right corner of the original square.
Art history
Create some art!

1. Cut out 5 different colored golden rectangles. They should measure:
   - 8x5, 5x3, 3x2, and 2x1

1. Create a spiral using a compass (connecting each square).
Summary:

The Golden Rectangle is beautiful.

Ratio: 1.618

The Golden Rectangle shows up in both nature and art and enhances beauty wherever it goes.

Life Lesson:
Math is beautiful. So is life.
Symmetry and Tessellations
Andrea, Sam, Jessica
MAT120 Group Teaching Project

http://www.youtube.com/watch?v=HqcIhzpjMa0
Famous Symmetrical Artwork

http://www.youtube.com/watch?v=8EmhGOQ-DNQ
Snowflake Time!!!

Create your own snowflakes that are symmetrical...... and then take it home!
Symmetry: one shape becomes exactly like another if you flip, slide, or turn it.

- Three different types of Symmetry
  1. Flip/Reflection – type of symmetry where one half is the reflection of the other half.
  2. Rotation - an object that looks the same after a certain amount of rotation
  3. Shift – a transformation in which a graph or geometric figure is picked up and moved to another location without any change in size or orientation
Did you know.....?

The human face is NOT perfectly symmetrical!
Famous Tessellations

M. C. Escher
What is a Tessellation?

- When you cover a surface with a pattern of flat shapes. There are no overlaps or gaps.

Pentagons  Octagons and Squares  Squares
There are only 3 regular tessellations

1. Triangles

2. Squares

3. Hexagons
Semi-Regular Tessellations: Made of two or more regular polygons. The pattern must be the same. There are 8 semi-regular tessellations.

Practice Time!!

3.3.3.3.6

4.6.12

4.8.8
3. Teaching Project Feedback

Question 1: Overall, I learned the math content taught by students: 4.2 / 5.0

Question 2: Overall, I enjoyed the student taught lessons: 4.6 / 5.0

Question 3: The best part of the teaching project was: “learning from peers and them using fun manipulatives like snacks”…”I learned my lesson better, because I had to teach it.”…”creative ways people taught the lessons”

Question 4: Suggestions for improving the teaching project: “Have professor review lesson taught by students” … “The lessons should be spread out.”
4. Co-op Group Activity

Step 1: Assign each group a different concept, or problem, or part of a problem to study and prepare to teach the rest of the class about (Sierpinski Tr., Jurassic Park Fractal, Golden Spiral, Tree fractal, or the Koch Snowflake).

Step 2: Each group solves the problem by working as a group. For this session (5 min.):
A. Draw a picture of or create your assigned fractal.
B. Answer the question about your fractal.
C. Create a different fractal that you make up as a group on your own.

Step 3: Each group in turn teaches the class by sharing their results. (1 min.)
5. Final Creative Project

**Step 1:** Students, in pairs, choose a topic of their interest that is related to a topic previously studied in the course.

**Step 2:** Students research their topic to find additional information beyond what was covered in class.

**Step 3:** Students apply their research to create or develop something new.

**Step 4:** Students present their project for the final exam, teaching what they have learned. Classmates give feedback.

**Step 5:** The professor assesses the research, the creativity, and the presentation.
Finance project

Ken, Nick, and Elly
### Elly’s car

**Toyota Prius**

- **Three**
- $25,765 starting¹

- 51/48 est. mpg⁷
- Display Audio with Navigation¹¹ and Entune® App Suite¹² — includes 6.1-in touch-screen with integrated backup camera²² display
- Smart Key System¹⁸ on three doors
- Available Solar Roof Package⁹

<table>
<thead>
<tr>
<th></th>
<th>Monthly Payment 3 years</th>
<th>Monthly Payment 4 years</th>
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<td>Three</td>
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Ken’s house

Interest rate 4.5%

I chose the 25-year mortgage rate because I will pay less interest than the 30-year mortgage but it the most realistic

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<td>$2777,708</td>
<td>$304,986</td>
<td>$333,622.80</td>
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WASTING FOOD IN THE DC

Jim & Catherine
AMOUNT OF FOOD WASTED MONTHLY BY AN AMERICAN FAMILY OF 4:

- Fresh fruit and vegetables: 24 pounds
- Processed fruit and vegetables: 10.5 pounds
- Grains: 18.5 pounds
- Meat and fish: 10.4 pounds
- Sweeteners: 15 pounds
- Fats and oils: 8.6 pounds
- Other food (includes eggs; peanuts; tree nuts; dry beans, peas and lentils; dairy other than fluid milk): 12.8 pounds
- Fluid milk: 22 pounds
OUR RESULTS:

