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Task 2: Part B, Instruction Commentary

1. **Which lesson or lessons are shown in the video clip(s)? Identify the lesson(s) by lesson plan number.**

The lesson shown in this video is a clip of the Theorem Investigation that took place of Day Two (Lesson 2) of the learning segment.

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 this video clip, you will notice a general rapport with students as we complete the constructions and have class discussions about the task itself.

   This class is a class that engages well with the material and often does exactly what is asked. Students participate well and as this lesson was taught, all students were participating in the constructions and making observations and generalizations with those around them.

   You’ll notice a mutual respect in the video simply in the way in which I engage the students in the class. There is an understanding between students’ and I that if we can communicate well and engage, students are free to ask questions aloud, voice concerns, and ask each other questions. Students have respected this procedure in my classroom—in this clip; you will notice that students make observations aloud without fear of saying wrong answers. By creating a community in the classroom that values participation and engagement, students are free to engage with the material without fear failure or receiving punishment for talking out of turn.

   In my reactions to student participation, for example, you will notice both an acknowledgment of incorrect and correct answers. Take, for example, the conversation had at 8:54 in the clip provided. After fumbling with technology, I ask students, “Why are these answers not perfect?” Students respond, “Human errors.” This classroom discussion and question and answer time allowed students to think critically about the lesson that they were engaged in. Later, around 9:53, you’ll notice a discussion that students and I have about common errors and why we got them. As we were discussing, a student was able to correct himself and explain to the group why he originally had a wrong answer and the way he was able to correct it. This conversation reveals that a safe environment has been created and that students are challenged to engage in their own learning and thinking process. The individualized time I am able to spend with students throughout the construction also allows me to ask more personalized questions that meet the varied needs of the students.

   I am able to engage students with varied needs and backgrounds through the way I differentiate my responses and interactions with students. Throughout this learning task, I would spend time assisting students who struggled to grasp the concept we were discovering. This included individual help with protractors, rephrased directions to individuals, and assistance by putting examples on the board. For students with a more in-depth understanding, I was able to probe with more difficult questions that forced students to think critically about the concept, rather than simply following instructions and complying. This included asking individual students—“Why would tangent lines meet a radius at a right angle? What theorem would allow us to make that argument? How do we know that the intersection of perpendicular bisectors is a center? By providing questions to these individual students, you provide them with a richer understanding of the material without jumping ahead or leaving other students behind.
### 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

i. Conceptual understanding,

The premise of this learning task is to get students to engage in conceptual understanding prior to even encountering the material. The design of this activity gives students promptings to create constructions to demonstrate new concepts in our circle clip. In the video clip, you will notice the first construction relates central angles and inscribed angles. In doing this construction, students can first predict the relationship, observe the way that these angles compare, and use inference and reasoning skills to develop their own ideas of what is going on mathematically. Then, as we discuss the theorems as a class, students are either confirming their own understanding or asking questions as to why their initial thoughts were incorrect.

Our discussion about mathematical precision, which came out of an honest mistake, challenged students’ understanding of the mathematical use of accuracy and precision. This discovery design of this activity and the use of new theorems without prior knowledge challenges students to investigate concepts and reason through them without first being instructed.

ii. Procedural fluency, AND

In general, this activity speaks most closely to conceptual understanding and mathematical reasoning. It sets a firm foundation for procedural fluency later. For example, the first construction allows students to see the 1:2 ratios between inscribed angles and their intercepted arcs. In order for students to develop a deep procedural fluency in this unit, students must understand the idea conceptually. In order to develop a procedure for problems in this unit, students must first be able to understand and explain the concepts themselves. This will sharpen students’ abilities to solve problems—rather than guessing, “Should I multiply this by 2 or ½? Which one is larger again?” Hopefully, this activity engages students conceptually in order that procedural knowledge is sharpened later.

Additionally, students learn to develop procedure on problem-solving skills. Students must ask themselves, “What do I know? What can I infer from this information? How can I develop a procedure to test my hypothesis?” Rather than teaching procedural fluency for the problems presented in this unit, this specific segment reinforces procedural fluency for mathematical thinking and problem-solving skills.

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

One example in the clip that engaged students in reasoning and problem solving skills was the discussion in the clip about human error in our constructions. When students were investigating the relationship between central and inscribed angles that intercept the same arc, students were not always able to find the relationship between the two kinds of angles. Oftentimes, this was because of error in the construction. The conversation that resulted gave students an opportunity to consider the ways in which human error affected the constructions, as well as how we might fix the errors.

Additionally, students are asked to develop theorems and conjectures about the relationships they observe first without being given the theorem. In some classrooms, there is a direct-instruction approach where the theorems would be given to students as notes and then applied in practice. By giving students constructions and offering them time to reflect, engage, and ask questions, students derive the theorems themselves, or at least recognize patterns
within the examples. In doing so, they engage in mathematical reasoning. How can we explain error? Is this true all of the time? In the rest of the lesson following this clip, students were able to even infer and predict later theorems simply by working with the constructions. This fact proves that students were developing reasoning skills and problem-solving abilities.

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

This activity links prior knowledge that was developed both within this learning segment, as well as learning development in prior courses. You will notice that students are asked recall information from a previous measuring unit, a skill developed in a previous course. This included recalling vocabulary like perpendicular, parallel, acute, obtuse, and intersect. Additionally, this included skills like using protractors and straightedges to complete constructions.

