Origami for Precision and Cooperation
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"Accuracy in the units does help, and some effort will have to be made in class to make sure that students' units are decent. They should not look like they were folded by someone wearing mittens." –Tom Hull

Overview

The lessons included in this curriculum unit seek to introduce origami in the middle school classroom as a means to help students learn to work together in a small group setting, in pairs and individually. An equally important goal is to encourage students to attend to precision and persevere in problem solving. The latter two goals have been chosen from the Standards for Mathematical Practice, which accompany the Common Core Standards. Lessons are designed to help students learn to cooperate effectively through folding and constructing modular origami units together. Students will also have roles within their group or pair as teacher, learner and artist. This unit is designed for an 8th grade mathematics class but could easily be used in 5th through 8th grade classrooms and has application across content disciplines. It is recommended that the teacher familiarize herself with the fold patterns prior to implementation. Materials required for this unit are purposefully minimal in cost and are readily available by online or craft store purchase. The work presented in this unit was developed as a result of my participation in the course *Origami Engineering.* The class was taught by Professor Cynthia Sung at the Teachers Institute of Philadelphia at University of Pennsylvania in the Spring of 2018.

Rationale

Henry C. Lea Elementary School sits on the corner of 47th Street and Locust Street in the West Philadelphia neighborhood of Philadelphia. The neighborhood is rapidly changing as a result of gentrification, mirroring the changes across the city at large. Vacant for nearly a decade, West Philadelphia High School on the opposite corner is in the process of being converted into loft style apartments that are likely well beyond the means of most of my students' families. Why does all this matter to my students? Well, perhaps it doesn't, but it reminds me that my 7th grade students are

facing dynamics both locally and nationally that will require a strong command of language, an ability to understand complex concepts, varied technological and career skills and the necessary knowledge to find relevance and opportunity in a city that will only continue to grow around them.

Lea students are diverse: linguistically, culturally, and socio-economically. A significant population of the school is English Language Learners. My own class includes students whose families have arrived in the United States in the last generation from Panama, Sudan, Democratic Republic of Congo, Dominican Republic, Mauritania, Ivory Coast, Bangladesh, Saudi Arabia and the United Arab Emirates. There are also many students whose families have lived in Philadelphia for generations. The School District of Philadelphia lists the school as having 100 % of the 600 students "Economically Disadvantaged." Many of the students in my class are significantly behind academically as measured on standardized tests. They are bright, they are energetic, they are fully capable of mastering complex content without a doubt. But their tested mathematics skills lag terribly. Last year 97% of Lea students currently in the 7th grade failed to reach the level of "*proficient*" on the Pennsylvania State System of Assessment in mathematics, their annual standardized test. 60% of the students received a "*below basic*" score on the mathematics portion of the test, the lowest reporting category.

Students are at varying levels of engagement regarding the value of their own education. Many students aspire to do well and hope to get into "good" high schools and proceed to college. However, some students are quite open about wanting to drop out of school or doubt that education will have much value for them. With a highly scripted set of mathematical objectives required by the state and the school district, it is often challenging to find time and resources for students to explore learning creatively or to have their voice heard in the context of learning and problem solving in the mathematics classroom.

With particular emphasis on student engagement and communication, my hope is to create a series of origami-themed lessons that give voice to student problem solving but also help students learn to be patient, learn to persevere, learn to work together, and learn to take pride in their achievements. My students thrive when given tangible tasks and the opportunity to *do* and explore will definitely increase engagement. Using the Mathematical Practice Standards that are a central part of the Common Core Standards, a significant part of the unit will seek to improve skills that are not *explicitly* taught in the context of the regular math and literacy curriculum. Desired benefits include increased attention to detail and precision, developing perseverance in order to find a solution or master a skill, and assisting students in finding a way to effectively communicate academic problems and solutions with peers and teachers.

Background

Enter the word *Origami* into the search box on Google Scholar. If you were expecting to find articles about the history of paper cranes or the evolution of this centuries old practice, you are going to have to refine your search significantly. Origami has

catapulted itself into the 21st Century. Modern paper folding techniques and their subsequent models have applications in the fields of engineering, architecture and biological and medical sciences many of which come with a contemporary twist of technology and materials. Enter the word *Origami* in Google Scholar and a list will emerge that may include: "Self-assembly of Carbon Nanotubes into Two-Dimensional Geometries using DNA Origami Templates" and "Capillary Origami: Spontaneous Wrapping of a Droplet with an Elastic Sheet." Modern applications of origami offer engineers, designers, and artists unique capabilities with regard to portability, engineering for very small or unusual spaces, and the creation of affordable prototypes.