- For 5 days, we counted consecutive DC dinner plates on the conveyor belt.
  - 134 plates total
- 64 people ate everything on their plate, everyone else wasted a portion of their meal.
## SERVING AMOUNT — NUMBER DISCARDED OF THAT SIZE

- $0 - 64$
- $1/6 - 4$
- $1/5 - 1$
- $1/4 - 7$
- $1/3 - 2$
- $1/2 - 13$
- $5/6 - 1$
- $7/8 - 2$
- $1 - 28$
- $1 1/6 - 1$
- $1 1/4 - 2$
- $1 1/3 - 1$
- $1 7/8 - 1$
- $2 - 6$
- $2 1/2 - 1$
<table>
<thead>
<tr>
<th>Unhealthy</th>
<th>Healthy</th>
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<tbody>
<tr>
<td>11 Sandwich</td>
<td>1 Wrap</td>
</tr>
<tr>
<td>6 Mashed potatoes</td>
<td>1 Taco bowl shell</td>
</tr>
<tr>
<td>4 Spaghetti</td>
<td>1 Taco salad</td>
</tr>
<tr>
<td>3 Chicken</td>
<td>1 Fish</td>
</tr>
<tr>
<td>2 Soup</td>
<td>1 Pasta &amp; Mixed veggies combo</td>
</tr>
<tr>
<td>2 Burger</td>
<td>1 Fries</td>
</tr>
<tr>
<td>2 Hot dog</td>
<td>1 Pasta</td>
</tr>
<tr>
<td>2 Pizza</td>
<td>1 Spaghetti sauce</td>
</tr>
<tr>
<td>1 French toast stick</td>
<td>1 Meat moosh</td>
</tr>
</tbody>
</table>
Mean = .47 (rounded)
Median (Q2) = 1/6
Mode = 0
Minimum = 0
Maximum = 2 1/2
Q1 = 0
Q3 = 1
HISTOGRAM:
BOX AND WHISKER PLOT
WHAT YOU CAN DO:

At home:
- Avoid buying in bulk
- Try to eat all that you cook, and don’t let leftovers sit in the refrigerator too long
- Stack the refrigerator with older food in the front

At college:
- Place smaller portion sizes on your plate. You can always go back for more!
- Finish your sandwich before you get more food.
thefreedictionary.com says that the butterfly effect is an idea, used in the chaos theory, that a very small difference in the initial state of a physical system can make a significant difference to the state at some later time.
The original term ‘butterfly effect’ came from the idea that a butterfly flapping its wings could eventually alter the path of a tornado. “While the butterfly does not cause the tornado, the flap of its wings is an essential part of the initial conditions resulting in a tornado.”
I think that this a real application in our lives. Math helps us realize that in our lives, even the simplest decisions can effect the rest of our day, our year, or our any part of our future.
For example, when you wake up in the morning, you have the choice to go to breakfast. If you don’t go to breakfast, that can cause you to be very hungry during class. If you’re hungry during class, you may not pay as much attention as you need to. Because of that, you fail your next test. Because of that, you lose your motivation and end up dropping out of school. You are then forced to get a job you hate and end up spending the rest of your life in a cubical when you would much rather be an astronaut.

If only you had gone to breakfast....
To illustrate this point further, I have written a story about a girl named Caroline. Actually, two stories. In the first, she chooses to take the elevator. In the second, she chooses the stairs. This small difference changes the story drastically.
The point of my project is that I really think that this is something important. I think this math theory can teach us that we should make our choices carefully and never take a moment of our lives for granted. If we could learn to make choices wisely and not carelessly and if we could learn to not take a single moment for granted, I think our world would be a very different place.
Math + Art =
Calculated Creativity
Investigations of Mathematics Final Project
by
Barbara
• The purpose of this presentation is to demonstrate the harmony of math and art despite common stereotypes
• Using what I learned from mathematics, I created three art projects using Symmetry, Tessellation, and the Golden Ratio
• Inspired by M.C. Escher and his style
• Complex shape, but edited them to make different/add variety

Advanced Tessellation
Incorporating the Golden Ratio of 1.618 in facial proportions

Much more difficult than first appears

Would seem to need computer

Golden Ratio in the Human Face
Sharing Ideas

• At your table, discuss some ways you have students teach other students, or some ideas that you would like to try.
• Be prepared to share with the larger group.
Students Teaching Students Meets Many Goals

- Student Engagement
- Real Life Experience
- Communicating Understanding

Learning More Fun
0. Before the session begins:
Consider these statements from AMATYC’s IMPACT document in chapter 5 on Engagement. See if you can fill in the blanks with a word that starts with the letter “c”:

A. “Mathematical knowledge is now viewed as being socially __________, that is, mathematics is learned through a process of __________ within a _________ of learners” (IMPACT, p.45).

