Transforming Students Through Geometric Transformations

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About the School Where You Are Teaching

1. In what type of school do you teach? (Type an “X” next to the appropriate description; if “other” applies, provide a brief description.)
   
   Middle school: __X__
   High school: ______
   Other (please describe): ______

2. Where is the school where you are teaching located? (Type an “X” next to the appropriate description.)
   
   City: ______
   Suburb: ______
   Town: __X__
   Rural: ______

3. List any special features of your school or classroom setting (e.g., charter, co-teaching, themed magnet, remedial course, honors course) that will affect your teaching in this learning segment.

   [CY Middle School is a 6-8th-grade school with an enrollment of 755 students. About 30% of students qualify for free or reduced lunch. 85% of the student population is Caucasian, 9% are Hispanic, 1% are American Indian/Alaska Native, 1% are Black/ African American, 1% are two or more races, less than 1% are Native Hawaiian/ Pacific Islander, and less than 1% are Asian. The school employs 115 staff members including 51.5 regular education teachers and 8.5 special education teachers. The school is part of a district of choice. During the open enrollment period, families from all over town can choose which middle school they would like their student to attend. These students come from all different neighborhoods and backgrounds. It is important to keep this in mind while teaching because although some students may live in a wealthier neighborhood, other students may live in lower income neighborhoods and they may not have the same opportunities as others. Also, because we are in a district of choice, this school does not receive any Title 1 funding.

   The school has a full inclusion policy; therefore, special education teachers co-teach mainstream core classes. In this specific classroom, I will be co-teaching with a special education teacher. In addition, due to the high number of special education students and at-risk students, there is also a paraprofessional in this classroom. We all work collaboratively together to implement and adjust our instruction to better serve all our students. This class is quite large (26 students) to even out the ratio of special education students to general education students. For this reason, I make sure to incorporate many different management strategies into my lessons in order to best meet the needs of all my diverse learners.]
4. Describe any district, school, or cooperating teacher requirements or expectations that might affect your planning or delivery of instruction, such as required curricula, pacing plan, use of specific instructional strategies, or standardized tests.

[There is no required curricula or pacing plan that my district and school follow. The only requirement is that I teach to the Common Core Math Standards. My cooperating teacher, along with the other 8th grade Math teacher at the school, has chosen the priority standards for the year, therefore, I have focused my unit on one of these. The rest of the planning for my unit has developed from the research and ideas of Dr. Robert Marzano and Marzano Research. Although my school still utilizes the traditional grading scale, they are transitioning into developing a more standards-based system. I had to plan my unit keeping this in mind, therefore, I first created a proficiency scale for the priority standard. After, I formed a blueprint for my assessments and then created my assessments. Once I knew what I was going to assess and how I was able to create my lessons so that they would meet the needs of all students.

Furthermore, our state requires that students take a standardized test three times a year. This test is called The Wyoming Test of Proficiency and Progress (WY-TOPP) and students take it in the Fall, Winter, and Spring. It is an online adaptive assessment that assesses student proficiency in Wyoming Content and Performance Standards. When planning my learning segment, I must be aware of the format of the assessment and the types of questions that students will be assessed on. This helps me figure out what types of questions to include in my assessment and in my lessons.]

About the Class Featured in this Learning Segment

1. What is the name of this course?

[8th grade Pre-Algebra]

2. What is the length of the course? (Type an “X” next to the appropriate description; if “other” applies, provide a brief description.)

   One semester: ______
   One year: __[X]__
   Other (please describe): ______

3. What is the class schedule (e.g., 50 minutes every day, 90 minutes every other day)?

   [50 minutes every day]

4. Is there any ability grouping or tracking in mathematics? If so, please describe how it affects your class.

   [The only grouping that exists for this class involves the special education students. This is one of two classes that I co-teach with the special education teacher, therefore, the special education students are split between those two classes. As far as the general education students go, there is an Algebra class for the advanced students. Since most 8th-grade students are in Pre-Algebra, the kids who are not in the advanced class or special education are randomly placed into the four other sections, including this focus class.]

5. Identify any textbook or instructional program you primarily use for mathematics instruction. If a textbook, please provide the title, publisher, and date of publication.
We utilize a textbook to supplement our learning material. It is the textbook: Math Common Core Course 3 Volumes 1 and 2, McGraw-Hill, 2013. Although the lessons are not taught from this textbook, I utilize this textbook to supplement the learning material that I create if needed. It also serves as a great guide when choosing problems that students should be able to answer because it is based on the Common Core Math Standards.

6. List other resources (e.g., electronic whiteboard, graphing calculators, online resources) you use for mathematics instruction in this class.

[This learning segment is inquiry-based therefore I am using GeoGebra and Desmos for students to do their own inquiries. They will complete their activities in the classroom set of Chromebooks. I will use an electronic whiteboard to project my computer screen to give students directions and to have class discussions. Students are always able to use their calculators in this classroom. I use the McGraw-Hill online resources that are included with our book to supplement the learning material if needed. Everything that is completed in class is posted to the class’ Google Classroom page and students can access this from anywhere.]

About the Students in the Class Featured in this Learning Segment

1. Grade-level composition (e.g., all seventh grade; 2 sophomores and 30 juniors):
   [All eighth grade]

2. Number of
   - students in the class: __ [25] __

3. Complete the charts below to summarize required or needed supports, accommodations, or modifications for your students that will affect your instruction in this learning segment. As needed, consult with your cooperating teacher to complete the charts. Some rows have been completed in italics as examples. Use as many rows as you need.

Consider the variety of learners in your class who may require different strategies/supports or accommodations/modifications to instruction or assessment (e.g., students with Individualized Education Programs [IEPs] or 504 plans, students with specific language needs, students needing greater challenge or support, students who struggle with reading, students who are underperforming or those with gaps in academic knowledge).

For Assessment Task 3, you will choose work samples from 3 focus students. At least one of these students must have a specified learning need. Note: California candidates must include one focus student who is an English language learner.²

<table>
<thead>
<tr>
<th>Students with IEPs/504 Plans</th>
<th>Supports, Accommodations, Modifications, Pertinent IEP Goals</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEPs/504 Plans: Classifications/Needs</td>
<td>Number of Students</td>
</tr>
<tr>
<td>Specific learning disability</td>
<td>1</td>
</tr>
</tbody>
</table>

² California candidates—If you do not have any English language learners, select a student who is challenged by academic English.
### Secondary Mathematics

**Task 1: Context for Learning Information**

<table>
<thead>
<tr>
<th>Specific learning disability</th>
<th>Numbers</th>
<th>Supports, Accommodations, Modifications</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>Alternate response, calculator, preferential seating, access to a word processor</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Calculator, visual presentation of materials, break down assignments into single steps with visual support</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Calculator, seating close to the teacher, extended time to complete assignments, check for understanding of each step of math problems</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Clarify and repeat directions, check for understanding, word processor, extended time to complete assignments, use of erasable pen</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Clarify and repeat directions, check for understanding, have a designated reader for lengthy passages/story problems, break down assignments into single steps, calculator, extended time to complete assignments</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Clarify and repeat directions, check for understanding, read and re-read aloud directions and test questions, calculator</td>
</tr>
</tbody>
</table>

### Language Needs

<table>
<thead>
<tr>
<th>Students with Specific Language Needs</th>
<th>Numbers of Students</th>
<th>Supports, Accommodations, Modifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students with Specific Language Needs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N/A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>At-risk for Mathematics level 2</td>
<td>3</td>
<td>Students who are at-risk for math are given extra support through scaffolding and modeling. They also receive extra one-on-one and small group instruction.</td>
</tr>
<tr>
<td>At-risk for Mathematics level 3</td>
<td>4</td>
<td>Same as above</td>
</tr>
<tr>
<td>At-risk for ELA level 3</td>
<td>4</td>
<td>Students are given extra time to write notes, students are not called on to read aloud if not agreed to previously</td>
</tr>
</tbody>
</table>

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taskId=1

1. **Central Focus**
   
a. Describe the central focus and purpose of the content you will teach in the learning segment.

   [This learning segment is part of a larger unit on geometric transformations. The purpose of this unit is to develop students' understanding of the four transformations: translation, reflection, rotation, and dilation. Students have previously learned three of the transformations using the words slide, flip and turn in their earlier years. In this unit, prior to this learning segment, students will have experimented and inquired about translations and reflections. The purpose of this specific learning segment is to develop and enhance students' knowledge of a rotation. This segment is designed to build on students' prior knowledge (they know about a turn) and to introduce the accurate name, vocabulary, and properties associated with a rotation. The central focus will be to understand, identify, and perform a rotation on a coordinate grid using the appropriate vocabulary. Students will expand their knowledge of what a rotation is, they will apply rotations to shapes to change their position, and they will graph the preimage and image of a shape after a rotation.]

b. Given the central focus, describe how the standards and learning objectives within your learning segment address
   - conceptual understanding,
   - procedural fluency, **AND**
   - mathematical reasoning and/or problem-solving skills.

   [There are two standards for this segment and they both address conceptual understanding. The first standard, "verify experimentally the properties of rotations, reflections, and translations", requires that students have a conceptual understanding of each individual transformation. By "verifying experimentally", students take charge of their own learning and they can gain a deeper understanding of each transformation, and more specifically, the properties of a rotation. In lesson 1, the learning objective is "Students will be able to identify and describe rotational symmetry, the angle of rotation and the center of rotation". Students begin to develop their own conceptual understanding of a rotation and its different components when they are completing an inquiry lab on the website "GeoGebra". They can gain a general understanding of the underlying concepts such as rotational symmetry. The second standard, "describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates”, addresses conceptual understanding because students must have a deep conceptual understanding of a rotation and its properties to describe how it affects a shape on a coordinate grid. This is addressed in lesson 2 and lesson 3. The learning objective for these lessons is that students will be able to identify and graph rotations on the coordinate plane. In order to achieve this, they must know how a rotation affects a shape. They must know that it changes a shapes orientation, but not size or shape. They must understand that lines are taken to lines, rays to rays, segments to segments, angles to angles and parallel lines to parallel lines. They also must understand how the coordinates change after a rotation of 90-degrees clockwise versus a rotation of 90-degrees counterclockwise. In addition, if a student does not have a conceptual understanding of the center of rotation, then]
they will not be able to perform a basic rotation because they will not know what to rotate their shape around.

The first standard, “verify experimentally the properties of rotations, reflections, and translations”, addresses procedural fluency because students must understand that to perform a rotation, it requires an understanding of several components in addition to the fact that lines are taken to lines, rays to rays, segments to segments, angles to angles and parallel lines to parallel lines. In lesson 1, students gain this basic knowledge of properties of rotations that is necessary to perform this transformation. On the computer, they will be able to rotate shapes and visualize how the shape stays the same and how distances are preserved. This is vital to students’ procedural fluency because when they are rotating a shape, for example, they must know if a vertex is three units from the origin (the center of rotation) then it must be three units from the origin in the other quadrant. These skills will also be addressed in lessons 2 and 3. Additionally, the second standard, “describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates”, addresses procedural fluency because a student must know all the properties of a rotation and how they come together to complete a rotation. Describing the effect of a rotation first requires that they know they must start with the preimage and its coordinates. They then must identify how much they are rotating a shape (angle of rotation) and what they are rotating the shape around (center of rotation) and understand what the shape will look like on the coordinate grid. Once they have this information, they can then perform the rotation to get the image. They can describe the effect of the rotation from the pre-image to the image using the mapping rules.

Finally, the standard “verify experimentally the properties of rotations, reflections, and translations” requires that students justify the properties of a rotation, thus developing their mathematical reasoning skills. Furthermore, students must investigate the properties of rotations for themselves, which enhances their problem-solving skills. In lesson 2, students are asked to investigate rotations and its properties using shapes, numbers, and letters. This requires them to use their mathematical reasoning skills and take what they learned from the previous day and apply it to different activities. Moreover, mathematical reasoning is addressed in the standard “describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates” because, to describe the effect of a rotation, the student must be able to reason through why a specific rotation affects a shape differently than any other transformation. For example, a student must reason through why a 90-degree clockwise rotation about the origin is different than a 90-degree rotation about a point on the shape.

c. Explain how your plans build on each other to help students make connections between concepts, computations/procedures, AND mathematical reasoning or problem-solving strategies to build understanding of mathematics.