The history of origami is limited in documentation probably based on the degradability of paper itself. The Japanese word *origami* has a literal translation of *paper fold* and many people may think of this word associated with the folding of cranes, frogs, and boxes traditionally taught in Japan. But the modern day use of the term includes scientific, engineering and artistic uses from all over the globe, so I will use the terms origami and paper folding interchangeably here regardless of the original source. There is even a growing field in origami robotics, though the robot likely does not know the Japanese origin of the word it implements.

While the origins of paper folding are somewhat unclear, one consensus emerges among scholars: the invention of paper necessarily creates the art of paper folding. Or more succinctly put: if paper exists, then folded paper comes shortly thereafter. Chinese Tsai Lun is credited with the invention of paper in AD 105. The Chinese used paper for calligraphic writing and for ornamental use. It would take another five hundred years before paper making techniques reached Japan. (Hunter, 1978) The Japanese then used paper for wrapping objects of significance and for prayers. (Hatori, 2011) The first known book of origami instructions was published in Japan in 1797, with Akisato Rito's *Sembazuru Orikata* which educated readers in making one thousand paper cranes.

Paper and folding techniques were developing as well in the western hemisphere with the earliest examples possibly originating from folded baptismal certificates of Central Europe during the seventeenth and eighteenth centuries. (Hatori, 2011). With a different purpose, an intricate system of "locking" paper correspondence also developed in Europe, Russia and North Africa. This "letterlocking" was a way of insuring the letter arrived unopened as the paper for the letter was used for the lock as well. (Dambrogio, 2018) When Friedrich Froebel started the first modern Kindergarten in Germany in the early 19th century, he included a type of origami as a central "play" activity. (Hatori, 2011) There seems to have been little crossover between the Western and Eastern traditions of paper folding based on an analysis of fold patterns (Hatori, 2011) When Japan was forced to open its doors to outsiders in the mid 19th Century, cross cultural exchange began, and origami began to take on new forms as cultures mixed. (Hatori, 2011) Codification of origami instructions does not take place until the 20th century with the work of

Akira Yoshizara, who developed symbols and arrows to help guide readers. This system is still widely used today.

My interest in origami began in my childhood. My father, a biostatics professor, was offered the opportunity to work at the Radiation Effects Research Foundation in Hiroshima, Japan: a joint American-Japanese institution devoted to studying the effects of the atomic bomb. While the rest of my peers were celebrating America's bicentennial, I boarded a 747 and flew with my parents and brother to Japan to spend a year in Hiroshima. I remember seeing small children folding origami figures while playing outside near our home in the outskirts of the city. Interesting paper use was everywhere in Japan in a way that I had not seen before: from shoji screens to exquisite wrapping paper to spectacular paper dolls and for use as vehicles for prayers at the many Shinto temples we visited that year. A neighborhood child taught me some folds. It was our common language! I learned to fold pretty well, and to love the paper and the precision and the product. And of course, as a family we visited the Hiroshima Peace Park and viewed the horrific images of the atomic bomb destruction. Outside the museum was a monument to the lost children with strand upon strand of a thousand cranes that were meant to symbolize peace and an offering of hope. Every child could fold a crane in Japan, so I learned too. But another memory stands out to me as an educator: My mother who worked as a mathematics teacher in the United States, visited a Japanese classroom of elementary school students and was completely impressed with the level of problem solving the students were able to achieve. (I believe she witnessed a third grade math class solving a problem. When she brought the problem home to me, her fifth grade daughter, I could not solve the problem.) She quipped "I think it's the origami."

Is my mother correct? Does origami really help children with their mathematical skill? What benefit does folding cute frogs and flowers and cranes really give a child when they reach school? It seems the research into this is limited and relies much on anecdotal evidence. The takeaway from two studies of origami with middle school students is about engagement rather than concrete skills. A study with 56 middle school students found that spatial awareness increased marginally, but engagement was significantly increased. (Boakes, 2009) In a different study, positive impact on spatial awareness was also noted, but again engagement and a noted anecdotal increase in positive attitude towards math class seemed to be equally as important. (C'Akmak, 2009). Origami, both reading the directions and creating the finished product, does address several of the Common Core Standards for Mathematical Practice including*: Making sense of problems and persevere in solving them, Reasoning abstractly and quantitatively, Modeling with mathematics, and Attending to Precision.*

The chance to engage students with paper folding in the context of mathematics class seems a worthwhile expenditure of time. The Common Core Standards when coupled with the testing economy leave little time for exploration. Classroom

origami instruction affords a small chance to rectify that. And resources for children abound. A search on Amazon.com resulted in 2000 suggested books for "origami books for children. With the incredible use of origami techniques for engineering and medicine, it is time to fully bring this practice in the classroom and give students the chance to be ready to meet the challenges of 21st Century design.