B. “Students should interact with each other often through meaningful discourse and __________ activities for the purpose of sharing and refining ideas” (IMPACT, p.46)

C. “Designing a learning environment that fosters active student engagement in mathematical thinking, encourages student ________ and risk-taking … is a shared responsibility of students, faculty, institutions, and other stakeholders” (IMPACT, p. 43).

1. Why have Students Teaching Students?

The Courage to Teach
--Parker Palmer
“My students will learn much more when I turn their eyes from always looking at me and help them look at one another” (p. 137). http://www.couragerenewal.org/parker/

Creating Wicked Students: Designing Courses for a Complex World
--Paul Hanstedt
“The best way to create an environment conducive to developing authority in our students is to place them in situations where they must assume it…The best way to gain a sense of authority is to practice it in meaningful content-rich contexts” (p. 6-7).
https://teachinginhighered.com/podcast/creating-wicked-students/

What the Best College Teachers Do
--Ken Bain
We should “encourage students to construct their own explanations, to reason, to draw conclusions, to act…Students become the actors in the learning process” (p. 52).
http://www.schreyerinstitute.psu.edu/pdf/BestTeachers.pdf

--using The Heart of Mathematics by Burger and Starbird
2. Jigsaw Group Activity
Each “expert group” gets a different proof of the Pythagorean Theorem to learn and then teach to the other group members.


**Step 1**: Move into “expert groups” (at least one person from each group moves to the four corners of the room and middle) where you will study one proof of the Pythagorean Theorem with your new “expert group.” The number of “expert groups” will match the number of topics you have.

**Step 2**: Working together, prepare to teach the main ideas of your topic to the other students in your home group. If you have time, consider the other topics. (5 minutes)

**Step 3**: After a few minutes, move from your “expert group” back to your home group, where each student in the home group is now an expert on a different topic. Take turns teaching what you have learned to the others in your home group. (5 minutes)

**Topics:**

**Group A (President Garfield’s Proof)**
Use the formula for the area of a trapezoid \((a + b)/2\cdot(a + b)\) and set it equal to the sum of the areas of the three triangles. Then simplify.

**Group B (Proof without words)**
Consider the area of the pieces on the left and the area of the pieces on the right. You may want to label the sides a, b, and c.

**Group C (Proof arranging the pieces)**
First, consider the area of the top diagram. Then rearrange the pieces to make two squares.

**Group D (Area formulas)**
Consider the area of the whole square and set that equal to the area of the 5 inside pieces. Simplify with algebra.

**Group E (Small square in the middle)**
Consider the area of the whole square and set that equal to the area of the 5 inside pieces. Simplify with algebra.

Think about: What are the Advantages/Disadvantages of Jigsaw?
3. Group Teaching Project

Step 1: Groups draw a random number and then have a “draft” to choose which topic they will teach the class (such as Pythagorean Theorem, Golden Rectangle, Symmetry and Tessellations, Platonic Solids, Fractals, etc.).

Step 2: Groups meet with the professor about a week beforehand to discuss plans and get ideas for their lesson.

Step 3: Groups meet outside of class to plan their lesson, which includes a handout, a PowerPoint, group activities, and creative components such as videos and candy prizes.

Step 4: Groups are responsible for teaching the class their lesson on the assigned date. Classmates give feedback on how well they learned and how much they enjoyed the lesson.

Step 5: The professor assesses the project in terms of the lesson design and presentation.

MAT 120
Group Teaching Project

Group teaching project: The best way to really understand mathematics is to teach it. Groups will teach themselves—and each other—the material from one section of the textbook. Then each group will develop a detailed handout (including activities and the class assignment), present a PowerPoint display, and teach the class for one class period. Students should meet with the professor to discuss the teaching project at least one week before the presentation.