[There is a clear progression in this learning segment to help students make connections between concepts and expand their knowledge of rotations. My first lesson plan leads students to have a conceptual understanding of the various parts of a rotation before performing rotations. It consists of an introduction to the concept and properties of a rotation. At the beginning of the lesson, we will discuss their prior knowledge of turns and symmetry. Then students will connect this to their new learning when they complete the inquiry lab on the website “GeoGebra”. They will develop their understanding of rotational symmetry, the angle of rotation, and center of rotation. After each individual investigation, we will have a discussion about each concept and how the figures changed. This discussion will allow students to connect what they learned in the first investigation to the second investigation and then what they learned in the first and second investigations to the third investigation. The goal of this task is to]
lead students to the understanding that a rotation does not change the shape or size of a figure, but it will change its orientation. The homework for lesson 1 is an extension of what the students learned in class, but it dives more into how to perform a rotation on a coordinate grid. This homework requires students to take more responsibility for their learning and understanding of the concepts. They will learn the procedures for performing a rotation on their own, so they will have to make the connections from that day’s lesson to their homework on their own. This homework set them up for the learning activity on the next day.

The second lesson connects to what students learned the day before because it builds on the concepts that students studied in the first lesson and it will have them performing rotations on a coordinate grid using the knowledge that they gained from their homework. This lesson takes what they learned the day before and has students put the concepts into action. Depending on the station, students will have to answer questions relating to rotational symmetry, the center of rotation, and angle of rotation, graphing a pre-image on a coordinate grid, and graphing an image after a rotation. There will also be stations relating to reflections and translations. This will help students compare the similarities and differences between the three transformations—reflection, translation, and rotation. This connects students’ learned knowledge from the previous week to their present learning which in turn leads them to a deeper understanding of rotations.

The final lesson is a culmination of everything that the students have learned. They will have to put all the knowledge that they have gained from the past two days together to complete a series of rotations. Instead of asking leading questions to get students to think about the different components of a rotation, like in the station activity, students will have to think about these on their own to perform the rotations. They will have to connect all the skills that they have learned and put them together along with using mathematical reasoning to carry out the specific transformations. Because this learning segment is based on inquiry learning, students have a chance to develop their own procedures for completing rotations. One student might depend on using the mapping rule, another might physically rotate their paper to find the coordinates of the image after a rotation, and other students might develop other ways. Whatever mathematical reasoning skill works best for them will be put to the test on this day and it will determine their proficiency in performing rotations.

2. Knowledge of Students to Inform Teaching

For each of the prompts below (2a–c), describe what you know about your students with respect to the central focus of the learning segment.

Consider the variety of learners in your class who may require different strategies/support (e.g., students with IEPs or 504 plans, English language learners, struggling readers, underperforming students or those with gaps in academic knowledge, and/or gifted students).

a. Prior academic learning and prerequisite skills related to the central focus—Cite evidence of what students know, what they can do, and what they are still learning to do.

[At the beginning of the overall unit of Transformations, I administered a formative pre-assessment to students to gather data on what they understood about transformations and to see if they could perform any. I had eight students correctly define a rotation, center of rotation and angle of rotation. In addition, I had nine students correctly identify a rotation on a coordinate plane. However, there were only three students who correctly performed a rotation.]
Prior to this learning segment, students have had a lot of experience with simple transformations. In prior grades, students learned what a flip, slide, and turn is. These are the three transformations reflection, translation, and rotation, in simple terms. They have performed these transformations with simple shapes, but not on a coordinate grid. In addition, they have experience performing these actions in real-life. They have all slid an object across a table, they have flipped a page of a book and they have turned a piece of paper. Although they did not know it, they were building the foundation for their understanding of these three mathematical concepts.

Finally, this learning segment is being implemented right after the students have finished their linear equations unit. This means students know what a coordinate grid is, including the two axes and they can graph a point on a coordinate grid using an ordered pair. However, lower-level students still need help correctly graphing on a coordinate grid. Additionally, students know the basic geometrical concepts needed to perform a rotation on a coordinate grid including what a line, ray, vertex, angle, and shape is, to name a few.

b. Personal, cultural, and community assets related to the central focus—What do you know about your students’ everyday experiences, cultural and language backgrounds and practices, and interests?

[The school district that we are in is a school district of choice. Because of this, I have students from all diverse cultural and financial backgrounds. This focus class is predominantly Caucasian students that come from lower to middle-class homes. Many students do not have much academic support at home. In addition, many of the students lack the perseverance and motivation needed when it comes to academics. As a result, most of the students do not try hard when they are learning new things and homework does not influence them like it should. These students give up very quickly when they do not understand how to do something. They struggle to complete the bare minimum that is asked of them and they do not care what their grade is or about growing their minds. With technology nowadays, you can find anything that you want in a matter of seconds. This has greatly affected my students’ work ethic because they depend on it too much. They always say things like “why do I have to learn this stuff when I could just look it up on Google if I needed to”.

As far as their culture and interests go, most students are interested in socializing with other students rather than focusing on their learning. Cell phones are a huge distraction because students would rather “Snapchat” their friend across the room than try and learn a new math concept. Also, students are always trying to listen to music on their cell phones while I am trying to teach a lesson. I have set strict cell phone policies in my classroom as a result. This learning segment is designed to try and get students excited about their own learning. I have incorporated technology and other manipulatives to spark student interest. In addition, the segment is centered on inquiry-based learning to also motivate students. Because students have a familiarity with transformations and what a rotation is, some of the posed questions should be easy for them to answer. It is my hope that this gives students a little motivation and confidence to keep going and persevere through the more challenging questions.

On the other hand, I have about 6 students who always try hard and are motivated to learn new concepts. These are my highest achievers and the only ones that seem to care about their learning and their grade. The rest of the class has a grade of C or below. For these 6 motivated students, having an inquiry-based segment still allows them to work at their own pace and they will not be held back by the rest of the class. As they are completing their own work, I can verbally ask them more high-level questions that get them thinking even more. If they finish
c. Mathematical dispositions—What do you know about the extent to which your students

- **perceive** mathematics as “sensible, useful, and worthwhile”\(^1\)
- **persist** in applying mathematics to solve problems
- **believe** in their own ability to learn mathematics

This class is not an advanced class so most students in this class are only there because they have to be. Many of my students do not see the value or importance of learning math and how crucial it will be to their future achievement outside of school. I have a couple students that will just sit there in class and try to get away with doing nothing for the day. In addition, I have many students who are always questioning why we are learning different math concepts. It seems like every day that I get asked “Why do I have to learn this” or “when am I ever going to use this in life”. I believe that a lot of this negativity comes from a lack of confidence in their math ability. Many students say “I am bad at math” but nobody is “bad” at math. I think that these students heard that at an early age and now they just use that as their excuse to give up when a problem becomes challenging. These students usually start off the day by trying, but as soon as they do not understand something, that is when I get the “why” questions. I have seen all my students succeed at one point, so I try to remind them of this with the hope that it gives them a little confidence to keep trying. Only a couple of the students view mathematics as useful and worthwhile, so they are the ones that go above and beyond what is expected of the class. Most of the class, however, only tries to complete what is required of them and most times they complete less than that.

### 3. Supporting Students’ Mathematics Learning

Respond to prompts below (3a–c). To support your justifications, refer to the instructional materials and lesson plans you have included as part of Planning Task 1. In addition, use principles from research and/or theory to support your justifications.

a. Justify how your understanding of your students’ prior academic learning; personal, cultural, and community assets; and mathematical dispositions (from prompts 2a–c above) guided your choice or adaptation of learning tasks and materials. Be explicit about the connections between the learning tasks and students’ prior academic learning, their assets, their mathematical dispositions, and research/theory.

[I chose to teach the concepts of rotational symmetry, the angle of rotation and center of rotation in lesson 1 and rotations on a coordinate grid in lesson 2 through an inquiry lab because inquiry labs require using higher-order thinking skills that make for independent thought and action. Students know what a rotation is because they see objects rotating in real-life all the time. Aktas and Unlu (2017) said that the hardest part of learning rotations for students is understanding the concept of angle of rotation and center of rotation. This is why I dedicated one full day to learning these concepts and another full day to introducing them along with performing a rotation. By utilizing an inquiry lab, it is my hope that students gain a better understanding of these concepts when they are forced to use their higher-order thinking skills. In addition, I]

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\(^1\) From The Common Core State Standards for Mathematics
believe that letting the students inquire about their own learning will spark student interest and my students will be more engaged.

Aktas and Unlu also say that using computer software is the best way to help students gain a conceptual understanding. My students love their technology so incorporating “GeoGebra” is a win-win situation for everybody. Aktas and Unlu say that technology helps students to better visualize the concepts, such as changing the angle measure of a rotation. This will help my students who have trouble persevering through their work because the technology will make the concepts neater and my students will not be focused on smaller parts that do not matter as much.

Finally, because students are able to work at their own pace in an inquiry lab, my advanced learners will not be held back by the rest of the classroom. The inquiry labs allow the students who work at a slower pace to do so and advanced students to get the enrichment that they need.

b. Describe and justify why your instructional strategies and planned supports are appropriate for the whole class, individuals, and/or groups of students with specific learning needs.

Consider the variety of learners in your class who may require different strategies/support (e.g., students with IEPs or 504 plans, English language learners, struggling readers, underperforming students or those with gaps in academic knowledge, and/or gifted students).

[The “GeoGebra” inquiry lab is broken up into three investigations which enables students to work at their own pace while still allowing the whole class to come together to discuss. While the students are working individually, they are able to work at their own pace to best understand the concepts. In addition, there are three teachers in this classroom that can help students. While the students are working individually, the three teachers can be walking around and helping students get the one-on-one support that they need. We are able to give the students that need extra help some more guiding questions and we are able to give the advanced students more high-level thinking questions.

Furthermore, during lesson 2, the three teachers can give students the one-on-one attention that they need, again. There will be one teacher fixed at one of the stations that will be going over how to perform a rotation with each student. By working in small groups to teach this transformation, it allows the teacher to better assess if each student has learned the skill or not. From here, the teacher can ask one of the other teachers to give the student further instruction while working at another station. On the other hand, one teacher can tell another teacher to better challenge students who have a good understanding of how to perform a rotation.

Finally, the third lesson is a chance for all students to put what they have learned over the past three days together. By grouping the students by ability, it gives the teachers a chance to focus on what needs to be done. There will be a red group for students who need remediation. The teacher with this group can give further instruction to the struggling students. There will also be a yellow group for students who are almost proficient at the skill but still need a little help. The teacher working with this group will be able to help students as needed. Finally, there will be a green group for students who have proven to be proficient at rotations. The teacher working with this group can provide enrichment as needed. This makes sure that all student needs are being met.]
c. Describe common mathematical preconceptions, errors, or misunderstandings within your central focus and how you will address them.

[The main mistakes that students make when applying rotations are rooted in a misunderstanding of the center of rotation and angle of rotation. Aktas and Unlu (2017) did a study and found that students did not know how to apply angle of rotation. For example, when students needed to apply a 180-degree counterclockwise rotation they only did a 90-degree counterclockwise rotation. Edwards and Zazkis (1993) performed a similar study and found that students had a misconception that the center of rotation must be a point on or within the object itself. This misconception comes from everyday experiences such as watching wheels on a car rotate or a record spinning.

To address these misunderstandings and misconceptions, I have set aside one full day for students to learn about the angle of rotation, the center of rotation and rotational symmetry. The students will be learning these concepts with the technology “GeoGebra” which Aktas and Unlu and Hollebrands (2003) have said are the best way to aid students and to help them gain a conceptual understanding. After students answer questions about each concept, we will come back together as a class to discuss what they have learned.

In addition, I will use a pinwheel to illustrate the concepts as we discuss them. For example, I will blow on one side of the pinwheel and ask students if it has rotational symmetry. They should answer yes. Then I will twirl the pinwheel from the bottom of the stick and ask the same question. Students should answer no. We will then discuss what is different between the two examples including how the center of rotation is different and how the angle of rotation changes.]

4. Supporting Mathematics Development Through Language

As you respond to prompts 4a–d, consider the range of students’ language assets and needs—what do students already know, what are they struggling with, and/or what is new to them?

a. Language Function. Using information about your students’ language assets and needs, identify one language function essential for students to develop conceptual understanding, procedural fluency, and mathematical reasoning or problem-solving skills within your central focus. Listed below are some sample language functions. You may choose one of these or another language function more appropriate for your learning segment.

<table>
<thead>
<tr>
<th>Compare/Contrast</th>
<th>Justify</th>
<th>Describe</th>
<th>Explain</th>
<th>Prove</th>
</tr>
</thead>
</table>

Please see additional examples and non-examples of language functions in the glossary.

[Students must be able to explain the concepts and properties associated with performing a rotation to be successful within this central focus. If a student cannot explain what the center of rotation is and its function in completing a rotation, they will be unable to perform any of the rotations. The same goes for the angle of rotation, and the properties of a rotation including lines go to lines, angles go to angle, etc.]

b. Identify a key learning task from your plans that provides students with opportunities to practice using the language function identified above. Identify the lesson in which the learning task occurs. (Give lesson day/number.)