Unit Plan

This unit is designed for implementation at the beginning of the year when students are learning classroom procedures for working with partners, working in small groups and learning as a class in whole group instruction. There are several paramount goals of this unit. One major goal is to have students learn to work together constructively in pairs as well as in small groups. Origami folding will become the means by which students learn to problem solve and respectfully communicate with each other so that they can continue throughout the year in math class with a sense of meaningful collaboration for problem solving. A second stated goal is to practice following direct instruction procedures and then quiet independent reflection and work through journaling. A third stated goal of this unit is to deepen student skills for several of The *Standards for Mathematical Practice* as outlined in the Common Core Standards. Those practices include: making sense of problems and persevering in solving them, reasoning abstractly and quantitatively, modeling with mathematics, attending to precision. These origami activities are designed to help students with those practices as a precursor to the type of problem solving they will be asked to do during their year as pre-algebra students. It is also designed to explicitly teach concepts of perseverance, attending to precision and paying close attention to detail. Follow up journal writing should aid in highlighting those concepts.

The classroom should be arranged for students to work in pairs for at least some of class. The classroom should also provide a space for the teacher to work with small groups. A final important goal is for students to take pride in what they have created so a designated space for display is important.

Materials for this Unit: Origami paper. Different sizes may be desirable for different activities. A major goal in creating this unit was to keep the material requirements minimal and easily attainable for teachers. Origami paper is not expensive, but the cost can add up when making multiple pieces with multiple classes. Fundraising may be necessary. Paper and pop up activity for letter locking may require an alternate shape. Access to computer and or interactive white board is necessary. Glue, scissors, and markers are needed for some of the lessons.

Strategies

Paired Learning: Paired learning involves placing well-suited students in pairs to work as partners. Students must be taught how to work together effectively which may include developing communication skills, taking turns, and appropriate ways to share information with each other. Paired learning requires some foresight on the part of the teacher. Students likely will not learn most effectively with their choice of partner. The teacher must pair students based on factors which should include:

academic ability, behavior concerns, gender. Pairs should stay together for at least several class periods, in this case for the duration of the origami unit. Part of the goal of the unit is to teach students to work in pairs effectively! Teacher should monitor the pairs. If a group is not working well together: change it!

Video learning/self teaching: Students use online learning from a video or website to teach themselves. This involves perseverance and the ability to replay the video or reread the material as needed. This is a critical skill as students move in to an increasingly digital world. It may encourage them to persevere in individual learning by pausing video, replaying, and researching on other sites.

Peer teaching: Students work in pairs. Each individual masters a skill and then becomes a tutor for the other student. Students must take turns presenting material to each other. This is different from peer learning where students are trying to learn something together. This strategy involves turn taking, patience, perseverance and accountability for both the students.

Small group instruction: Four to eight students with similar academic abilities will meet with teacher to review or practice a new skill. This gives the instructor a chance to differentiate instruction for students according to the needs of the student. Students of similar ability can be place together to work on a specific skill. Part of the stated goal of this unit is for students to learn to work effectively in a small group with attention to detail and perseverance. Teacher must also plan for what students who are NOT in small groups will be doing at the same time.

Journal Writing/Reflective Writing: Students can reflect on activities and concepts through journaling. This can involve specific prompts or questions designed to help students understand material further. For this unit students will reflect individually on both the process of folding and the final product. Teacher questions should include a reflection on how students handled challenges or obstacles.

Direct instruction: Teacher instructs the whole class regarding a typical concept. Students are all working on the same concept or skill. This is an effective way to get information to a whole group quickly and to give instructions.

Classroom Activities/Lesson Plans:
These lessons are designed in sequential order to aid in developing classroom procedures at the beginning of the year. It may be necessary to repeat lessons multiple times for student mastery. Computer access and interactive whiteboard access is important for the implementation of this unit. The reflection sheet for the lessons is attached at the end of the lesson instructions.