A. Textbook Sections

<table>
<thead>
<tr>
<th>Sections</th>
<th>Topics: Choose from the following:</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1</td>
<td>Pythagorean Theorem</td>
</tr>
<tr>
<td>4.3</td>
<td>Golden Rectangle</td>
</tr>
<tr>
<td>4.4</td>
<td>Symmetry &amp; Tessellations</td>
</tr>
<tr>
<td>4.5</td>
<td>Platonic Solids</td>
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<tr>
<td>4.7</td>
<td>Fourth Dimension</td>
</tr>
<tr>
<td>6.1 &amp; 6.3</td>
<td>Fractals</td>
</tr>
<tr>
<td>6.2</td>
<td>Dynamics of Change</td>
</tr>
<tr>
<td>6.5</td>
<td>Predetermined Chaos</td>
</tr>
</tbody>
</table>

B. Evaluation Criteria (80 points total):
20 points Teaching Presentation - (motivating start, good group activities, clear explanations, good class participation, effective examples)

20 points Class Handout – (well-planned structure, includes all main ideas, attractive design, good instructions for activities, creative)

20 points PowerPoint – (creative, self-contained, informative, good summary, effective mathematics)

20 points Content – (correct mathematics, good summary of the section, good visuals and/or manipulatives, understood by the class, math life lesson)

C. Teaching Presentation:
Be prepared to teach the class for at least 30-40 minutes. You may not be able to cover the entire section in class, but you should pick the most interesting topics. Develop a handout, including the assignment in our handout book, and have enough manipulatives for all groups. There should be group activities, a life lesson, and it must last at least 30 minutes. Be creative by using songs, stories, manipulatives, candy, prizes, etc.

D. PowerPoint Presentation:
Prepare a PowerPoint presentation that will help you present the topic to the class. Be creative and use lots of pictures if possible. Try your PowerPoint on the classroom projector before class time to make sure it will work, save your presentation in more than one way for a back-up, and give a copy to your professor.

E. Preparation
Don't wait until the last minute to plan your presentation. Give the handout to the professor at least one class period in advance so he can make copies for you. Please send a copy by e-mail.
MAT 120
Group Teaching Project Ideas

Make sure you communicate the main idea to the MAT 120 students through your lesson. The options are a list of possible things you may want to do in your lesson.

Section 6.1, 6.3 Fractals
Main Idea: help students see how simple processes when repeated can produce fascinating results, so that students can produce fractals and appreciate their beauty.

Options:
- Show a variety of kinds of fractals, including some cool pictures
- Define what a fractal is and explain self-similarity
- Help students draw their own fractals with several examples
- Show how fractals are found in nature
- Students could make their own fractal picture
- Show websites on fractals
- Show YouTube videos
- Discuss history of fractals, including Mandelbrot
- Do a hands-on Jurassic Park fractal with paper
- Discuss how fractals relate to real life

MAT 120 Teaching Project Feedback

Lesson Topic:
I understood the lesson: Yes 5 4 3 2 1 No
I enjoyed the lesson: Yes 5 4 3 2 1 No

The best part of the lesson was:

I least understood …/ Suggestions for improving the lesson:

Other comments:

Think about: What are the Advantages/Disadvantages of a Group Teaching Project?

4. Co-op Group Activity

   Step 1: Assign each group a different concept, or problem, or part of a problem to study and prepare to teach the rest of the class about. For this session, each group will be assigned a different kind of fractal (Sierpinski Triangle, Jurassic Park Fractal, Golden Spiral, Tree fractal, or the Koch Snowflake).

   Step 2: Each group solves the problem by working as a group. For this session (5 min.):
   A. Draw a picture of or create your assigned fractal.
   B. Answer the question about your fractal.
   C. If you have time, create a different fractal that you make up as a group on your own.

   Step 3: Each group in turn teaches the class by sharing their results. (1 minute each)

(Other types of activities that work for Co-op: Four or five practice problems and each group teaches their solution, read an article and each group takes a part to present, each group studies a different mathematical property, demonstrate a different area formula like trapezoid, rectangle, triangle, etc.)
Group A (Sierpinski Triangle)
1. Draw the Sierpinski Triangle on your triangle paper to as many iterations as you have time. (Color in the white, middle, triangles to make it easier to draw.)
2. Consider how many triangles are colored at the nth stage.
3. If you have time, create a different fractal that you make up as a group on your own.