[While all my lessons provide students opportunities with the language function, the “GeoGebra” lab in lesson 1 focuses the most on using this language function. This is the lesson that
introduces students to rotations, the angle of rotation, the center of rotation, rotational symmetry
and the properties of a rotation. In lesson 1, the learning objective is "Students will be able to
identify and describe rotational symmetry, the angle of rotation and center of rotation ". Students
are required to perform the inquiry lab, discuss their findings with a partner and then we will
discuss them with the whole class. This provides them with multiple opportunities to gain a
conceptual understanding of the material, so they could come up with their own explanation.]
c. **Additional Language Demands.** Given the language function and learning task
identified above, describe the following associated language demands (written or oral)
students need to understand and/or use:

- **Vocabulary and/or symbols**

- **Mathematical precision**\(^2\) (e.g., using clear definitions, labeling axes, specifying units
  of measure, stating meaning of symbols), appropriate to your students’ mathematical
  and language development

- **Plus** at least one of the following:
  - Discourse
  - Syntax

[There are a lot of vocabulary words that students need to know to be successful. They must
know and understand these vocabulary words: rotation, rotational symmetry, the angle of
rotation, the center of rotation, coordinate grid, ordered pair, x-axis, y-axis, origin, degree, 180-
degrees, 90-degrees, clockwise, counterclockwise, about, quadrant and transformation. They
also must recognize the symbols: x, y, +, -, (x, y) and °. Students should be familiar with most
of these words from their linear equations unit and past geometry units.

For mathematical precision, students must be able to correctly graph an ordered pair. This
includes correctly identifying the x and y-axes and the order in which you label an ordered pair.
They also must be able to do the reverse and find the coordinates of a point on a graph and
label it as an ordered pair. In addition, they must correctly identify which way is clockwise versus
counterclockwise and 180° versus 90°.

The syntax that students need to know is the three different mapping rules for completing a
rotation. The rule for a rotation 90° clockwise about the origin is: (x, y) -> (y, -x). For a rotation
90° counterclockwise about the origin: (x, y) -> (-y, x) and for 180° clockwise about the origin: (x,
y) -> (-x, -y).]
d. **Language Supports.** Refer to your lesson plans and instructional materials as needed
in your response to the prompt.

- Identify and describe the planned instructional supports (during and/or prior to the
  learning task) to help students understand, develop, and use the identified language
demands (function, vocabulary and/or symbols, mathematical precision, discourse,
or syntax).

[Students know all the vocabulary involving graphing from a previous unit. They will learn the
new concepts such as angle of rotation and center of rotation during the "GeoGebra" inquiry lab
in lesson 1. We will go over the words after each investigation as a class to make sure that

\(^2\) For an elaboration of "precision," refer to the “Standards for Mathematical Practice” from The Common Core State Standards for
Mathematics (June 2010), which can be found at [http://www.corestandards.org/assets/CCSSI_Math%20Standards.pdf](http://www.corestandards.org/assets/CCSSI_Math%20Standards.pdf).
students have the correct understanding of the words. During lesson 2, there will be more hands-on modeling of how the concepts play into performing a rotation. As students get more practice learning and performing rotations on a coordinate grid, we will write down the different mapping rules on a notes sheet. Once they have these, they can use the note sheet over and over so there is no misunderstanding about how to write the mapping rules.]

5. Monitoring Student Learning

In response to the prompts below, refer to the assessments you will submit as part of the materials for Planning Task 1.

a. Describe how your planned formal and informal assessments will provide direct evidence of students’ conceptual understanding, procedural fluency, AND mathematical reasoning and/or problem-solving skills throughout the learning segment.

[I have planned numerous informal assessments throughout each lesson to monitor student learning. In lesson 1, I will collect the student answer sheets for the “GeoGebra” lab to see if each student met the learning objective for the day. These will show me if the student has a conceptual understanding of the new concepts. In addition, I will be able to monitor student learning as I walk through the classroom. Checking in with students orally will tell me a lot about whether they have a conceptual understanding or not. In lesson 2, I will be walking around the classroom constantly. Again, this gives me a chance to check in with each student orally to see assess their learning. For lesson 3, I will collect the worksheets as a small formal assessment of student learning. This worksheet will give me direct evidence of students’ conceptual understanding, procedural fluency, and problem-solving skills. In addition, the student will complete a reflection about their learning during the first two days. These are another informal way to monitor if they have a conceptual understanding. Outside of the classwork, there will be a “Quizizz” for homework halfway through the learning segment. The quiz will incorporate everything from vocabulary to performing rotations on a coordinate grid. This will tell me what students have a conceptual understanding, procedural fluency, and problem-solving skills. Finally, at the end of the larger unit of Transformations, there will be a formal summative assessment.]

b. Explain how the design or adaptation of your planned assessments allows students with specific needs to demonstrate their learning.

[There are three teachers in this room, which allows me to give students with specific needs more one-on-one time. Because a lot of the informal assessments will be done orally, the number of teachers is crucial to getting this done. I am able to check in with all my students with specific learning needs and spend more time with them, if necessary. The three lessons and homework are designed to scaffold students learning from one day to the next. They are also designed to differentiate student learning. These multiple forms allow me to reach students and support students with multiple learning needs. For example, students who do not feel comfortable sharing aloud will be better assessed during the one-on-one-time. On the other hand, students who do not get as much one-on-one time can be assessed through their work on the worksheets and they can receive more help the next day if needed.]
1. Which lesson or lessons are shown in the video clip(s)? Identify the lesson(s) by lesson plan number.

[Lesson #1 is shown in the video clip.]

2. Promoting a Positive Learning Environment

Refer to scenes in the video clip(s) where you provided a positive learning environment.

   a. How did you demonstrate mutual respect for, rapport with, and responsiveness to students with varied needs and backgrounds, and challenge students to engage in learning?

   [In the clip, there are many ways that I demonstrate mutual respect for and rapport with my students. First, I spent the entire time helping students individually or in small groups. I demonstrated mutual respect and rapport with my students by checking in with every single one of them individually. Although it does not show me talking to every student in the video, I made sure to check in with every student to see if there were any questions. I circled the room evenly and did not leave out a student. In addition, I provided individual help and attention to every student. I was courteous to students at all times. Finally, I listened to each student, I gave them my complete focus, and I used eye contact and appropriate responses. I also encouraged my students by saying things like "Awesome", "Good job" and "Perfect" when they demonstrate a correct understanding of the concept.

At the beginning of the video, I talk through a problem with a student who is on an IEP. She struggles with math and needs a lot of direction on what to do. The parent of this student asked for her daughter to be shown very minimally in the video, so therefore I am the main focus of the video at this point. When I am helping her, I repeat the questions on the paper to her orally and provide further instruction such as "type in any negative number". I then give her further prompting by saying “What do you notice about all three numbers?” (00:25) and “are they positive or negative?” This shows my responsiveness to my students' needs. After checking to see if the student understood and she did not, I provided the support necessary for her to be successful. In the video, I do this with numerous other students as well.

Moreover, there is a student at (05:30) with her head down on her desk. When I politely ask if she is OK and if she will answer a question for me, she says “NO”. It appears that I just let this student act how she pleases when I say, “OK” and back away. According to this student’s educational plan, if she puts her head down, she is allowed a couple of minutes to regroup before she must start working again. I did not engage with this student when she gave some attitude because I was aware of her plan. This demonstrates that I realized what my student needed at the moment, and that was not to be pushed further. Later, at (09:30) she can be seen interacting with her group during the discussion, therefore, giving my student the space, she needed was effective. I have a very good relationship with this specific student, so my actions also helped me to build continual rapport with her.
In addition, I challenge students to engage in learning by never giving them the answers. If a student is struggling, I ask them questions that guide them to the right answer. Also, I use academic language appropriately. At (01:35) when the student is struggling, I did not simplify the question or vocabulary for him. I used academic language to state the question in a different way that did not lower the rigor of the problem. Moreover, I allow students to get up and collaborate with each other after the class has finished one of the investigations (08:20). This allows students to learn from each other and it helps students with varied needs. It gives students the chance to talk about their findings aloud and it is more engaging because they can pick who they talk to. This presents a challenge to students without feeling like there is a lot of pressure.

3. Engaging Students in Learning

Refer to examples from the video clip(s) in your responses to the prompts.

a. Explain how your instruction engaged students in developing

- conceptual understanding,
- procedural fluency, AND
- mathematical reasoning and/or problem-solving skills.

[My instruction engaged students in developing conceptual understanding by requiring that students use their prior knowledge about concepts such as symmetry to inquire about new concepts such as rotational symmetry. Once they recall what a rotation is, what symmetry is, and the different components of a graph, students are asked to apply these concepts to new ideas. This is all completed on Chromebooks, so students can visualize the concepts as they learn them. In addition, the students were asked to share their latest ideas and discuss with other classmates, which deepens their conceptual understanding of the new material. This lesson is designed so I can participate in these conversations to assess student understanding and help revise understandings if needed.

After learning about rotational symmetry in the first problem, students were asked if another shape had rotational symmetry. This developed students’ procedural fluency in identifying rotational symmetry because they had to move the picture on the screen to find if there was rotational symmetry. While doing so, students are learning about the properties of a rotation. As they rotate each image, they are visualizing the fact that lines are taken to lines, rays to rays, segments to segments, angles to angles, and parallel lines to parallel lines. Because this lesson takes place on the computer, students can better visualize these properties and how distances are preserved which is vital to students being able to perform rotations. Also, at the end of the lesson, I had a class discussion with a pinwheel and asked students if the pinwheel had rotational symmetry and I asked about different centers of rotation. This also helped students develop procedural fluency because even though I was the one rotating the shape, the students had to apply their knowledge to answer the question correctly.

As far as mathematical reasoning and problem-solving skills go, this whole lesson focuses on developing these skills. Students were not given any instruction on these concepts before this lesson. The “GeoGebra” lab required that students took charge of their own learning and figured out how to navigate the lesson independently. Students were posed with various questions and had to use their mathematical reason and problem-solving skills to answer each question and move from one section to the next. For example, students had to learn...
and understand rotational symmetry before they could move on and talk about the angles of rotation. Moreover, students’ mathematical reasoning skills were further developed when they had to explain their reasoning to their classmates. For their classmates to understand them, students had to develop a clear and concise argument that came from their mathematical reasoning skills.]

b. Describe how your instruction linked students’ prior academic learning and personal, cultural, and/or community assets with new learning.

[My instruction is driven strongly by my students’ prior knowledge and personal, cultural and community assets. First, only 8 students were able to correctly define rotation, rotational symmetry, and angle of rotation and center of rotation on the pre-assessment. This is why the first lesson is focused solely on understanding vocabulary concepts necessary to perform a rotation. Second, students had previous knowledge and experiences with many of the basic ideas of this lesson including symmetry and rotations. Students have been studying symmetry since elementary school and they see objects, like tires, rotating every day. This lesson requires an understanding of these basic concepts to be successful with their new learning, including rotational symmetry and center of rotation.

In addition, we had just finished our linear unit, so students were very familiar with a graph and its different components. In Investigation 3 of Lesson 1, students had to recall this knowledge in order to understand how the shape was rotating on the graph and how the angle of rotation changed. Although these questions were focused solely on the center of rotation and angle of rotation, by placing the figure on a graph, it allowed me to have deeper conversations with my gifted students. I was able to ask them how the coordinates were changing when the shape rotated, which got them ready to start thinking about the mapping rules that they would learn the next day. Also, I was able to use students’ previous knowledge of a graph to help the struggling students. If students do not understand right away, they tend to shut down and stop doing work. If this happened, I was able to ask other questions that they could easily answer based on the graph to get their confidence back up.

All my students in this classroom have a cell phone and access to a computer. They are interested in electronics and are very familiar with how to operate technology. This lesson allowed students to tap into these experiences and interests and connect it to how you can learn math concepts and solve problems using various websites. I also have many students who have become bored from completing practice problems on paper. If they see a worksheet, they immediately become disinterested and do not want to work. I took this knowledge and recreated the worksheet, so it was online and more interactive. Just knowing that they were going to be using the Chrome books for this lesson was enough to get students initially engaged.

Finally, Lesson 1 shows and highlights our classroom’s culture of collaboration. In Lesson 1, students are asked to get up and share their new findings with classmates. This supports all students since they can choose whom they want to talk to and they must work together. Additionally, this allows students to gain a deeper understanding of the concepts because student vocabulary is usually different from teacher vocabulary. The students were able to explain concepts such as the center of rotation to each other in a way that was easier to understand. Also, they have the same interests (video games, sports, etc.) so students could make better connections to what they see and experience in the real-world.]

4. Deepening Student Learning during Instruction
Refer to examples from the video clip(s) in your explanations.

a. Explain how you elicited and built on student responses to promote thinking and develop conceptual understanding, procedural fluency, AND mathematical reasoning and/or problem-solving skills.

