1. Analyzing Student Learning
   
a. Identify the specific learning objectives measured by the assessment you chose for analysis.

Students should be able to… (Content Objectives)
   • Apply formulas for inscribed and central angle measures (as they relate to arc measurement) when given a picture representation.
   • Apply definitions of circle laws and relationships to calculate angle measures and lengths in and around circles.

Students should be able to… (Academic Language Objectives)
   • Students will be able to describe the arc/angle relationships in circles and articulate the reasoning and justification for their answers to challenge problems through explanation.
   • Draw conclusions based on data given in diagrams.
   • Displaying information based on mathematical representations.
   • Compare and apply definitions.
   • Record answers efficiently.

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.

Refer to Evaluation Criteria for specific criteria used to assess and summarize students learning for the whole class. The chart below depicts the results of one class period of students performing on both portions of the assessment criteria (solutions and explanations).

<table>
<thead>
<tr>
<th></th>
<th>Mastery</th>
<th>Proficiency</th>
<th>Emerging</th>
<th>Basic</th>
<th>Beginning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written Explanations</td>
<td>5 students</td>
<td>8 students</td>
<td>4 students</td>
<td>3 students</td>
<td>4 students</td>
</tr>
<tr>
<td>Solutions</td>
<td>7 students</td>
<td>6 students</td>
<td>5 students</td>
<td>4 students</td>
<td>2 students</td>
</tr>
</tbody>
</table>
Students were evaluated on two separate skills in this assessment. The first focused on content objectives, which highlighted the relationships between arcs and angles in the context of circles. This was assessed through students’ ability to recognize relationships in the diagram given, identify relationships, and accurately apply theorems and generalizations to find variables.

The second major area of assessment was the ability of students to explain their thinking, assessed through their explanations. Students were asked to write all solutions and explain what theorems/conjectures were used to solve for variables. Assessment looked primarily at students’ abilities to describe in their own words the relationships we have studied, integrate relevant unit vocabulary, justify solutions, draw conclusions based on information given, and record answers efficiently.

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
   i. conceptual understanding,

   Conceptual understanding was the primary focus of this assignment—how can I have students not only show their understanding of the mathematical procedure, but also have students reveal their thought processes and engage their conceptual understanding?

   The most apparent pattern in the data accrued from the whole class was the correlation between those students receiving a mastery on writing to those receiving the same score on their solutions. It was obvious that the students who performed well on explanations did just as well, if not better, on their solutions. Additionally, both students who received only “Beginning Understanding” on writing criteria also received that category for solutions. This revealed a pattern for success for those learners who were able to articulate their thinking and clearly and concisely argue their understanding.

   The “star problem,” which had a star inscribed in a circled, asked students to think about the sum of all of the interior angles of the star. This required no procedural knowledge—they were never taught about how to explore this problem. However, they could apply their conceptual understanding of the arcs’ relationships to the inscribed angles that intercept them to reason through the problem. The discussions that happened at this station were magical—students were really discussing and arguing their points and it was obvious at this station which students had an in-depth understanding of angle-arc relationships.

   ii. procedural fluency, AND

   In my assessment of student solutions, I was able to easily assess students’ understanding of information and ability to create a sound procedure for solving for variables. Simply, students who came into class with a rich procedural fluency were able to apply their knowledge of these circle relationships and quickly develop a procedure for solving these problems. In their explanations, it was obvious those students who were strong in procedural knowledge, as their thoughts were much more organized and easy to understand.

   For example, in focus student #1’s work, much of explanation is sporadic and rushed. This student, who has Autism and excels greatly in mathematics, often rushes through assignments, yet has a deep understanding of the material. This is evident throughout the assessment, yet most answers are incorrect. This is likely due to a procedural fluency issue—the student is able to recall big picture ideas and is able to quickly determine an answer to obvious questions. Yet, when more time is involved, the student often rushes and doesn’t apply his knowledge accurately.
On student #2’s problem #6, you will notice a great understanding and application of procedural fluency. The diagram immediately sparks a need for students to apply the concept of inscribed quadrilaterals having opposite angles supplementary. You’ll notice that this is the first step of student #2’s procedure. This student has developed an understanding of these types of figures that allows her to know immediately to look for opposite angles in a quadrilateral. She was able to see instantly the angle measures for two of the angles. Next, the student recognized that in order to solve for other variables, one must first apply the idea of inscribed angles intercepting arcs that are twice the measure. The student states, “Arc g is 100 degrees because [angle] D is 75 degrees it would be supplementary to [angle] R, which would be 105, thus adding 105 to itself (210), then subtract it by 110 to get 100 degrees for g.” This explanation reveals errors in vocabulary use, but it also reveals sound procedural fluency. The student was able to recognize the relationships between opposite angles in a quadrilateral, was able to connect these angles to their intercepted arcs, and use mathematical reasoning to determine the value of the variables.