Lesson #1: Small Square Paper: Small Group Setting

Materials: 13" square paper required, fold instruction:
https://www.youtube.com/watch?v=N8p_MIq4ngU

Duration: 30-45 minutes depending on group size.

Objective: Students will be able to follow verbal teacher instructions in a small group setting in order to create an origami figure.

1) Prior to lesson: Teacher should study the following origami box fold and be prepared to show students: https://www.youtube.com/watch?v=N8p_MIq4ngU
2) Have previously selected small groups (4-8) join teacher at table separate from rest of class. The rest of the class must be engaged in another activity.
3) Distribute paper to students in small group and explain that students will be working on origami in various different settings in the classroom. Explain that today you are going to get them started in a small group setting.
4) Have students examine paper: colored on different sides, square. It may be necessary to talk about the importance of not wasting the paper.
5) Students should follow teacher instructions as the teacher leads them through folding the pattern described in the video (but hopefully without the use of the video). Teacher should make sure to pause and help each student as each fold occurs, so that all students fully participate and none are left behind.
6) If this activity is a challenge for students, it may be necessary to repeat this process at subsequent small group meetings until students
7) Find an appropriate display spot for each student's box. **Subsequent student work can be kept in these boxes. If boxes are too small, it may be necessary to make more!**
8) Repeat this process with each different small group. This may take a week or so to get through all of the small groups in the class.
9) Students should record thoughts and observations on reflection sheet.

Lesson #2: Small Square Paper: Small Group Setting #2

Materials: 4" square origami paper-2 sheets per student, fold pattern for fluted diamond using two sheets of paper:
https://www.youtube.com/watch?v=NDLx7BAl8sU&t=4s

Duration: 30-45 minutes

Objective: Students will be able to use visual skills in order to learn a set of origami instructions.

1) Students who have already completed the previous activity can now participate in this lesson. With the same group the teacher worked with last

time, students will now approach folding by viewing a video set of instructions and replicating the fold.

2) Teacher may want to display a fold pattern chart (attached).
3) Teacher should demonstrate basic folds such as mountain fold, valley fold, and show accompanying diagram instructions and symbols.
4) Teacher should have students view the video before giving them the origami paper. Explain that they will only get enough paper for this fold pattern, and their challenge is to try to create the figure.
5) Teacher will provide support as needed but allow students to try to figure out fold and construct pattern independently. Students can be encouraged to help each other. Video can be stopped as needed.
6) If this is a challenge for students, it may be necessary to repeat this process at subsequent small group meetings until students
7) Find an appropriate display spot for each student.
8) Repeat this process with each different small group. This may take a week or so to get through all of the small groups in the class.
9) Students should record thoughts and observations on reflection sheet.

Lesson #3: Small Square Paper: Large Group Setting

Students are ready for whole class instruction.

Materials: 4" Square origami paper-3 sheets per students, https://www.youtube.com/watch?v=2O2o0VgTK9A

Duration: 20-30 minutes

Objective: Students will be able to independently follow a set of oral instructions in order to create an origami figure.

1) Now that students have some familiarity with origami and the teacher has had a chance to see how each student adapts to the folding process, students can begin to learn to fold in a larger class setting.
2) The teacher gives each student three sheets of origami paper and shows the video to them through making one unit of this figure. The video can be stopped as often as needed.
3) Explain that students can work in pairs to try to solve the fold together and that their goal is to each create one unit of the figure. They can help each other solve as they go. In other words: if you have it and your buddy doesn't, help them figure out what to do!
4) Once one unit has been completed, lead students through a repeat of the necessary parts of the video. Perhaps students will be able to complete the third unit on their own.
5) Teacher demonstrates how to put units together. It may be beneficial to pass around several completed hexahedrons so students can see how to connect

units. A hexahedron photo on display on interactive white board may be helpful as well.

6) Students should be encouraged to help their partner and to persevere rather than getting frustrated and immediately asking for help.
7) Students can display their origami.
8) Students should record thoughts and observations on reflection sheet.

Lesson #4: Small Square Paper: Paired Learning

Students are seated in pairs.

Materials: 4" square or smaller origami paper-6 sheets per student, fold pattern: https://www.youtube.com/watch?v=r6KCpxpaBM0

Duration: 30 minutes

Objective: Students will be able to independently follow a set of written instructions in order create an origami figure with a partner.