[I elicited and built on student responses to promote thinking and develop conceptual understanding throughout the whole lesson. In the video clip, I am constantly asking questions to steer students to engage with the concepts even more. (In the video clip at 00:25, 1:50, 03:45, 04:45, 06:24, and 10:40). Based on how each student is doing, I ask leading questions or probing questions that will provide each student the support they need. For example, the student at the beginning was confused and her confidence was dwindling. I noticed this and asked her easy leading questions such as "are they all positive?" (00:30). When she said she did not know, I asked: "Well, do you have any negative numbers here?" (00:38). These leading questions allowed the student to gain back some of her confidence and allowed her to tackle the next question which was "why do you think they are all positive?" This was one of the important concepts to understand and the student would not have arrived there without the leading questions. For the student who did not understand center of rotation (06:50), I asked her probing questions such as "If you were to take your pencil and stick it anywhere on the screen, where would you stick it so it would be the point where the shape is turning around". This made more sense to the student than the definition of the center of rotation and allowed her to gain a better conceptual understanding.

In addition, the students were asked to move around the room and share their new findings with a partner (08:50). The students shared their new knowledge and asked their partner questions about what their partner found to be true. This allowed students the opportunity to share their knowledge and build on their understandings of the concepts based on what their partner shared. This not only built on students’ conceptual understanding, but it also helped their procedural understanding. Students had to explain their thought process, which forced them to review their ideas and make any changes, if necessary.]

b. Explain how you used representations to support students’ understanding and use of mathematical concepts and procedures.

[This entire lesson is centered on representations because geometry is a visual subject. Rotations involve rotating objects on a graph; therefore, you must be able to visualize those rotations and how it is affecting the object or shape. This lesson was centered on two different forms of visualization. First, there were the visuals created on the “GeoGebra” lab and second, I used the pinwheel as a visual. The reason I chose to do Lesson 1 on the Chromebooks is because I believed that it would present the best visuals for students to understand. The “GeoGebra” lab allowed students to be hands-on with their learning while also organizing the material in a way that led to student understanding. Students were able to look at a shape and move the “slider” to see how the shape rotated. Having these visual representations on the computer also allowed students to easily see how different angles affect a shape and rotational symmetry. If students had to find these angles on their own with manipulatives, it would take away from learning the concepts because the focus would be elsewhere.

The pinwheel allowed students to take what they learned in the “GeoGebra” lab and apply it to a real-life manipulative. They were able to connect the concepts and visualize how it affects a concrete object. This visual was very important to student understanding of the...
concepts because it brought them to life. Students are used to seeing objects such as tires, a fan, merry-go-rounds, etc. rotate in real-life so having these concrete visuals allowed students to gain a better conceptual understanding because it better related to their past experiences.

5. Analyzing Teaching
Refer to examples from the video clip(s) in your responses to the prompts.

a. What changes would you make to your instruction—for the whole class and/or for students who need greater support or challenge—to better support student learning of the central focus (e.g., missed opportunities)?

Consider the variety of learners in your class who may require different strategies/support (such as students with IEPs or 504 plans, English language learners, struggling readers, underperforming students or those with gaps in academic knowledge, and/or gifted students).

[If I were to reteach this lesson, the first change that I would make would be adding more problems to the “GeoGebra” lab. There were only three visuals in the lab and a couple of questions to go with each concept. I do not think that this was enough for students to gain the understanding that I was hoping for. I believe with more visual examples and problems, the students would have gained a better understanding. I think that this was a good opener to the new concepts, but students struggled with applying them over the next couple of days because they did not have the deep understanding that was needed.

The second change that I would make would be taking more time to point out examples of where students see rotations in real-life. This could just be a brief discussion, probably only a couple of minutes, but I believe it would be very beneficial to help students start thinking about the different components of rotations. For example, I would talk about a tire rotating, and through our discussion, I would get students to start thinking about how it spins on an axel (center of rotation). We could then think of other examples such as a fan. I had this conversation individually with some students, but it would be more beneficial to have it as a whole class. This would help scaffold students’ prior knowledge and better prepare them for this lesson.

Additionally, I would change the manner in which students had their discussion. The way that it was set up was too open-ended and I did not hear the discussions that I had hoped for. Many students simply just stated their answers or they were talking about something entirely different. If I were to teach this lesson again, I would create extra questions to get the students thinking deeper about the material. I would also create groups of students that I wanted to talk together instead of letting the students choose. Most students just choose their friends which did not challenge them as much as if they were forced to talk to classmates that they are not used to. Creating my own groups would also allow me to target groups and give them specific questions. This would better meet the needs of all my students because I could give higher-level thinking questions to the gifted students and more clarifying questions to the students who needed it.]

b. Why do you think these changes would improve student learning? Support your explanation with evidence of student learning AND principles from theory and/or research.
[First, I would include more visuals and problems in the “GeoGebra” lab so students could have a better conceptual understanding. After finishing lesson 2, it was obvious that my students did not have the conceptual understanding that I thought they did from the day before. Although students understood rotational symmetry when it came time to perform rotations they forgot what role center of rotation and angle of rotation play. According to the National Council of Teachers of Mathematics, students demonstrate conceptual understanding of mathematics when they provide evidence that they can recognize, label, and generate examples of concepts. Having students only look at one visual for each concept does not give them enough opportunity or provide enough evidence that they have a conceptual understanding.

Second, I believe that even a brief discussion about where students see rotations in real-life would provide enough scaffolding for the students to be more successful in this lesson. I had multiple students who seemed lost when it came to learning the new material even though they all had previous experiences with the material in one way or another. According to Vygotsky's Zone of Proximal Development, students cannot learn new concepts unless they are in the zone of proximal development. To get students in this zone, you must scaffold the material. By briefly reviewing with students how they have seen the concepts before would provide the necessary background knowledge that seemed to be missing.

Finally, I would organize the discussion part of the lesson better so that it was more worthwhile for the students. The way that it was originally structured, it was just an opportunity for students to recite their answers and talk to their friends. If I created specific, higher-level questions beforehand, this would spark more of a discussion between students that would lead to improved conceptual understanding, procedural fluency, and mathematical reasoning.]
1. Analyzing Student Learning

a. Identify the specific learning objectives measured by the assessment you chose for analysis.

[The assessment that I chose took place 1.5 weeks after Lesson #3. It is a summative assessment of everything that students learned during our unit of Transformations which includes the learning segment on rotations. There are multiple learning objectives that this assessment measured. They are:

1. Students will be able to identify and describe rotational symmetry, angle of rotation and center of rotation
2. Students will be able to identify rotations
3. Students will be able to graph rotations on the coordinate plane
4. Students will be able to generate the rule for rotations]

b. Provide a graphic (table or chart) or narrative that summarizes student learning for your whole class. Be sure to summarize student learning for all evaluation criteria submitted in Assessment Task 3, Part D.

<table>
<thead>
<tr>
<th>Student</th>
<th>Pre-Assessment</th>
<th>Post-Assessment</th>
<th>Gain</th>
<th>% Increase</th>
</tr>
</thead>
<tbody>
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<td>44</td>
<td>97</td>
<td>53</td>
<td>120.45%</td>
</tr>
<tr>
<td>B</td>
<td>22</td>
<td>82</td>
<td>60</td>
<td>272.73%</td>
</tr>
<tr>
<td>C</td>
<td>0</td>
<td>10</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>D</td>
<td>32</td>
<td>54</td>
<td>22</td>
<td>68.75%</td>
</tr>
<tr>
<td>E</td>
<td>22</td>
<td>82</td>
<td>60</td>
<td>272.73%</td>
</tr>
<tr>
<td>F</td>
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<td>51</td>
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</tr>
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<td>G</td>
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</tr>
<tr>
<td>H</td>
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<td>111.43%</td>
</tr>
<tr>
<td>K</td>
<td>34</td>
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</tr>
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</tr>
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</table>

Averages: 20.906666667, 59.47619048, 39.45454545, 292.63%
This chart shows the learning progression of my students from the pre-assessment to the post-assessment. The assessment was out of 34 points total and the table gives student scores as a percentage out of 100. The pre-assessment was administered to students at the beginning of the Transformations Unit which was approximately one week before the start of the rotations learning segment. The post-assessment was given to students approximately 1.5 weeks after the end of the learning segment.

From the table, it is evident that students performed significantly better on the post-assessment, which is to be expected. On average, students gained 39.45% on their score from the pre-assessment to the post-assessment, which translates to a 262.63% increase. This shows that students learned and understood a good portion of what was taught throughout the unit and learning segment. Although there is a significant percent increase from the pre-assessment scores to the post-assessment scores, the average score on the post-assessment is a 59.48%. In terms of grading on the 100-percent scale, this means that the class scored an F on average. There were only four students who earned an A or a B. There were four C’s, five D’s, and nine F’s.

I created this assessment using strategies from Marzano Research and their approach to teaching to the standards. Based on the standards, I created a proficiency scale to allow me to assess if each student is proficient at the standard or not. The scale is broken down into levels 1, 2, 3, and 4, and students can earn .5 of each level. Based on scale, this assessment is split up into three main sections. The first section is named Level 2 and includes everything that I deemed necessary for students to know to be considered “approaching standard”. This includes being able to define the vocabulary from the unit and identify transformations including rotations. The Level 2 section addresses learning objective 1 (students will be able to identify and describe rotational symmetry, angle of rotation and center of rotation) and learning objective 2 (students will be able to identify rotations). The Level 3 questions utilize the skills that are necessary for a student to be considered “proficient” at the standard. This section includes performing transformations on a coordinate grid, applying transformations to a single point, writing the mapping rules for transformations, and naming a sequence of transformations. Level 3 addresses learning objectives 3 (students will be able to graph rotations on the coordinate plane) and 4 (students will be able to generate the rule for rotations). The Level 4 section allows students to show that they can go above and beyond what was taught in class. This section is extra credit for students because they are only required to show that they are proficient at the standard. Provided below is a graphic of student’s proficiency scores at the end of the unit:

<table>
<thead>
<tr>
<th>Proficiencies</th>
<th># of students</th>
<th>% of Class</th>
</tr>
</thead>
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<tr>
<td>0</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>0.5</td>
<td>1</td>
<td>4.55%</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0.00%</td>
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<td>1.5</td>
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<td>13.64%</td>
</tr>
<tr>
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<td>6</td>
<td>27.27%</td>
</tr>
<tr>
<td>3.5</td>
<td>2</td>
<td>9.00%</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>4.55%</td>
</tr>
</tbody>
</table>
As you can see, most students were either at/above proficient or approaching proficient at a 2.5. Although the majority of students received an F on their test, if you look at the results from a standards viewpoint, most of the class is proficient on the standard. The reason that the proficiency scores and the traditional letter grades are so different is because percentage does not equal proficiency. Most students missed many points on the assessment because they did not read the directions carefully and answer everything that they needed to. The percentage grades were greatly affected by this. However, if students had one part of the question correct, but they forgot to answer the second part, I was still able to assess whether they understood the concept or not. This is why students were able to get a good proficiency score but low percentage score.

With all that said, there are still concepts and procedures that my students did not understand and that I may need to reteach. Since this assessment is based on proficiency scores for the standard, it is very easy to analyze what concepts and procedures the students did not understand. Underneath the three different proficiency levels, each level can be separated into specific concepts and procedures. Level 2 can be separated into two different sections. The first section (Section 1) tests students' understanding of the vocabulary for the unit, and the second section (Section 2) assesses whether a student can identify a specific transformation or not. Level 3 comprises much of the assessment and it can be broken up into 4 parts. Section 3 tests students' ability to perform transformations on a coordinate plane, Section 4 asks students to apply a transformation to a given point, Section 5 assesses using mapping rules, and Section 6 evaluates ability to identify multiple transformations. Finally, Section 7 measures students' ability to perform above what was taught in class. Here are how students performed on each section:

<table>
<thead>
<tr>
<th></th>
<th>Section 1</th>
<th>Section 2</th>
<th>Section 3</th>
<th>Section 4</th>
<th>Section 5</th>
<th>Section 6</th>
<th>Section 7</th>
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<tbody>
<tr>
<td>Student A</td>
<td>6</td>
<td>4</td>
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<tr>
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<td>2.5</td>
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<tr>
<td>Student E</td>
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<td>4</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Student F</td>
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<td>7</td>
<td>3</td>
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<tr>
<td>Student G</td>
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<tr>
<td>Student H</td>
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<td>Student L</td>
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<td>Student N</td>
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<tr>
<td>Student T</td>
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<td>4</td>
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<tr>
<td>Student V</td>
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<td>1</td>
<td>2.5</td>
<td>4</td>
<td>3</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Averages: 4.08168182 3.77272727 2.72727273 2.65909090 3.40909090 2.54545454 1.547019048

Max Points: 6 4 8 4 8 4 3
c. Use evidence found in the 3 student work samples and the whole class summary to analyze the patterns of learning for the whole class and differences for groups or individual learners relative to
- conceptual understanding,
- procedural fluency, AND
- mathematical reasoning and/or problem-solving skills.