Students were also asked to recall information presented within this learning segment. The instructions for this activity asked students to draw chords, perpendicular bisectors, and tangent lines. All students had to apply their understanding of unit vocabulary (developed in lesson one of the unit) to create diagrams and representations when given directions. At this point, it will be clear the extent to which students have met vocabulary objectives.

In terms of personal, cultural, and community assets, this activity serves to give all students representations of new concepts that extend beyond notes. For students with language needs, this activity offers a visual representation of concepts alongside written ideas. The activity respects a variety of learning styles, as well as respects students’ need for a variety of learning opportunities. Looking specifically at the assets of this group of honors students, I realized that giving them the opportunity to discover and investigate concepts themselves. Designing an activity that allowed students to take ownership over the material was purposeful in allowing student assets to shine.

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.

Conceptual understanding was developed throughout this specific lesson through my response to student interaction, questions, and participation. Around 10 minutes into the video, you see a discussion between a student and I about a mistake he made. Not only did this conversation aid the student in understanding and conceptual knowledge, but it also opened up conversations between individuals throughout the classroom, often those who were making the same mistake. By responding to specific student ideas, I create a classroom environment that fosters involvement and engagement.

Procedural fluency, like previously mentioned, is a skill that is developed later in this unit that is built upon the skills built in this unit. By discussing concepts deeply, students will begin to develop their own procedures for problems involving the theorems they learn in this learning task. Student responses that include the recognition of pattern—for example, when students realized the pattern between angles and arcs—will aid students in their procedural fluency.

Mathematical reasoning is the basis of all student responses in this lesson. All questions raised in this lesson are aimed at facilitating a discussion around rich mathematical concepts. When questions are raised about precision and error, student responses reveal objectives being met, as well as help facilitate class discussion. These conversations are driven by questions created by instructor and build upon one another.
b. Explain how you used representations to support students’ understanding and use of mathematical concepts and procedures.

The task itself is designed to promote student understanding through the use of representations. Throughout the clip, you will notice that students are responding to promptings to create their own constructions. In this way, students take responsibility for their learning and discover concepts themselves. For example, one of the first constructions that you observe in the clip is the construction that compares an inscribed angle to a central angle that intercepts the same arc. By facilitating constructions in a way that students are creating their own examples, using mathematical procedures like measurement, protractor and straightedge use, students are able to discover theorems themselves. Students then are able to recognize patterns, as well as discuss how and when error comes into play in the investigation.

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)?

The purpose of this instructional day was to give students the opportunity to discover relationships among chords, angles, and arcs in circles. The inquiry-based learning activity was developed to give students the opportunity to create the theorems themselves, giving students ownership over their learning and the material.

Though I believe that this was accomplished, as I reflect, I see many ways in which I could adapt this instruction to make it better for students. The first change would be to give student circle centers for the circles that did not require students to find the centers themselves. Without giving them this information, there were more opportunities for calculation and measurable error, which affected the students’ abilities to see patterns. For examples, some students were able to recognize the relationship between a central angle and inscribed angle that share the same intercepted arc. However, others had such stark differences in their values that they were unable to see a pattern. Giving centers of circles could be one way to eliminate error for calculations.

I also think that student engagement could have improved. If I were to do this lesson again, I may do a major overhaul of the design of the lesson. Rather than have all students do this together at once, I would split the class into groups and assign each group 2 different tasks/theorems to prove. Each group would have 30 minutes and a large sheet of poster paper to create similar investigations. Different group members would have different tasks—one would be the task manager, one a scribe, one a creative director, and another a presenter (I could add jobs or make fewer). At the end of the period, there would be a presenter from each group that showed the results of their investigation. Every group would be experts on two theorems—students would then become the teachers! In doing this, students would take more responsibility for the task, and could be working together on inferring theorems and relationships. It also gives me as the instructor time to work with individuals and groups—something I was unable to do during this lesson.

Finally, I would post this student work throughout the room to have as a visual for students to refer to throughout the learning segment and unit as a whole. We could do this a second time as we learning more relationships between secant and tangent lines later in the unit.

The change to this learning task would also allow me to differentiate my instruction to cater to students of all ability levels. For example, students who need more support could work together on a more basic theorem. By investigating it thoroughly, they will have a greater
chance at understanding basic concepts at a more conceptual level. High-level students will have the opportunity to explore deeply more difficult concepts related to the central focus. I can ask their groups more conceptual questions that require critical thinking. As a whole group, I was unable to do this well.

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.

The most blatant research that supports this kind of change to my lesson is Bloom’s Taxonomy. As I watched students in the days after this lesson, I found them often referring to the notes from this lesson. While I loved that they were using this task as a resource, it would be ideal that their engagement with the material was so impactful the first time that they could reason through problems without direct notes. Bloom’s Taxonomy shows the different kinds of engagement students have and correlates these engagements with their ability to recall and apply information. The most valuable form of engagement, according to this research, is a student creating and constructing original work. By adapting the lesson to incorporate more creatively, creating on a larger scale, and producing and teaching material, students will gain a much richer encounter with the concepts in the lesson. Students will be analyzing, evaluating, and creating, rather than simply complying this verbal directions. Students were still creating original work and constructing examples in this lesson, but I directed them on specifically how to design their constructions, rather than giving them creative liberty.

Giving students opportunity to be the teachers should also improve language use and conversational mathematics, as well as deepen students’ conceptual understanding of the material.