Throughout the assessment, I observed conversations between students that dove deeply into mathematics. Students argued and discussed and challenged each others’ ideas in a positive manner. It connected, for me, procedural fluency and mathematical reasoning.

iii. mathematical reasoning and/or problem-solving skills.

The aim of this assessment was to develop content skills and conceptual understanding of this material. However, it was also designed so that students were given questions that were not easy to immediately answer. This group of honors students are highly skilled and often quickly breeze through example problems. By providing them with examples that required more than one step and more than one theorem, students were forced to use mathematical reasoning. The discussions I witnessed involved more problem solving than I have seen in most other assessments and assignments. Students were often frustrated—this frustration stemmed from having to really engage in mathematical reasoning. But the results were fantastic.

Focus student #3 showed this kind of thinking in her answer for problem 4. The problem asked students to recognize that the angle given was not inscribed, and therefore, the arc measure was not a one-step solution (students were tempted to simply multiply by 2). Student #3 noticed that a right triangle could be drawn from the radius meeting the tangent line. This stemmed from the student’s understanding of a tangent line having to meet the radius at a right angle at the point of tangency. Thus, a right triangle was created, now with two of three angles. The student then made the argument that the third angle could be determined by the definition of a triangle, and then finally related the measure of a central angle and its’ intercepted arc. This one example problem required a student to understand three concepts entirely—and then proceed to reason through them and arrive at an answer.

Problem-solving, at it’s core, it asking students to create solutions where the solution is not easily found or there is not a clear procedure to follow. In these examples (minus a few simpler problems), students were forced to combine their own thinking and the thinking of their classmates to create a mathematically sound solution.

Overall, students excelled at creating solutions and combining knowledge of several topics. Many times, there were flaws in their reasoning, but it was an encouragement to see students accessing prior knowledge and combining this with new knowledge about the relationships present in circles.

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.
No student faces are visible in the video. Students participating in discussion during clip are not focus students.

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. Choose one of the following:

Student feedback was written directly on work samples. This can be found in Part A of Task 3 as a part of the focus students’ assessments.

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

Focus student #1 is an extremely bright student on the Autism spectrum. The student is capable of understanding rich content and creatively responds to mathematics by creating practice problems and stories that accompany them. For this student, my feedback was most oral, as he does not respond well to criticism if it is not immediately clear what was wrong. This student is devoted to school and doing well, so I chose to deliver his assignment to him and speak personally with him about how he could improve.

I did want to comment on his work, though. First, I went through his solutions and found major themes of error. Generally, these errors occurred when the student thought an angle was inscribed when it wasn’t. This student was the first to complete the assignment and was the only one to attempt all problems. This led me to believe that the student had the capability of successfully completing all problems, but chose to be a bit hurried.

In terms of student #1’s abilities, I felt confident about his mathematical knowledge and grasp of content objectives. In general, he was able to take his understanding of formulas and theorems and apply that understanding to representations in the assessment. He did this extremely well when asked about the relationships between central angles, inscribed angles, and their intercepted arcs. Errors were made—this student has not mastered the content, but he was proficient and showed growth and understanding of new concepts. The academic language objectives were not met with such strength, as this student struggles to put down in words what he is thinking. However, I was thrilled with his ability to draw conclusions from diagrams and apply his content knowledge and attempt to describe his procedure.

This student’s strength is his ability to create thoughtful and imaginative stories that involve solving math problems. After he turned in this assignment and told me he was done, I asked this student to create problems for me. He later turned in a problem that asked the reader to solve for four variables and the problem included a story that went along with it! His strength as a creator showed me his understanding of the content objectives and his ability to grow in his academic language objectives.

If I had another class period for him to work on this assessment, I would have circled problems that I wanted this student peek at again. This strategy has been helpful in working with this student, as he is motivated by questions, rather than criticism.