Consider what students understand and do well, and where they continue to struggle (e.g., preconceptions, common errors, common struggles, confusions, and/or need for greater challenge).

[Based on my analysis of the evidence from the whole class summary, students showed substantial growth in their conceptual understanding of rotations. This is clear because students scored an average of 4.7 points out of 6 total points on the vocabulary section. This means that students were able to correctly define rotation, center of rotation, angle of rotation, and rotational symmetry. In addition, students averaged 3.8 out of 4 points on Section 2 where they had to correctly identify transformations including rotations. If you look at the table for the section breakdown, there are only two students who did not score a 4 out of 4 on this section. Based on these two pieces of information, it is evident that students have a basic conceptual understanding of what rotations are, the different components of a rotation, and what a rotation looks like on a coordinate grid.

The scores begin to drop substantially at Level 3 Section 3 because even though students have a conceptual understanding of rotations, they lack the procedural fluency skills necessary to perform a rotation and identify vertices. In this section, students are asked to perform transformations and state the ordered pair for a specific vertex of the image. Student A’s work is shown in Student Work Sample 1. From the table above, she is the only student who answered this section 100% correctly. The rest of the class’ work closely resembles Student E’s work (shown in Student Work Sample 2). Although Student E was able to perform the rotation correctly, his ordered pair for the image was incorrect. He seems to have counted the length of the right side of the parallelogram instead of counting down from the x-axis. Most of the students made simple errors like this. Although they performed the rotation correctly, they messed up writing the ordered pair. This shows that students understand the procedure for performing a rotation but lack the procedural fluency skills of writing coordinates. Other students did not show their work when doing the rotation, so their coordinates were wrong. The lack of work leads me to believe that these students do not understand the procedure for performing a rotation.

Additionally, the evidence from Level 3 Section 4 shows that many students lack the procedural fluency needed to apply a transformation to a given point not on a coordinate grid. Students A and E answered these questions correctly, however Student T (Student Work Sample 3) was incorrect. For this section, students were told that they could use graph paper to answer the questions and it can be solved using the mapping rules. Student T did not use graph paper and she does not appear to use a mapping rules which leads me to believe that she just guessed or tried to visualize the rotation in her head. The lack of work again leads me to believe that she does not understand the procedure for performing a rotation and it also tells me that she does not have the mathematical reasoning skills to think through a problem of this nature.
Students’ mathematical reasoning and problem-solving skills appear to be effective throughout the beginning of the test until they get to the more difficult material in Level 3 Section 5 and 6. In Section 5, students are asked to state the transformation and write the mapping rules. Most students struggled greatly with writing the mapping rule and most students either forgot or did not even attempt to think about it. The mapping rule is difficult because you do have to reason through what is happening to the coordinates of each vertex and how you would reflect his using mapping rule notation. Student A correctly states what is happening to the pre-image, however she fails to write the mapping rule. Also, many students struggled with Level 3 Section 6. For example, Student E thought that a dilation and rotation were both occurring in the first picture. Although it appears to be a rotation at first glance, once you look at the vertices of the pre-image and image, it is clear that it cannot be a rotation because the vertices would not line up. Student E appears to have paid no attention to this detail which shows a lack in both conceptual understanding and mathematical reasoning skills.

d. If a video or audio work sample occurs in a group context (e.g., discussion), provide the name of the clip and clearly describe how the scorer can identify the focus student(s) (e.g., position, physical description) whose work is portrayed.

[ N/A ]

2. Feedback to Guide Further Learning

Refer to specific evidence of submitted feedback to support your explanations.

a. Identify the format in which you submitted your evidence of feedback for the 3 focus students. (Delete choices that do not apply.)

- Written directly on work samples or in separate documents that were provided to the focus students

If a video or audio clip of feedback occurs in a group context (e.g., discussion), clearly describe how the scorer can identify the focus student (e.g., position, physical description) who is being given feedback.

[ N/A ]

b. Explain how feedback provided to the 3 focus students addresses their individual strengths and needs relative to the learning objectives measured.

[ I wrote my feedback directly on each of my student’s assessments. For the three focus students, these can be found in the document labeled student work samples. On each student’s assessment, I wrote various comments for incorrect answers depending on their answers. These comments may include simply circling what is incorrect about the answer, underlining words in the directions, drawing arrows or lines on a diagram, or writing specific comments. I also made sure to acknowledge correct answers by drawing smiley faces or writing simple comments such as “good!”. If students are super close to getting the correct answer, I will write “close!”. I do not tell students the correct answers because every student has the chance to come in and make corrections for some points.

Student A, who is one of my gifted students, received a 97% on their assessment therefore she did not need many comments about incorrect answers. The only place that Student A missed points was on Level 3 Section 5. This is the section that asked students
to identify the transformation and write the rule. This student described what was happening in the transformation, but it was not using mapping notation. As the beginning of the assessment, I went over the instructions with students and made sure to tell them they needed to write the rule in mapping notation. This student may have just forgot or did not understand so I circled “write the rule” in the instructions and then I wrote the format for writing mapping rules next to it i.e. “(x,y) -> (__, __)”. This is a subtle reminder for her of what the mapping rules look like and it still gives her the opportunity to think about it and answer it on her own. The majority of students missed the problem about a dilation transformation on page 4 in the top right. Student A is one of the students to figure out the scale factor, so I wrote “Yes! =)” next to her answer. Also, this student had many pages that were 100% correct so at the bottom of each one I wrote a smiley face. This is a subtle way to acknowledge that I can see how great she did. Finally, she got all three extra credit points at the end of the test, so I wrote “Excellent!” to let her know that she did a job well done. Upon further reflection of my feedback to this student, I realize that I could have given her more specific feedback about her strengths instead of just writing simple things like smiley faces. For example, on page 3 I could have done a better job of acknowledging how good she did at showing her work.

Student E also displayed some of the same qualities that Student A did. He answered the first two pages 100% correctly and I wrote smiley faces down in the bottom corner to show him that I realized this. Again, after further reflection I wish I would have wrote more specific comments about this student's strengths instead of simple acknowledgements like a smiley face. For example, on problem 3 on page 4, he found all the coordinates of the image instead of just the one that I asked for. I could have acknowledged that he went above and beyond what was asked and did so correctly. On page 3, this student did not draw the image every time which was a requirement in the instructions. For this problem I told him to draw the image on the ones that he was missing. For two of the images that he did draw correctly, he wrote the coordinate incorrectly. On these problems I acknowledged that his image was correct and told him to check his point. I did not draw on the figures or say anything more because then he still has a chance to think about the answer and come to the correct solution on his own. On page 5, the student incorrectly thought that a dilation and rotation occurred. A rotation could not have occurred because then the vertices would not match up. To steer him toward the right track I said, “The vertices would not match up after a rotation. How else might the image “flip” over the y-axis?”. This tells the student that he is incorrect and gives him the opportunity to think through the other transformations and hopefully come up with reflection.

Student T is one of my students who is on an IEP and she is considered at-risk for math. In accordance with her IEP, she was able to test in another room with the Special Education Teacher where she was provided some extra help. For example, on page 3 she was told to write (x,y) above ordered pair so she remembered the order that ordered pairs are written in. This student became very frustrated because she still could not figure out the answers to page 3 so she gave up. To give her some encouragement, I wrote “Come into bridges and we will try these together”. Bridges is our before-school tutoring session, so it was my hope that she would come in and get the extra help that she needed. Because this student tends to get frustrated and give up easily, I made sure to write lots of encouraging remarks on her paper. On page 4 I wrote “close!” and “yes!” and on page 5 I wrote “great!”. I wanted to encourage this student and highlight the concepts that she did know so she would have some motivation to keep trying to learn these concepts. This
student struggled the most when it came to writing mapping rules. I wanted her to still think about the concept of writing a mapping rule for herself, so I gave her clues such as “Write the coordinates for points \( P \) and \( P' \). Which ones stay the same? Which ones change? How do you show this in your rule?”.

Furthermore, as I pass back these assessments I will try to give the students some positive encouragement because the scores were not great. I will say things such as “excellent job!”, “I like how hard you tried!”, “I appreciate that you gave it your best!” and “thanks for your hard work!”.

c. Describe how you will support each focus student to understand and use this feedback to further their learning related to learning objectives, either within the learning segment or at a later time.

To support not only each focus student, but the whole class, to understand and use my feedback, I will always set aside a time in class to pass back the assessments and to go over them with the students. I will talk to the class about how they did as a whole and go over problems that a majority of the class missed. This alleviates the need for me to explain the same thing 22 separate times. I will then pass back the assessments and give students time to read through my feedback on their own. If there are any questions I will be right there to answer them or clarify my feedback.

Some points that I will highlight for the whole class include reading the directions carefully and making sure that you have answered each part. Many students missed a lot of points because they did not read the directions, or they just forgot to answer the second part. On page 3 of the assessment, many students did not show their work when they were performing the transformations. This immediately lowered their score by 4 points. Also, many students identified the transformations on page 4 and 5, but they did not write the mapping rule. Again, this immediately lowered their score by 4 points.

More specifically, for Student A, I will use this feedback to encourage the student to keep reaching for the stars and striving to do their best. There is no doubt in my mind that this student should have received a 108%. I know from the learning segment that this student knows how to write the correct mapping rules, but we all make mistakes. I will provide further feedback to this student to encourage her to keep working hard in school and being a good role model for her peers. The rest of the class tends to give up easily, so I want her to keep working hard even though the environment can be negative. As for the missed mapping rules, I will make sure to tell this student to read the directions and clarify anything that she is unsure of on tests.

For Student E, I will use this feedback to remind him to read the directions very carefully, especially on tests, I will use it as a reminder to slow down and take your time on tests. This student made many simple errors that I believe could be corrected if he slows down and takes time to think about his answers. Furthermore, this student has had a rough year in his personal life. He has been struggling with some personal family issues however he has not let that slow him down. I will use this feedback to encourage him to keep being positive and working hard. He does not like math, but he still works hard and earned a grade higher than the majority of the class. Above all, I will use this feedback to show the student how proud I am of him for persevering and as a reminder of the good that he is doing.
For Student T, my feedback will hopefully be a positive encouragement for her to continue working hard. This student struggles a lot, and she realizes that, but she will always start class ready to keep trying. I hope that my positive comments will give her some motivation to keep trying. Additionally, I will use the feedback to help her better understand how to write mapping rules. This is the area that this student most struggled in, so I hope that my comments will get her to start thinking about the idea on her own.

3. Evidence of Language Understanding and Use

When responding to the prompt below, use concrete examples from the clip(s) and/or student work samples as evidence. Evidence from the clip(s) may focus on one or more students.

You may provide evidence of students’ language use from ONE, TWO, OR ALL THREE of the following sources:

1. Use the video clip(s) from Instruction Task 2 and provide time-stamp references for evidence of language use.

2. Submit an additional video file named “Language Use” of no more than 5 minutes in length and cite language use (this can be footage of one or more students’ language use). Submit the clip in Assessment Task 3, Part B.

3. Use the student work samples analyzed in Assessment Task 3 and cite language use.

a. Explain and provide concrete examples for the extent to which your students were able to use or struggled to use the

   - selected language function,
   - vocabulary and/or symbols, AND
   - mathematical precision, discourse, or syntax
to develop content understandings.

[In the Lesson 1 video clip from Instruction Task 2, my students were introduced to the vocabulary for the learning segment and they used the vocabulary throughout the entire clip. At the beginning of the clip, students have been introduced to center of rotation. At (01:38) the student explains to me what the center of rotation is. My language function involves being able to explain the concepts and properties associated with performing a rotation., which includes center of rotation. This student fails to meet the language function because he cannot explain what it is, he can only recite what the paper says. Additionally, the student at (06:40) fails to meet the language function because she cannot explain what the center of rotation is either. I give her lots of prompting including, “if you could stick your pencil anywhere on the computer screen, where would you stick it so the shape is rotating around it?”. Even after this, the student is unable to explain the center of rotation.]
My students were very capable of using the vocabulary from this segment. This can be seen from the scores on their assessment under Level 2 Section 1. The average score on this section was 4.7 points out of 6. This shows that my students were capable of recognizing the vocabulary and defining it. However, they failed at using the symbols. In addition, students can be heard using vocabulary in the video clip at (00:57) and (04:52) “counterclockwise”, (02:28) (07:59) “origin” and more.

