# UTeach Observation Protocol (UTOP) Sample Scoring: Grades 10–11 Science, Project-Based Learning Video 2 (Day 4)[1]

Complete **AFTER** observation of lesson, using field notes, teacher post-interview, and student work samples and/or comments (plus video if available).

Note: An observer scored this sample based on a classroom observed at Manor New Tech High School in Manor, Texas. The project observed in this classroom was a multi-day project. The video, sample scores, and more for this and other days of the project are available on the UTOP website: http://utop.uteach.utexas.edu/?q=sample-utop-scoring.

## I. BACKGROUND INFORMATION

**Teacher:** NA
**School:** Manor New Tech High School
**Date of Observation:** NA
**Start and End Time of Observation:** NA
**Date of Post Interview:** NA
**Method of Post-Interview:** Face-to-face
**Subject Observed:** Phylgebrics (Physics I and Algebra II combined class)
**Grade Level:** 10 and 11
**Course Level:** (Regular or Advanced/Accelerated): Regular
**Observer:** UTOP Expert

## II. LESSON OVERVIEW

In a paragraph or two, describe the lesson you observed. Include where the lesson fits into the overall unit of study. Be sure to include enough detail to provide a context for your ratings of the lesson and also to allow you to recall the details of the lesson when needed in the future.

This lesson took place on the fourth day of a three-week project-based unit called My Li'l Galaxy. The overarching goal of the project required students to design a solar system that included at least one planet that could sustain life.

In this day's lesson, students attended a workshop in which they learned how to find the equation of a circle given the center and radius length. This introductory lesson about circle equations would later support the students in their determination of the "habitable zone" of

[1] NOTE: The UTOP was adapted from Horizon Research, Inc., *2005–06 Core Evaluation Manual: Classroom Observation Protocol* by UTeach Natural Sciences, University of Texas at Austin.

This document is an example of an instrument that an observer has filled in after observing one period of a grades 10–11 math/science classroom. For more information about the UTOP, see http://utop.uteach.utexas.edu. This is Day 4 of the three-week project, but it is only the second example—we are not documenting every day of the project.

their solar system. After a brief warmup at the beginning of class, one of the two instructors conducted a whole-group workshop using Geometers Sketchpad. He first demonstrated how to derive the equation of a circle and then worked through sample problems with the students. After the circle equations workshop, students worked in groups, accessing the electronic project rubric checklist to assess their progress on the project, and then working on assigned circle equation problems and/or the Table of Characteristics for the star(s) that would center their solar system. (See the Rubric Checklist on the UTOP website.)

## III. RATING SCALES

| | |
|---|---|
| 1 = Not observed at all / Not demonstrated at all | 4 = Observed often / Demonstrated well |
| 2 = Observed rarely / Demonstrated poorly | 5 = Observed to a great extent / Demonstrated to a great extent |
| 3 = Observed an adequate amount / Demonstrated adequately | |

### *1. Classroom Environment*

| Rating | Indicator |
|---|---|
| **4** | **1.1 Classroom Engagement:** The classroom environment facilitated by the teacher encouraged students to generate ideas, questions, conjectures, and/or propositions that reflected engagement or exploration with important mathematics and science concepts.<br>Description, Rubric, and Examples |

***Evidence***

The students frequently and consistently asked questions during both group work time and during the in-class workshop. During the workshop, students would often ask questions when they were having difficulty understanding the vocabulary used or the procedures demonstrated by the teacher [7:18, 17:42, 19:51]. There were a few missed opportunities when the students asked questions that could have been probed by the teacher to ensure or develop higher-level understanding. For example, the teacher writes two equations on the board to illustrate how students could solve for the radius $–x^2 + y^2 = r^2$ when the center of the circle is at (0, 0) and $(x + h)^2 + (y + k)^2 = r^2$ when the center is shifted away from the origin [7:16–7:20]. A student asks “So, whenever it’s not sitting at (0, 0), that’s the equation you use?” and the teacher responds “Well, this is the equation but when it’s centered at (0, 0), this is 0 (pointing to the *h* term in the second equation) and this is 0 (pointing to the *k* term in the second equation) so they just go away.” This quick explanation is correct, but the student’s question suggests that she believes these two equations are different — e.g, it is not apparent from the video that all students understand that both equations are relaying the same information. This is a missed opportunity to ask students a probing question to check on their understanding of the differences or similarities between the two representations.