1) Each student pair group will be given one set of instructions for X-Faced Cube on one sheet of paper. Students will also *each* receive 6 sheets (all same size) of origami paper.
2) Have students think before working. *Who is going to make the folds? Are you going to take turns? Who is going to decipher the instructions? Is one person going to read while the other one folds? What kind of communication will you need to be able to figure out this figure?* Explain that each student will ultimately end up with a cube.
3) Students have to work together to create the object. Success is two of the same and teacher observation that students have worked together to complete the task.
4) Students should record thoughts and observations on reflection sheet.

Lesson #5: Small Square Papers: Paired Learning #2

Students are seated in pairs.

Materials: 4" square paper or smaller-six sheets per student, fold pattern for a different cube: http://www.origami-instructions.com/easy-origami-cube.html

Duration: 30 minutes

Objective: Students will be able to work together as partners in order to create an origami figure.

1) Each student will receive instructions to create three units for a cube.
2) Students will **each** create three units and then have the task of putting the cube together. (A total of 6 units is needed to make a cube.)
3) Then students will create three units again and make another cube.
4) Students should reflect on the process of working together in their origami reflection sheet.

Lesson #6: Small Square Paper: Paired Teaching

Students are seated in pairs.

Materials: 4" square or smaller-one sheet per student. Students chose fold patterns from https://www.origami-fun.com
or students may want to choose alternate fold patterns that they know. Laptops or access to computers is required.

Duration: 2-3 class periods

Objective: Students will be able to instruct a partner in making an origami figure. Students will be able to teach their origami figure to another student.

1) Each student in pair chooses one origami fold that they want to try from the website listed above or alternate source. It will be necessary to show students the book and have them choose what they would like to do. Or teacher may choose to choose and randomly assign fold patterns.
2) Each student must fold and master at least 5 of their figure independently.
3) Students will write a reflection on their sheet about how they believe they can best teach their partner BEFORE they try.
4) When they have mastered the folds and made 5, students then teach their partner using only verbal instructions.
5) Now reverse the process and have the other student teach her origami figure.
6) Students should then reflect on their sheet about what it took to master the fold pattern they chose and teach and also about what it took to learn the new pattern from their partner.

Lesson #7: Small Square Paper: Pop UP!

Students are seated in pairs.

Materials: Paper of choice for pop ups, thicker paper like construction paper may help. Markers, scissors, glue. Fold video:
https://www.youtube.com/watch?v=7CkxiCq97zI

Duration: 30 minutes

Objective: Students will create an origami "pop up" to label their figures for display.

1) Students will create a pop up display card using the following fold pattern.
2) Students can make a brief description or label of what they learned on a card to be included in pop up.
3) Students can display all of their origami in a box with pop-up label in front.
4) Students should record thoughts and observations on reflection sheet.

Lesson #8: Send a Locked Letter Invitation

Students are seated in pairs or can work individually.

Materials: Rectangular shaped copy paper. Sealing wax or stickers. Scissors. Writing implements. Fold patterns: https://letterlocking.org/categories/

Duration: Two 45-minute class periods.

Objective: Students will be able to communicate through a written letter to invite people to an event.

1) Students learn the process of letter locking, working independently to make a letter to send. They can practice from the following videos: https://letterlocking.org/categories/
2) Students write a letter to a teacher, administrator or adult in the building asking them to come to the origami "gallery opening" so they can share their work.
3) Students may need a review of letter writing salutations and format. (Rough draft of letter could be done first on regular letter and then copied on to locking version.)
4) Students will "lock" their letters with stickers or sealing wax and then deliver their letter/invitation via US mail.
5) Students should record thoughts and observations on reflection sheet.

Lesson #9: Sharigami! Have an origami sharing party.

Materials: Origami boxes and journals.

Objective: Students will be able to communicate the process of origami folding with adults and peers.

1) Students will keep their origami boxes at their desk along with their journals.
2) Adults and students are invited to come in to view.
3) Students will share what they have done and talk about the process of folding. They can also share their reflection sheets.
4) Students may want to be prepared to teach some fold patterns to visitors.
5) Students should record thoughts and observations on reflection sheet.

References

Boakes, Norma J. (2009). Origami Instruction in the Middle School Mathematics Classroom: Its impact on spatial visualization and geometry knowledge of students. Research in Middle Level Education Online, 32:7, 1-12. https://doi.org/10.1080/19404476.2009.11462060

This source provided a case study of origami implementation in one middle school classroom. The results were inconclusive and largely anecdotal.