Finally, my students fail at mathematical precision when it comes to naming or plotting points on a coordinate grid. For example, Student E incorrectly names the point \( L' \) and the point \( K' \) on page 3 of the assessment. Additionally, Student T incorrectly names point \( K' \) on their assessment on page 3. This same problem was seen across the board of all the assessments. Moreover, students struggled using the correct syntax when writing the mapping rules. Student A did not write the mapping rules, Student E did not write the mapping rules on page 5, and Student T incorrectly wrote 3 out of 4 mapping rules. Most students throughout the class also did not even try to write the mapping rules, or they used the wrong ones.

4. Using Assessment to Inform Instruction

   a. Based on your analysis of student learning presented in prompts 1b–c, describe next steps for instruction to impact student learning:

   - For the whole class
   - For the 3 focus students and other individuals/groups with specific needs

   Consider the variety of learners in your class who may require different strategies/support (e.g., students with IEPs or 504 plans, English language learners, struggling readers, underperforming students or those with gaps in academic knowledge, and/or gifted students needing greater support or challenge).

[ For the whole class, I will respond by reviewing the procedure for completing a rotation. From my analysis of student learning and the lack of work shown, I have no choice but to assume that students did not show their work because they do not understand how to. A majority of the assessments were missing their work and it appeared that students were just guessing where the image would end up. From the learning segment, students realized that the numbers in the coordinates will usually stay the same, but one may be negative, both may be negative, the x-coordinate might become the y-coordinate and so on. This made it easy for students to be able to guess which one it would be. I will have a day to review this skill with students and then I will give them an exit pass to assess whether they know it or not. This review will include performing rotation on a computer. Students have not had the chance to visualize rotations on a computer since the very first day. On that day the focus was not on completing rotations, so I believe it would be helpful to bring the segment full circle. Furthermore, I will review how to write the mapping rules for a transformation. For a rotation there are only three and students are only required to know two of the three. Along with the exit pass mentioned above, I will have students write the mapping rule for each rotation they complete on the exit pass.

As for Student A, I need to continue to challenge her and give her enrichment material. She already has all the skills down, so when we have a remediation day I will provide her
with some more challenging material. At the 8th-grade level, students are only required to state which multiple transformations are happening to a shape. I could provide the student with a task such as writing the mapping rule for multiple transformations.

For Student E, I will have him practice labeling vertices from a coordinate grid. This student could correctly perform a rotation, but his error was in naming points. Based on his answers throughout the rest of the assessment, I can tell that he understands an ordered pair. My review with this student could be as simple as a small conversation about ordered pairs. I could give him a couple examples of ordered pairs and ask him to write the coordinates. Also, I could give him coordinates and ask him to draw the ordered pair.

Student T will need a lot more remediation than what I can give her during class. For this student I can do two things. First, I will ask her to come into Bridges (our tutoring session) so I can give her some extra one-on-one attention. With this option there is no guarantee that she would come. The second option is to give her Skill Builders teacher a review, so she can get some extra help in her other class. Hopefully this student will take to one of these options and we can get her to being proficient. For her review I would give her problems involving performing transformations, applying transformations to a point and writing the mapping rule.

b. Explain how these next steps follow from your analysis of student learning.

Support your explanation with principles from research and/or theory.

[ These next steps follow from my analysis of student learning because through my analysis, I realized multiple things. First, my students struggled performing a rotation and other transformations on a coordinate grid. Secondly, the majority of students appeared to be lost when it came to writing mapping rules. I want my students to be able to perform a rotation on the computer because it puts the focus solely on the rotation. Students will not be forced to think about the axes, counting units and other factors of graphing. When these rotations are done on the computer, these factors will be calculated by the computer and students can focus on visualizing how the rotation changes the shape. According to Hollebrands (2003), computer software is the best way to help students gain a better conceptual understanding. To apply a rotation in “Geometer’s Sketchpad (a computer software), students must mark the center of rotation, specify a number of degrees, a direction and select the pre-image. Students are then able to measure the distance from the center point to a pre-images point and the distance from the center point to its corresponding image point. They can then see that the measures are equal no matter how the pre-image point is changed. Students are also able to change the degree and direction of rotation to see how this affects the image. I believe that this will help students better visualize rotations when they are performing them on a page and it will help them write mapping rules because the coordinates will be given to them. The more practice that they get writing mapping rules correctly with the help of computer software, the more likely they are to do it correctly on their own.]
Transformations

Assessment 1

Level 2-Match the following vocabulary. Write each vocabulary word after the correct definition.

<table>
<thead>
<tr>
<th>Angle of rotation</th>
<th>Center of dilation</th>
<th>Center of rotation</th>
<th>Congruent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dilation</td>
<td>Image</td>
<td>Line of reflection</td>
<td>Preimage</td>
</tr>
<tr>
<td>Reflection</td>
<td>Rotation</td>
<td>Rotational symmetry</td>
<td>Transformation</td>
</tr>
<tr>
<td>Translation</td>
<td>((x, y) \rightarrow (x + a, y + b))</td>
<td>((x, y) \rightarrow (-x, y))</td>
<td>((x, y) \rightarrow (x, -y))</td>
</tr>
</tbody>
</table>

Two images having the same size and shape____Congruent______________________________

A transformation that enlarges or reduces a figure by a scale factor____Dilation________

A line over which a figure is reflected____Line of Reflection____________________________

The figure after a transformation takes place___Image____________________________________

A transformation that slides a figure from one point to another without turning

______Translation or \((x, y) \rightarrow (x + a, y + b)\)________________________________________

The original figure before a transformation takes place__Preimage________________________________

The measure of the angle that a figure is rotated by____Angle of Rotation____________________

A transformation where a figure is flipped over a line __Reflection or \((x, y) \rightarrow (-x, y)\) or

\((x, y) \rightarrow (x, -y)\)

A fixed point around which a shape rotates ___Center of Rotation____________________________

The center point from which dilations are performed____Center of Dilation_____________________

A transformation in which a figure is turned about a fixed point ____Rotation__________________

Using a rotation, reflection, translation or dilation to map a preimage to an image

____Transformation______________________________________________________________
Level 2 State which transformation (reflection, rotation, translation, dilation) takes place in the following graphs.

- Rotation
- Reflection
- Dilation
- Translation
Level 3 - Perform the following transformations and state the appropriate ordered pair. Show your work.

If the figure is translated 3 units left and 4 units down, what are the coordinates of K’?

\[ (0, -4) \]

If the figure is dilated using a scale factor of \( \frac{1}{2} \), what are the coordinates of M’?

\[ \left( \frac{1}{2}, 1 \right) \]

If the figure is rotated 90° clockwise about the origin, what are the coordinates of L’?

\[ (2, -4) \]

If the figure is reflected over the x-axis, what are the coordinates of K’?

\[ (3, 0) \]
Level 3 - Apply the following transformations to determine the new ordered pair.

Find \( A' \) after \( A(2, 5) \) is rotated 180° clockwise about the origin? \((-2, -5)\)

The ordered pair \( D(0, -5) \) is translated 2 units left and 6 units up. Find \( D' \). \((-2, 1)\)

Find \( B' \) after the figure \( ABC \) is dilated by a scale factor of 3. \( A(1, 3), B(6, 3), C(6, 0) \) \((18, 9)\)

The ordered pair \( K(3, -1) \) is reflected over the y-axis. Find \( K' \). \((-3, -1)\)

Level 3 - State the transformation and write the rule.

Translation: \((x, y) \rightarrow (x + 1, y - 3)\)

Rotation: \(180° (x, y) \rightarrow (-x, -y)\)
Level 3 - State the transformation and write the rule.

- Reflection over y-axis \((x, y) \rightarrow (-x, y)\)

- Dilation with a scale factor of 1.5 \((x, y) \rightarrow (1.5x, 1.5y)\)

Level 3 - Name the sequence of transformations completed.

Reflect & dilate (in any order)
If students also add the word translate it is acceptable

Reflect, reflect, translate (in any order)
Or students may say Rotate
Level 4: Create and label a preimage with three or more vertices. Next, create a sequence of at least two transformations and label the image. Finally, graph and describe your sequence.
# Lesson Plan

**Topic:** Rotations  
**Lesson:** #1  
**Time:** 50 minutes

## Part One: Goals and Objectives

### Mathematical Goals

Students will understand that...
- Translations can be applied to shapes to change their position and size.
- There are four forms of transformations; translations, reflections, rotations, and dilations.

Students will be able to...
- Students will be able to identify and describe rotational symmetry, angle of rotation and center of rotation.

## Materials

- GeoGebra
- SMARTboard
- Chromebooks (one for each student)
- Transformations packet (one for each student)

## Concepts

- **Angle of Rotation** – The degree measure of the angle through which a figure is rotated.
- **Center of Rotation** – A fixed point around which shapes move in a circular motion to a new position.
- **Congruent** – Having the same measure; if one image can be obtained by another by a sequence of rotations, reflections, or translations.
- **Image** – The resulting figure after a transformation.
- **Preimage** – The original figure before a transformation.
- **Rotation** – A transformation in which a figure is turned about a fixed point.
- **Rotational Symmetry** – A type of symmetry a figure has if it can be rotated less than 360° about its center and still look like the original.
- **Transformation** – An operation that maps a geometric figure, preimage, onto a new figure, image.
- \((x, y) \rightarrow (y, -x)\)
- \((x, y) \rightarrow (-x, -y)\)
- \((x, y) \rightarrow (-y, x)\)
**Modifications:**
Student with specific learning disability:
• A paraprofessional is present in the classroom for the student when he needs help staying on track.
• Has been given permission to use headphones to listen to music during no instructional time. This helps him focus on the task at hand.
• The lesson uses technology, which helps him stay focused and interested in the lesson.

**Formative Assessment**
The following three-point rubric will evaluate students’ work during this lesson:

- **Three points:** demonstrates a strong understanding of transformations based on their participation in class and their ability to complete the Classroom Activity Sheet.
- **Two points:** demonstrates a moderate understanding of transformations based on their participation in class and their ability to complete the Classroom Activity Sheet.
- **One point:** demonstrates a weak understanding of transformations based on their participation in class and their ability to complete the Classroom Activity Sheet.

**Common Core Content Standards**
- **CCSS.MATH.CONTENT.8.G.A.1**
  Verify experimentally the properties of rotations, reflections, and translations:
  - **CCSS.MATH.CONTENT.8.G.A.1.A**
    Lines are taken to lines, and line segments to line segments of the same length.
  - **CCSS.MATH.CONTENT.8.G.A.1.B**
    Angles are taken to angles of the same measure.
  - **CCSS.MATH.CONTENT.8.G.A.1.C**
    Parallel lines are taken to parallel lines.
- **CCSS.MATH.CONTENT.8.G.A.3**
  Describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates.

**Part Two: Teaching Model**

**Launch (5–10 minutes)**
Learning GeoGebra Intro
1. Have all the students get a Chromebook, an answer sheet and a pencil.
2. Show the students how to get to the GeoGebra lab for the day. This is already installed on the home screen of their Chromebook as an app. They just need to choose the one that says rotations.
3. Show the students how to use the GeoGebra tools in the lab.
4. Show the students that they may check their answers to the multiple-choice questions on GeoGebra, but the still need to write down all their answers on the answer sheet. Let them know that this is their exit ticket for the day.

5. Ask the students if there are any questions before they begin.

**Explore (25–35 minutes)**

1. Let the students know that they will be working on the lab and write down the answers to the questions. When everyone has finished we will be going over the questions together to develop a few more ideas.

2. Have the students begin the lab.

3. While the students are working on the lab, walk around and make sure that they can do the lab as well as stay on task. Also ask the students questions that could initiate more critical thinking.

   **Is there symmetry in rotations?**

   Do you think your answer to this question makes sense? (For students that have an incorrect answer to get them back on track)

4. When all the students have finished, go through the solutions together. Make sure to introduce the term center of rotation. Use a pinwheel to discuss center of rotation and rotational symmetry.

Questions to ask while monitoring groups:

- What does the word rotation mean to you?
- How will the coordinates in the preimage differ after a rotation of 90 degrees counterclockwise?
- How will the coordinates in the preimage differ after a rotation of 180 degrees?
- How might you represent this rotation using mathematical notation?
- How does a rotation relate to the preimage?
- How will the size/shape/orientation of the preimage change after a rotation?
- What are some things in the real world that have rotational symmetry?

**Summarize (5–10 minutes)**

1. Have students do the rotations reflection in the back of their transformations packet (8 min).

2. Have the students turn to their partner and share one of the things that they wrote about (1 min).

**Homework**

Complete pages 479-480
# LESSON PLAN

**Topic:** Rotations  
**Lesson:** #2  
**Time:** 50 minutes

## Part One: Goals and Objectives

### Mathematical Goals

Students will understand that...