![Sierpinski Triangle Stages](https://example.com/sierpinski_triangle_stages.png)

Stage one is made up of ____ dark triangles, or $3^1$. In stage three, there are ____ triangles? In stage n, there are ____?

Group B (Jurassic Park Fractal)
1. Draw the Jurassic Park Fractal on your paper to as many iterations as you have time. Or, fold your strips of paper in half from the right to left. Continue to fold it in half from the right to the left three more times. When the folds are made into right angles, the result should look like one of the iterations below.
2. Consider how the Jurassic Park Fractal is related to the Jurassic Park movie and the book.
3. If you have time, create a different fractal that you make up as a group on your own.

![Jurassic Park Fractal Iterations](https://example.com/jurassic_park_fractal_iterations.png)

Group C (Golden Spiral)
1. Draw the Golden Spiral on your paper.
2. Consider whether or not the Golden Spiral could be considered a fractal.
3. If you have time, create a different fractal that you make up as a group on your own.

![Golden Spiral](https://example.com/golden_spiral.png)

Group D (Tree Fractal)
1. Draw the Tree Fractal on your paper to as many iterations as you have time.
2. Consider as many examples that you can think of that demonstrate fractals in nature.
3. If you have time, create a different fractal that you make up as a group on your own.

![Tree Fractal](https://example.com/tree_fractal.png)

Group E (Koch Snowflake)
1. Draw the Koch Snowflake Fractal on your paper to as many iterations as you have time.
2. Consider whether the area and perimeter of the Koch Snowflake are finite or infinite.
3. If you have time, create a different fractal that you make up as a group on your own.

![Koch Snowflake](https://example.com/koch_snowflake.png)

https://natureofcode.com/book/chapter-8-fractals/
https://bentrubewriter.com/2012/04/24/fractals-you-can-draw-the-koch-snowflake/
https://bentrubewriter.com/2012/04/25/fractals-you-can-draw-the-dragon-curve-or-the-jurassic-fractal/

Think about: What are the Advantages/Disadvantages of Co-op activities?
5. Final Creative Project

Step 1: Students, working mostly in pairs, choose a topic of their interest that expands one of the topics previously studied in the course.

Step 2: Students research their topic to find additional information beyond what was covered in class.

Step 3: Students apply their research to create or develop something new, such as a statistical study of water usage, a study of ways to finance a house and car, a video or creative story or series of poems using the butterfly effect or Fibonacci numbers, a life lesson on the fourth dimension, a series of photographs that uses the golden rectangle or types of symmetry, etc.

Step 4: Students present their project to the class for the final exam, teaching them the new information they have learned and how they have applied it to real life. Students give feedback on their classmates’ projects.

Step 5: The project is evaluated in terms of the research, the creativity, and the presentation.

MAT 120
Final Creative Project:
Financial, Environmental, Philosophical, or Aesthetic Stewardship

I. Assignment Details
Pick a topic we have discussed in the MAT 120 class and go deeper by researching it and applying it to an area of your interest. Make sure your project has significant mathematics. Also, document where you found your research results.

1. Due at the Final Exam
2. Evaluation Criteria:
   - 20 points Meaningful Mathematics and Research (quality and quantity)
   - 20 points Written Paper (well written summary and documentation)
   - 20 points Presentation (interesting and informative and visual)
   - 20 points Quality and Creativity (thoughtfulness and excellent work)
   - 80 points Total

II. Directions
Working with a partner, decide on one of the four options:
Financial, Environmental, Philosophical, or Aesthetic Stewardship

............

III. Written Paper
Write an approximately 3-page paper that includes the following (these points #1-4 below approximately match the 4 steps above):

1. Why your chosen type of stewardship is important (about ½ page)
2. The results of your data collection or internet search and how you collected the data or went about the search, including references (about 1 page)
3. The results of your calculations or the results of your research or a copy or picture of your creation (about 1 page)
4. Suggestions you have as a result of your project, or what you have learned from your project (about ½ page).

IV. Class Presentation
At the final exam time, present your project to the class.

1. Include something visual to show to the class, such as a poster, drawing, PowerPoint, charts, graphs, handout, etc.
2. Take 4 to 6 minutes to share the project you did, your data collection, your results or creation, and your suggestions.

6. At your table, discuss some ways you have students teach other students, or some ideas that you would like to try.

Faculty are encouraged to allow “students to find and use their voices to teach others, while encouraging and empowering everyone to be engaged in meaningful, worthwhile discussion of mathematics” (IMPACT, p.46).