Focus student #2 is an English Language Learner. In creating this assessment, I questioned whether or not this assignment could really assess her ability to meet the objectives. I was floored with her ability to explain her thinking. On problem 6, she eloquently described her process. Though there were some terminology errors, her procedure and explanation was clear, straightforward, and correct. Since this was a formative assessment, I chose to respond to her assessment with questions that would guide her thinking throughout the learning segment. For example, “What do you know about rectangles? Think about opposite sides and angles. How
can you connect this knowledge to new theorems we have discovered about circles and arc relationships?

I realized that this student has strength in explaining her process. On a previous test, this student did very poorly, but was never afforded the opportunity to explain her thinking. My feedback was aimed to keep her encouraged and thinking. In my final note to this student, I asked her to think back to question 14 and think even more critically about her response. This student worked entirely independently on this assessment, and her ability to reasoning through this problem surpassed many of her peers. She went beyond the problem and found the value of EACH angle if the angles were congruent. I really desired that she would think even more about this conceptual type of problem, so I probed that.

In terms of the objectives, this student really surprised me. She was able to articulate her thinking, draw conclusions from diagrams (some even deeper than what was being asked), and recognized patterns and relationships in the given problems. The assessment was vital for my understanding of her as a student and for me to see a new strength in her ability to process her mathematical thoughts.

Focus student #3 is an example of a pretty typical student in our class. This student is high-ability and has often had experiences with the math we present prior to coming to class. This assessment required little criticism, as the assessment reveals a rich understanding of the content objectives, as well a firm grasp on academic language objectives. The student was able to accurately solve for variables in almost every example given. The student recognized angle and arc relationships and applied correct procedure to solve the problems. She was able to draw conclusions about the mathematical representations and correctly displayed and recorded information on her assessment. My feedback to her was positive and asked her to look back at problems where she misunderstood the question. An example of an error in her assessment occurred because she determined an arc measure that was not asked her. I suggested that she look back at this question and make one more calculation to find the solution. In my feedback, I praised her ability to incorporate unit vocabulary into her explanations, something that was a struggle for many students. This student is quiet and generally lacks participation, so this assessment was eye-opening for me as the instructor and I hope for her as she gains confidence in her understanding.

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.

My feedback to student number one was pretty immediate. This student showed me his assessment several times throughout the task, where I was able to redirect his thinking and encourage him to think more critically. After this assessment, I was able to have a conversation with this student about his assessment. Most of all, I asked him to take his time answering questions and show him the questions that he answered completely and accurately. I asked this student to then create a few problems like these example problems for me to complete. He was also asked to create a solution key. As he was explaining the problem to me, I was able to see his thinking and watch him engage in higher-ordered thinking.

Later, I hope to incorporate this same type of written explanation into student work. For student #1, this may be a struggle as he was getting frustrated when he was asked to explain. However, I hope to allow this student to similarly explain his own created problems to check that academic language objectives are being met. When asked to explain aloud, this student is much more patient and thoughtful with his responses. I also hope to have more time to ask this student questions about his responses, something I lacked during this lesson.
For student #2, I simply hope to keep allowing this student to explain her process. As she has struggled recently on summative and formal assessments, I am hoping to give her chances to do just as she did on this assessment—display her thinking in a way other than traditional fill-in-the-blank assessments. I will give this student the option to explain her thinking on formal assessments, even if the question is asking for a simple response. I also would like to give this student the opportunity to write questions to me personally, without having to ask aloud in class. This student seems to lack confidence in her ability to ask questions and respond aloud in class, but as a result of this assessment, I believe that this student has strength in expressing herself in writing. I hope to support this as we go further and give this student the opportunity to express thinking in this way.

For student number 3, I am hoping to find a way to get this student to feel really challenged. This student had questions throughout the assessment and I believe she was stretched, but I would love to have this student solve more complex problems that require more mathematical reasoning. As we move forward, I am hoping to take the students who achieved mastery on this topic and have them investigate further into this topic, but at a much deeper, conceptual level.

3. Evidence of Language Understanding and Use
   a. Explain and provide concrete examples for the extent to which your students were able to use or struggled to use the
      i. selected language function

      The language function that was focused upon for this assessment was explaining and justifying. Students were directed to find solutions to variables and then justify their answer by explaining their process and the techniques/theorems that they used to get to those solutions.

      Students varied in their ability to do this well. For some, there was frustration in needing to explain when the answers were straightforward. One student responded, “I’m not wasting my time explaining this when I know the right answer.” This led me to believe that I could have framed the activity with more purpose.