- Transformations can be applied to shapes to change their position and size.
- There are four forms of transformations; translations, reflections, rotations, and dilations.

Students will be able to...

- Identify rotations
- Graph rotations on the coordinate plane

## Materials

- Warm-up (Graphic Organizer “Transformation Packet”)
- Rotation Station Activity Sheet
- Station Materials: Dice, shape blocks, number and letter cutouts, Kuta Worksheet
- Homework (Kuta Rotations Worksheet)

## Concepts

- Congruent – Having the same measure; if one image can be obtained by another by a sequence of rotations, reflections, or translations.
- Image – The resulting figure after a transformation.
- Preimage – The original figure before a transformation.
- Transformation – An operation that maps a geometric figure, preimage, onto a new figure, image.
- Angle of Rotation – The degree measure of the angle through which a figure is rotated.
- Center of Rotation – A fixed point around which shapes move in a circular motion to a new position.
- Rotation – A transformation in which a figure is turned about a fixed point.
- Rotational Symmetry – A type of symmetry a figure has if it can be rotated less than 360° about its center and still look like the original.

- \((x, y) \rightarrow (y, -x)\)
- \((x, y) \rightarrow (-x, -y)\)
- \((x, y) \rightarrow (-y, x)\)
Modifications:
Student with specific learning disability:

- A paraprofessional is present in the classroom for the student when he needs help staying on track.
- Has been given permission to use headphones to listen to music during no instructional time. This helps him focus on the task at hand.
- The lesson uses manipulatives which helps him stay focused and interested in the lesson.

Formative Assessment
The following three-point rubric will evaluate students' work during this lesson:

- **Three points:** demonstrates a strong understanding of translations based on their participation in class and their ability to complete the Classroom Activity Sheet.
- **Two points:** demonstrates a moderate understanding of translations based on their participation in class and their ability to complete the Classroom Activity Sheet.
- **One point:** demonstrates a weak understanding of translations based on their participation in class and their ability to complete the Classroom Activity Sheet.

Common Core Content Standards
Understand congruence and similarity using physical models, transparencies, or geometry software.

- [CCSS.Math.Content.8.G.A.1](#) Verify experimentally the properties of rotations, reflections, and translations

Part Two: Teaching Model

**Launch (5–10 minutes)**

Graphic Organizer (“Transformation Packet”)

1. As students enter the room, they will each pick up their graphic organizers for the unit.
2. They will begin filling out the section on rotations. They will fill these out using their GeoGebra worksheet from the previous lesson.
Explore (25–35 minutes)

1. After students have filled out their graphic organizer, distribute the Classroom Station Activity Sheet and tell students that they are going to work in small groups at stations.

2. Students will have 6 minutes at each station to complete each task.

3. Walk around the classroom and answer any questions that students may have. One teacher will be stationed at the Kuta worksheet station to help students with rotations.

Questions to ask while monitoring groups:

• How can you identify rotational symmetry?
• What has rotational symmetry in the real-world?
• How else can you think of a rotation?
• How can you describe rotations?
• How will the size/shape/orientation of the preimage change after a rotation?
• How can you write this rotation using mathematical notation?
• How do the x and y coordinates change in a rotation?
• Is there symmetry in rotations?
• What shape do rotations remind you of? Why?

Summarize (5–10 minutes)

1. Display the reflection question on the board. Reflection Question:
   • What is the difference between rotating a figure about a given point that is a vertex and rotating the same figure about the origin if the rotations is less than 360 degrees?

2. Tell each student to write a quick response to answer this question. This will be their exit ticket.

Homework:

Complete Kuta Rotations Worksheet from station 5
# LESSON PLAN

**Topic:** Rotations  
**Lesson:** #3  
**Time:** 50 minutes

## Part One: Goals and Objectives

### Mathematical Goals

Students will understand that...

- Transformations can be applied to shapes to change their position and size.
- There are four forms of transformations; translations, reflections, rotations, and dilations.

Students will be able to...

- Graph rotations on the coordinate plane
- Generate the rule for rotations

## Materials

- Warm-up (Graphic Organizer “Transformation Packet”)
- ABC Graphic Organizer
- Rotation Kuta Activity Sheets

## Concepts

- Congruent – Having the same measure; if one image can be obtained by another by a sequence of rotations, reflections, or translations.
- Image – The resulting figure after a transformation.
- Preimage – The original figure before a transformation.
- Transformation – An operation that maps a geometric figure, preimage, onto a new figure, image.
- Angle of Rotation – The degree measure of the angle through which a figure is rotated.
- Center of Rotation – A fixed point around which shapes move in a circular motion to a new position.
- Rotation – A transformation in which a figure is turned about a fixed point.
- Rotational Symmetry – A type of symmetry a figure has if it can be rotated less than 360° about its center and still look like the original.

- \((x, y) \rightarrow (y, -x)\)
- \((x, y) \rightarrow (-x, -y)\)
- \((x, y) \rightarrow (-y, x)\)
Modifications:
Student with specific learning disability:

- A paraprofessional is present in the classroom for the student when he needs help staying on track.
- Has been given permission to use headphones to listen to music during no instructional time. This helps him focus on the task at hand.
- The student is allowed extra time to complete this assignment

Formative Assessment
The following three-point rubric will evaluate students' work during this lesson:

- **Three points**: demonstrates a strong understanding of translations based on their participation in class and their ability to complete the Classroom Activity Sheet.
- **Two points**: demonstrates a moderate understanding of translations based on their participation in class and their ability to complete the Classroom Activity Sheet.
- **One point**: demonstrates a weak understanding of translations based on their participation in class and their ability to complete the Classroom Activity Sheet.

Common Core Content Standards
Understand congruence and similarity using physical models, transparencies, or geometry software.

- [CCSS.Math.Content.8.G.A.1](https://www.corestandards.org/Math/Content/8/G/A.1) Verify experimentally the properties of rotations, reflections, and translations

Part Two: Teaching Model

*Launch (5–10 minutes)*

Graphic Organizer (“Transformation Packet” and ABC Sheet)

1. As students enter the room, they will take out their graphic organizers for the unit.
2. Students will have a couple minutes to review what they have written over the last two days.
3. Students will then fill out the ABC graphic organizer using vocabulary that they have learned over the Transformations unit. They will have four minutes to do so.
4. Students will then talk to at least three other classmates about what they wrote in each box. If one student did not have a word that their partner did, they are to add that word to their worksheet.
5. After students share, we will come back together as discuss the vocabulary as a whole class.
**Explore (25–35 minutes)**

1. After the class discussion, students will be given the worksheet for the day. It is a worksheet focused on performing rotations. I will organize the students into green, yellow and red groups depending on the results of the Quizizz homework and my informal assessments throughout the learning segment.

2. Students will be divided by group color and assigned an adult to work together in groups.

3. I will get the green group started and then walk around the classroom and answer any questions that students may have.

Questions to ask while monitoring groups:

- How can you identify rotational symmetry?
- What has rotational symmetry in the real-world?
- How else can you think of a rotation?
- How can you describe rotations?
- How will the size/ shape/ orientation of the preimage change after a rotation?
- How can you write this rotation using mathematical notation?
- How do the x and y coordinates change in a rotation?
- Is there symmetry in rotations?
- What shape do rotations remind you of? Why?

**Summarize (5–10 minutes)**

1. Display the reflection question on the board.
   
   Reflection Question:
   - What is the difference between rotating a figure about a given point that is a vertex and rotating the same figure about the origin if the rotations is less than 360 degrees?

2. Tell each student to write a quick response to answer this question. This will be there exit ticket.

**Homework:**

Finish the worksheet if not finished. Everybody completes "Quizizz" homework on Rotations.
Inquiry Lab - Rotations

A figure has rotational symmetry if it can be rotated or turned less than $360^\circ$ about its center so that the figure looks exactly as it does in its original position.

Investigation 1

1. Play with the slider. At what degree measures does the figure have rotational symmetry?

The degree of an angle through which the figure is rotated is called the angle of rotation.

2. How many angles of rotation did you find in investigation 1? Take $360^\circ$ and divide it by the number of rotations. This will give you the first angle of rotation. Show your work and check your answer using the slider and the figure.

3. To find the other angles of rotation, add the measure of the first angle of rotation to the previous angle measure. Stop when you reach $360^\circ$. Please show all of your work and check your answers with the slider and the figure.
4. Use the slider to determine if this figure has rotational symmetry. Please explain your answer.
The **center of rotation** is a fixed point around which shapes move in a circular motion to a new position.
5. What is the center of rotation in investigation 3?

6. In the input box, input -35. What is the red angle that is shown on the shape (this is a positive angle)?

7. Do this with other negative angle measures. Why is the angle shown always positive when you input a negative number?
Rotate a Figure About a Point

A **rotation** is a transformation in which a figure is rotated, or turned, about a fixed point. The **center of rotation** is the fixed point. A rotation does not change the size or shape of the figure. So, the preimage and the image are congruent.

**Example**

1. Triangle $LMN$ with vertices $L(5,4)$, $M(5,7)$, and $N(8,7)$ represents a desk in Jackson’s bedroom. He wants to rotate the desk counterclockwise $180^\circ$ about vertex $L$. Graph the figure and its image. Then give the coordinates of the vertices for $\triangle L'M'N'$.

**Step 1** Graph the original triangle.

**Step 2** Graph the rotated image. Use a protractor to measure an angle of $180^\circ$ with $M$ as one point on the ray and $L$ as the vertex. Mark off a point the same length as $ML$. Label this point $M'$ as shown.

**Step 3** Repeat Step 2 for point $N$. Since $L$ is the point at which $\triangle LMN$ is rotated, $L'$ will be in the same position as $L$.

So, the coordinates of the vertices of $\triangle L'M'N'$ are $L'(5,4)$, $M'(5,1)$, and $N'(2,1)$.

**Got It?** Do this problem to find out.

a. Rectangle $ABCD$ with vertices $A(-7,4)$, $B(-7,1)$, $C(-2,1)$, and $D(-2,4)$ represents the bed in Jackson’s room. Graph the figure and its image after a clockwise rotation of $90^\circ$ about vertex $C$. Then give the coordinates of the vertices for rectangle $A'B'C'D'$. 
Transformation Stations

Station 1 - Dice

1. Look at the side of the dice that has 4 dots.
   a. Does this side of the dice have any rotational symmetry? If so, at what degree measures does rotational symmetry occur?

   b. Does this side of the dice have any lines of reflection? Draw them.

   c. Repeat a and b with the side of the dice that has 6 dots.

2. What if you put two identical dice together, like a domino, which combinations have two lines of symmetry. Draw them and their lines of symmetries.

3. If you take four ‘threes’, could you arrange them to get one, two, three…..eight lines of symmetry?
   Here are a few to start you off, which are they?

   ![Images of dice combinations]
Station 2 - Triangle, trapezoid, rhombus, hexagon.

1. Look at the 4 shapes. Find one shape that has rotational symmetry. Draw it.

2. Now, find one shape that does not have rotational symmetry. Draw the shape that does not have rotational symmetry in quadrant III. Make sure to name the vertices (A, B, C, ...) and make sure to name their location (the x coordinate and the y coordinate).

3. Rotate the image 180° about the origin. Make sure to label your new vertices with the prime notation (A', B', C', ...) and their location (the x coordinate and the y coordinate).

Station 3 - Numbers and Letters

1. Look at the numbers and letters. Find 2 letters or numbers that have two lines of reflection. Draw the letter/number below and draw the lines of reflection.
2. Find one letter/number that has no rotational symmetry. Draw the letter/number below. Explain how you know that this letter/number has no rotational symmetry.

3. Choose one letter that has no curved lines. Draw it in quadrant I. Make sure to name the vertices (A, B, C, …) and make sure to name their location (the x coordinate and the y coordinate).

4. Use that graph and your letter from problem 3. Rotate the letter 90° counterclockwise about the origin. Make sure to label your new vertices with the prime notation (A’, B’, C’, …) and their location (the x coordinate and the y coordinate).

**Station 4 - Stars (Rotations)**

1. Choose a quadrant and trace a star on the graph paper

2. Label the vertices

3. Using the center of the star as the center of rotation, rotate the star 90° clockwise on top of the drawn preimage.
4. Now label your vertices using prime notation. (A', B', etc.)

5. Now, with the same preimage, rotate the star $180^\circ$ about the origin. (Attach the string to a vertex and the origin. Keep the string at the origin using your pencil.)

6. Next, trace the image and label the vertices using prime notation.

**Station 5 - Rotation Worksheet**
The worksheet is at the station. Please take it with you and turn it in with your name on it when you leave the station.
1. A turn is also called a ___________.
   - a) Translation
   - c) Rotation
   - b) Reflection
   - d) Transformation

2. What is the definition of rotation?
   - a) To move up, down, left, or right.
   - c) To make a circular movement around a point.
   - b) To flip.
   - d) To mirror.