While students worked in groups, the teachers made themselves available for questions. Throughout the majority of the lesson, students frequently asked either content-oriented or procedural questions regarding the instructions for the group portion of the lesson. For example, at time 01:50 students asked the teacher for clarification of directions. In addition, students frequently discussed with the teacher or in their groups their own ideas or conjectures about important mathematics and science concepts explored. For example, [30:11–31:09], students discussed how to describe their rationale for choosing the size of their star that would support a habitable zone or planet in their solar system. One student began the discussion by asking, “Too hot is too big and too small is too cold. And, like the sun, it’s just right. But how do we put that into words?” One student kept questioning the other until he got an explanation he could understand [31:05]: “If a planet is too cold to have liquid water, if it’s too hot to have liquid water, we can’t survive.” This discussion demonstrates students’ previous knowledge of conditions that sustain human life as well as exposes their assumptions made in the project about needing to define habitable zones in terms of the characteristics of life that exist on our own earth and in our own solar system.

| Rating | Indicator |
|---|---|
| 5 | **1.2 Classroom Interactions:** Interactions reflected collegial working relationships among students (e.g., students worked together productively and talked with each other about the lesson).<br>**It’s possible that this indicator was not applicable to the observed lesson. You may rate NA in this case.*<br>Description, Rubric, and Examples |

***Evidence***

At the beginning of class, students worked together to complete the warm up assessment. One student shared data, such as average lifetime and average luminosity, while the other entered their responses on the computer. The student double-checked what his partner typed while the teacher looked on [0:04–1:30]. At 1:30–1:52, another group of students clarified directions among themselves about the successful completion of the warm up. Though the workshop was primarily teacher-directed, one student asked another student who had just provided an answer to the teacher, “How are you doing this?” [22:52]. During group work time, most students stayed focused on the content and collaborated with each other. One pair of students discussed the correct response to one of the “equation of a circle” multiple-choice problems from the assignment [27:10–28:30]. One student began the dialogue by explaining, “I think it’s ‘g’. . . because it’s the, the five is positive. . . .” He was referencing a problem with a circle centered at (4,5) and with a radius of 4. (Note: Answer “g” is the correct response). The other group member said they would “check it” and pulled out the calculator. The first student went on to explain his reasoning, and in the end of the dialogue, they agreed and determined that the answer “g” was correct.

| Rating | Indicator |
|---|---|
| **4** | **1.3 Classroom On-Task:** The majority of students were on task throughout the class.<br>Description, Rubric, and Examples |

***Evidence***

More than 90% of the students were observed to be on task during the lesson's activities. In a few instances, not every group member was engaged in the activities; for example, one group member had ear buds in her ears while the teacher discussed the group's responses to several rubric checklist items and told them what additional information they must include to get full credit for the work. It appears that this one group member was listening to music and not participating in the conversation [29:06–29:19]. During the in-class workshop portion of the lesson, most students observed were paying attention and taking the notes in their journals [09:20–09:49].

| Rating | Indicator |
|---|---|
| **4** | **1.4 Classroom Management:** The teacher's classroom management strategies enhanced the classroom environment.<br>Description, Rubric, and Examples |

***Evidence***

The majority of students seemed to be on task throughout the duration of the video. At the beginning of class, the instructor monitored student completion during the warm up. At 0:04–1:30, she checked, provided feedback, and assessed student work. The classroom management system set up by the instructors provided just-in-time and ongoing assessment and feedback for each student group as they progressed through the tasks and activities required for project completion. For example, the instructor spent several minutes explaining what was necessary for successful completion of the tasks on the rubric to a group [28:30–30:04]. This efficient time management process allowed her to grade and monitor student progress during the lesson. Classroom routines, such as the in-class workshop, ran smoothly and productively. For example, during the workshop on circle equations, most students seemed to be taking notes in their journals [16:10–16:25].