Sedanur Cakmak, Mine Isiksal & Yusuf Koc (2013) Investigating Effect of Origami-Based Instruction on Elementary Students' Spatial Skills and Perceptions, The Journal of Educational Research, 107:1, 59-68, DOI: 10.1080/00220671.2012.753861

http://www.corestandards.org/Math/Practice/
Common Core Standards for Mathematical Practice
This website lists Common Core standards in an easily readable format. It also has a detailed breakdown of the standards for Mathematical Practice used in this unit.

Dambrogio, Jana (2018) http://www.janadambrogio.com/timeline or letterlocking.org
D'ambrogio has made a career of researching Letter Locking history. The site includes history and examples as well as phenomenal videos in how to make both letters that lock and folded letters that do now lock.

Fuse, Tomoko (1990) Unit Origami: Multidimensional Transformations. Tokyo and New York, Japan Publications.

Fuse has made *her* life's work around modular origami. This book contains fold patterns for various modular pieces sometimes using the same unit to create multiple different structures. Fold patterns are challenging but result in beautiful figures. The book also contains an explanation of some mathematical pattern associated with three dimensional figures.

Gleason, Katherine (2006), Geogami: Create Multidimensional Geometric Origami. New York, NY, Barnes and Noble Publishing.

This small booklet includes examples of modular origami that creates geometric figures. Each figure requires more than one sheet of paper, and each sheet if folded the same. Parts are then interlocked without glue to create a three dimensional figure. Used copies of the booklet are available from Amazon or Barnes and Noble. Original publication came with origami paper but that may need to be purchased separately.

Hatori, Koshiro (2011). History of Origami in East and West Before Interfusion. Origami^5: Fifth International Meeting of Origami, Science, Mathematics and Education, pages 3-11.
https://books.google.com/books?id=E7LMBQAAQBAJ&printsec=frontcover&=origami+5&hl=en&sa=X&ved=0ahUKEwiP3rjb8fbZAhUJVN8KHQynAWEQ6AEIKTAA -v=onepage&q=origami 5&f=false

Educational journal includes articles on the most recent applications of origami in the fields of engineering, robotics and medicine as well as educational applications. This article was a helpful recap of the history of paper and origami and addresses the difference in paper folding techniques from East and West.

Hull, Thomas. Project Origami: Activities for Exploring Mathematics. New York: CRC Press, 2013.

The chapter of this book explores the PHIZZ unit and modular origami including the mathematics behind the Buckyball. It is the source of the quote at the head of this paper. The humor and enthusiasm in Hull's work is notable.

Hunter, Dard (1978). Paper Making: The history and technique of an ancient craft. New York, NY, Dover Publications, Inc.

An exhaustive work on the history of paper and other means of communication in print form. This book is well researched and documented. It also includes photos and illustrations of different techniques for papermaking.

Montroll, John (1992). Easy Origami. New York, NY, Dover Publications, Inc.

This book contains an easy-to-follow set of origami instructions for a myriad of figures including animals, pinwheels, boxes and sailboats. Beginners and children may like this book for simple one page instructions. It also requires learning basic origami fold symbols and contains a key in the front of the book.

Additional Helpful Websites:

http://www.origami-instructions.com
https://origamiusa.org
https://www.origami-fun.com
youtube.com

Standards:
Common Core *Standards for Mathematical Practice*

1. **Make sense of problems and persevere in solving them.**
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. **Attend to precision.**
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

This website has a detailed explanation of the intention behind each Practice:
http://www.corestandards.org/Math/Practice/

PA Core Standard:
CC.1.4.8.X
Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Student Reflection Sheet for_____.

For each lesson, ask yourself:

- What did you like about folding this figure?
- What did you find challenging about creating this figure?
- What was the key to your success?
    - Listening?
    - Cooperating?
    - Watching?
    - Repeating steps?
    - Communicating?
    - Persevering?
    - Patience?
    - Other?
- Could you teach this figure to someone else? How would you approach teaching this to someone else?
- Tell Me More! What else do you think about this project?
- Make sure to write 5-7 sentences about each lesson.

Origami Box Lesson #1
Fluted Diamond Pattern Lesson #2
Hexahedron Lesson #3
X-Faced Cube Lesson #4

Second Cube Lesson #5
Teach Each Other Lesson #6
Pop Up! Lesson #7
Letterlocking Lesson #8

“Sharigami” Gallery Opening Lesson #9