3. How many degrees was the figure rotated?
   - a) 90 degrees counterclockwise
   - c) 90 degrees clockwise
   - b) 180 degrees

4. Describe the transformation shown in the graph.
   - a) Reflect over x-axis
   - c) Rotate 180 degrees
   - b) Reflect over y-axis
   - d) Rotate 270 degrees CCW

5. What is the angle of rotation for this counterclockwise rotation about the origin?
   - a) 90°
   - c) 270°
   - b) 180°
   - d) 360°
### Lesson Plan 3 Instructional Materials

<table>
<thead>
<tr>
<th>Name:</th>
<th>Class:</th>
<th>Date:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
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</thead>
<tbody>
<tr>
<td>F</td>
<td>G</td>
<td>H</td>
<td>I</td>
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<tr>
<td>U</td>
<td>V</td>
<td>W</td>
<td>X</td>
<td>Y/Z</td>
</tr>
</tbody>
</table>
Rotations of Shapes

Graph the image of the figure using the transformation given.

1) rotation 180° about the origin

2) rotation 90° counterclockwise about the origin

3) rotation 90° clockwise about the origin

4) rotation 180° about the origin

5) rotation 90° clockwise about the origin
   \( U(1, -2), W(0, 2), K(3, 2), G(3, -3) \)

6) rotation 180° about the origin
   \( V(2, 0), S(1, 3), G(5, 0) \)
Find the coordinates of the vertices of each figure after the given transformation.

7) rotation 180° about the origin
   \( Z(-1, -5), K(-1, 0), C(1, 1), N(3, -2) \)

8) rotation 180° about the origin
   \( L(1, 3), Z(5, 5), F(4, 2) \)

9) rotation 90° clockwise about the origin
   \( S(1, -4), W(1, 0), J(3, -4) \)

10) rotation 180° about the origin
    \( V(-5, -3), A(-3, 1), G(0, -3) \)

Write a rule to describe each transformation.

11)

12)

13)

14)
**Level 2 - Match the following vocabulary. Write each vocabulary word after the correct definition.**

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angle of rotation</td>
<td></td>
</tr>
<tr>
<td>Center of dilation</td>
<td></td>
</tr>
<tr>
<td>Center of rotation</td>
<td></td>
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<tr>
<td>Congruent</td>
<td></td>
</tr>
<tr>
<td>Dilation</td>
<td></td>
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<tr>
<td>Image</td>
<td></td>
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<tr>
<td>Line of reflection</td>
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<td>Preimage</td>
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<tr>
<td>Reflection</td>
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<td>Rotation</td>
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<tr>
<td>Rotational symmetry</td>
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<tr>
<td>Transformation</td>
<td></td>
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<tr>
<td>Translation</td>
<td></td>
</tr>
<tr>
<td>Two images having the same size and shape</td>
<td><strong>Congruent</strong></td>
</tr>
<tr>
<td>A transformation that enlarges or reduces a figure by a scale factor</td>
<td><strong>Dilation</strong></td>
</tr>
<tr>
<td>A line over which a figure is reflected</td>
<td><strong>Line of reflection</strong></td>
</tr>
<tr>
<td>The figure after a transformation takes place</td>
<td><strong>Image</strong></td>
</tr>
<tr>
<td>A transformation that slides a figure from one point to another without turning</td>
<td><strong>Translation</strong></td>
</tr>
<tr>
<td>The original figure before a transformation takes place</td>
<td><strong>Preimage</strong></td>
</tr>
<tr>
<td>The measure of the angle that a figure is rotated by</td>
<td><strong>Angle of rotation</strong></td>
</tr>
<tr>
<td>A transformation where a figure is flipped over a line</td>
<td><strong>Reflection</strong></td>
</tr>
<tr>
<td>A fixed point around which a shape rotates</td>
<td><strong>Center of rotation</strong></td>
</tr>
<tr>
<td>The center point from which dilations are performed</td>
<td><strong>Center of dilation</strong></td>
</tr>
<tr>
<td>A transformation in which a figure is turned about a fixed point</td>
<td><strong>Rotation</strong></td>
</tr>
</tbody>
</table>

Using a rotation, reflection, translation or dilation to map a preimage to an image | **Transformation** |
Level 2: State which transformation (reflection, rotation, translation, dilation) takes place in the following graphs.

rotation

reflection

dilation

translation
Level 3 - Perform the following transformations and state the appropriate ordered pair. Show your work.

<table>
<thead>
<tr>
<th>Transformation</th>
<th>Ordered Pair</th>
</tr>
</thead>
<tbody>
<tr>
<td>If the figure is translated 3 units left and 4 units down, what are the coordinates of (K')?</td>
<td>(K(0, -4))</td>
</tr>
<tr>
<td>If the figure is dilated using a scale factor of (\frac{1}{2}), what are the coordinates of (M')?</td>
<td>(M'(1, y\frac{1}{2}))</td>
</tr>
<tr>
<td>If the figure is rotated 90° clockwise about the origin, what are the coordinates of (L')?</td>
<td>(L(-2, -4))</td>
</tr>
<tr>
<td>If the figure is reflected over the x-axis, what are the coordinates of (K')?</td>
<td>(K(3, 0))</td>
</tr>
</tbody>
</table>
Level 3 - Apply the following transformations to determine the new ordered pair.

Find $A'$ after $A(2, 5)$ is rotated $180^\circ$ clockwise about the origin? $A'(-2, -5)$

The ordered pair $D(0, -5)$ is translated 2 units left and 6 units up. Find $D'(-2, 1)$

Find $B'$ after the figure $ABC$ is dilated by a scale factor of 3. $A(1, 3), B(6, 3), C(6, 0)$ $B'(18, 9)$

The ordered pair $K(3, -1)$ is reflected over the y-axis. Find $K'(-3, -1)$

Level 3 - State the transformation and write the rule.

Translation 1 unit right and 3 units down

Rotation $180^\circ$ clockwise about the origin.
Level 3 - State the transformation and write the rule. $(x, y) \rightarrow (\text{?}, \text{?})$

Level 3 - Name the sequence of transformations completed.

- Reflection across $x = 3$
- Dilation by $1.5$
- Dilation
- Reflection
- Translation
- Rotation
Level 4: Create and label a preimage with three or more vertices. Next, create a sequence of at least two transformations and label the image. Finally, graph and describe your sequence.

A(8,10) B(11,7) C(-7,7) First reflect over x axis then translate 3 units up and 5 units left.

+3 Extra Credit

Excellent!
Level 2-Match the following vocabulary. Write each vocabulary word after the correct definition.

<table>
<thead>
<tr>
<th>Angle of rotation</th>
<th>Center of dilation</th>
<th>Center of rotation</th>
<th>Congruent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dilation</td>
<td>Image</td>
<td>Line of reflection</td>
<td>Preimage</td>
</tr>
<tr>
<td>Reflection</td>
<td>Rotation</td>
<td>Rotational symmetry</td>
<td>Transformation</td>
</tr>
<tr>
<td>Translation</td>
<td>(x, y) → (x + a, y + b)</td>
<td>(x, y) → (-x, y)</td>
<td>(x, y) → (x, -y)</td>
</tr>
</tbody>
</table>

Two images having the same size and shape **congruent**.

A transformation that enlarges or reduces a figure by a scale factor **dilation**.

A line over which a figure is reflected **line of reflection**.

The figure after a transformation takes place **image**.

A transformation that slides a figure from one point to another without turning **translation**.

The original figure before a transformation takes place **preimage**.

The measure of the angle that a figure is rotated by **angle of rotation**.

A transformation where a figure is flipped over a line **reflection**.

A fixed point around which a shape rotates **center of rotation**.

The center point from which dilations are performed **center of dilation**.

A transformation in which a figure is turned about a fixed point **rotation**.

Using a rotation, reflection, translation or dilation to map a preimage to an image **transformation**.
Level 2: State which transformation (reflection, rotation, translation, dilation) takes place in the following graphs.

<table>
<thead>
<tr>
<th>Rotation</th>
<th>Reflection</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Rotation Diagram" /></td>
<td><img src="image2.png" alt="Reflection Diagram" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dilation</th>
<th>Translation</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image3.png" alt="Dilation Diagram" /></td>
<td><img src="image4.png" alt="Translation Diagram" /></td>
</tr>
</tbody>
</table>
**Level 3 - Perform the following transformations and state the appropriate ordered pair. Show your work.**

<table>
<thead>
<tr>
<th>Transformation</th>
<th>Ordered Pair</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>If the figure is translated 3 units left and 4 units down, what are the coordinates of K'?</strong></td>
<td>H (0,0)</td>
</tr>
<tr>
<td><strong>If the figure is dilated using a scale factor of ( \frac{1}{2} ), what are the coordinates of M'?</strong></td>
<td>Draw the image (5,1)</td>
</tr>
<tr>
<td><strong>If the figure is rotated 90° clockwise about the origin, what are the coordinates of L'?</strong></td>
<td></td>
</tr>
<tr>
<td><strong>If the figure is reflected over the x-axis, what are the coordinates of K'?</strong></td>
<td></td>
</tr>
</tbody>
</table>
Level 3 - Apply the following transformations to determine the new ordered pair.

Find $A'$ after $A(2,5)$ is rotated $180^\circ$ clockwise about the origin? $(-2, -5)$

The ordered pair $D(0, -5)$ is translated 2 units left and 6 units up. Find $D'$. $(-2, 1)$

Find $B'$ after the figure $ABC$ is dilated by a scale factor of 3. $A(1, 3), B(6, 3), C(6, 0)$, $A(33), B(18, 9), C(18, 0)$

The ordered pair $K(3, -1)$ is reflected over the $y$-axis. Find $K(-3, 1)$

Level 3 - State the transformation and write the rule.

**Dilation:**

$(x, y), (x\cdot 1, (y - 3) + 1)$

**Reflection over the $y$-axis:**

$(x, y), (-x, y)$
Level 3 - State the transformation and write the rule.

Reflection: 
\((x, y) \rightarrow (\_ , \_ )\)

Dilation: 
\(c_0 = \left( x, y \right) \rightarrow (\_ , \_ )\)

Level 3 - Name the sequence of transformations completed.

Dilation + 1
Rotation + 2

Notes:
The vertices would not match up after a rotation. How else might the image "flip" over the y-axis?
Level 4: Create and label a preimage with three or more vertices. Next, create a sequence of at least two transformations and label the image. Finally, graph and describe your sequence.

- Rotate 90° about the origin. Then Dilate by a scale factor of 2.

Check your graphing:
- 5, -2: You are close on your scale factor.
- 6, -4
Level 2: Match the following vocabulary. Write each vocabulary word after the correct definition.

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Two images having the same size and shape ___________________________  **congruent**

A transformation that enlarges or reduces a figure by a scale factor ___________________________  **Dilation**

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The figure after a transformation takes place ___________________________  **Image**

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The center point from which dilations are performed ___________________________  **Center of Dilation**

A transformation in which a figure is turned about a fixed point ___________________________  **Rotation**

Using a rotation, reflection, translation or dilation to map a preimage to an image ___________________________
Level 2: State which transformation (reflection, rotation, translation, dilation) takes place in the following graphs.

- Rotation
- Reflection
- Dilation
- Translation
Level 3 - Perform the following transformations and state the appropriate ordered pair. Show your work.

If the figure is translated 3 units left and 4 units down, what are the coordinates of K''?

If the figure is dilated using a scale factor of \( \frac{1}{2} \), what are the coordinates of M'?

If the figure is rotated 90° clockwise about the origin, what are the coordinates of L''?

If the figure is reflected over the x-axis, what are the coordinates of K'?
Level 3 - Apply the following transformations to determine the new ordered pair.

Find $A'$ after $A(2, 5)$ is rotated $180^\circ$ clockwise about the origin? $(-4, 5)$

The ordered pair $D(0, -5)$ is translated 2 units left and 6 units up. Find $D'$. $(-2, 1)$

Find $B'$ after the figure $ABC$ is dilated by a scale factor of 3. $A(1, 3), B(6, 3), C(6, 0)$ $3, 9$

The ordered pair $K(3, -1)$ is reflected over the y-axis. Find $K'$. $(-3, 1)$

Level 3 - State the transformation and write the rule.

Translation: $y = x + 3$

Reflection: $x = -x$
Level 3 - State the transformation and write the rule.

Write the coordinates for points P and P'.
Which ones stay the same? Which ones change? How do you show this in your rule?

Level 3 - Name the sequence of transformations completed.

What would the triangle ABC look like after just one reflection?
Level 4: Create and label a preimage with three or more vertices. Next, create a sequence of at least two transformations and label the image. Finally, graph and describe your sequence.