      One student responded extremely well to the directions and assessment. Her justification for a solution was as follows: “Subtract 180 from 38 to get 142. Because the triangle is isosceles, two sides are equal, so I divide the answer of 180-38 by 2 to get 71. And because 71 is an inscribed angle, then it’s intercepted arc is double.” This example shows a student’s ability to justify and explain her answer thoroughly and completely.

      Other students, though, struggled to justify even correct answers. Some students either resisted the explanation entirely, while other students could not apply appropriate unit vocabulary and basically showed their mathematical work.

      ii. vocabulary and/or symbols

      The biggest suggestion I gave to students before their assessment began was to incorporate relevant unit vocabulary. Students did this with a wide range of abilities. Small mishaps in vocabulary and symbols included things like name arcs like angles (and vice versa). Other students were unable to describe the relationship between angles and their intercepted arcs.

      Many students, however, made fantastic use of vocabulary and symbols. Almost every student was able to correctly explain the relationship between central angles and their intercepted arc.

      Students successfully named arcs and angles much of the time. Focus student #2 mistook an angle and wrote “Arc D,” when it was obvious that she was referring to the angle.
Students also showed the ability to name major and minor arcs with proper symbols. Focus student corrected use relevant unit vocabulary, as well as proper use of symbols in her response to question 1. “The measure of angle A is 65 degrees because the measure of a central angle (angle BDC) is equal to the measure of its arc (BC), so an inscribed angle is half of the arc.”

iii. AND mathematical precision, discourse, or syntax to develop content understandings.

This assessment the proper use of discourse. Students were able to develop structures of the written language through their justifications and explanations. Additionally, the assessment allowed students to work collaboratively, which influenced their ability to talk, write, and participate in knowledge construction. The richness of the conversations that I observed rivaled heated debates about pop culture and other topics that students so often discuss. Students were asked to use symbolic representations of situations, as well as mathematical terminology. Students, in their explanations, also created a type of narrative which described their procedure and thought process through their problem solving. By creating these descriptions, students developed in their ability to restate given information (from the diagrams), and justify their answers with proof.

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:
      i. For the whole class
      - Give students an opportunity to share their results. This will encourage oral communication and collaboration. Additionally, students will be able to witness multiple ways to find solutions to similar problems.
      - Provide more opportunities for students to justify work verbally, whether that be written explanations, creative responses, presentations, or debates.
      - Give students an opportunity to revisit these problems upon completion of the summative assessment.
      - Allow students to critique others' work. Develop procedure to make this effective and respectful.
      - Include more collaborative work stations and assessments that require personal responsibility.
      - Develop a project that allows students to engage in similar critical thinking skills—how can I include debate and persuasion into this?

      ii. For the 3 focus students and other individuals/groups with specific needs
      - **Student 1**: adjust assessments to include creative portions and providing feedback early and throughout the assessment in the form of questions and suggestions.
      - **Student 2**: Give more opportunity to express orally—adapt assessments to allow student to verbalize procedure to demonstrate ability to meet objectives.
      - **Student 3**: Refer to high ability learners—provide learner opportunities for challenge and more chances for whole class engagement and participation.
      - **High Ability Learners**: incorporate more challenging examples and activities, including more research based and problem-oriented tasks that require problem-solving skills.
• **ELL Learners:** I will give students an opportunity to see well-written responses and justifications to model to ELL students the kind of responses. Making content comprehensible—how can I further develop the vocabulary support to make this type of response for achievable for English Language Learners?

  b. *Explain how these next steps follow from your analysis of student learning.*
  Support your explanation with principles from research and/or theory.

Much of the reasoning behind my next steps stems from Bloom’s Taxonomy, and the need of students to be doing the creating. For example, in many math classrooms, there is a teacher-centered, direct instruction based approach that allows students to listen, record, and copy. However, by giving students opportunities to create original work (like in the case of focus student 1), or creating their own justifications, or even solving problems in different ways, you are engaging in higher-order thinking. Additionally, by providing means by which students can engage in critical thinking and problem solving, you are addressing deeper thinking processes.

By creating activities that allow for collaboration and group work, I am also engaging in English Language Learners in rich experiences that help their ability to articulate in a new language. Charles Curan’s theory of community language learning encourages group work and collaboration. By creating these types of assessments, this type of learning, as well as making content comprehensible, will aid students in understanding.