| Rating | Indicator |
| --- | --- |
| **4** | **1.5 Classroom Organization:** The classroom is organized appropriately such that students can work in groups easily and get to lab materials as needed, and the teacher can move to each student or student group.<br><br>Description, Rubric, and Examples |

***Evidence***

This classroom design was not ideal, as a small wall separating the room made it difficult for students in the back of the classroom to see what was projected at the front board. Also, computers were not arranged in stations but in long rows because of this non-negotiable architecture. However, both teachers moved continually around the classroom, maintaining accessibility to the students on both "rows" of computers. For example, at the beginning of the lesson, both teachers rotated and, one after the other, worked with the same group at the back of the class [0:04–1:30, 1:52–2:41]. During the class workshop, students moved chairs to sit at the front of the room and take notes in their journals while the teacher worked through examples using technology to display his work. However, not all students had equal access to the presentation, as some students sat at the tables in the front corner of the classroom (to the left of the screen), which made it difficult for them to see the board during the workshop [8:29–8:35].

| Rating | Indicator |
| --- | --- |
| **5** | **1.6 Classroom Equity:** The classroom environment established by the teacher reflected attention to issues of access, equity, and diversity for students (e.g., cooperative learning, language-appropriate strategies and materials, attentiveness to student needs).<br><br>Description, Rubric, and Examples |

***Evidence***

There do not appear to be any issues regarding equitable treatment of students in this classroom. All students were provided an opportunity to ask questions and were provided access to materials and the teachers regardless of their race, gender, first language, etc. In some instances, the teacher used ample wait time to allow students to process their thoughts and provide opportunity to ask any questions [14:40–15:00].

**Synthesis Rating for Classroom Environment**

| **Classroom culture is *non-interactive or non- productive*.** | **Classroom culture is productive and interactive only *occasionally*.** | **Classroom culture is *adequately* productive and interactive.** | **Classroom culture is *often* productive and interactive, with some collegial interactions.** | **Classroom culture is *consistently* collegial, interactive, and productive.** |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

## *2. Lesson Structure*

| Rating | Indicator |
|---|---|
| **4** | **2.1 Lesson Sequence:** The lesson was well organized and structured (e.g., the objectives of the lesson were clear to students, and the sequence of the lesson was structured to build understanding and maintain a sense of purpose). Description, Rubric, and Examples |

### *Evidence*

Since this lesson was situated within a project, My Li'l Galaxy, all students needed to learn how to apply the equation of a circle to define the "habitable zone" of their solar system. In order to meet this student need, the teacher held a class workshop open to the whole class in which students were taught how to find the equation of a circle given a radius and a center. The majority of the class session observed in the 34-minute video was spent in this workshop. (Note: Although the video is an edited 34-minute section, the entire class period was 90 minutes in length.) After the workshop, the class structure provided students time to work on their project tasks at their own pace, meet with their teachers to ask questions and receive feedback about their progress, and, finally, earn "stamps" (formative assessment checks given by the instructors for student work on project components) for completing different portions of the project rubric. The project rubric instrument itself is evidence of the teacher's well-thought-out design for the flow and sequence of the student work that would lead to accomplishing the goals of the lesson as well as the overall project. [Download the project rubric checklist from the UTOP website at http://utop.uteach.utexas.edu. Find the page for this lesson.]

| Rating | Indicator |
|---|---|
| **3** | **2.2 Lesson Importance:** The structure of the lesson allowed students to engage with and/or explore important concepts in mathematics or science (instead of focusing on techniques that may only be useful on exams). Description, Rubric, and Examples |

### *Evidence*

This lesson was focused on relevant mathematics content, finding the equation of a circle given the radius and center. This content of this lesson was situated within the project because the students need to find the habitable zone for their solar system. The teacher's plan was to direct students through this workshop by first asking guiding questions to help them consider how to modify the standard form of the equation for a circle that is not centered at the origin. Next, the teacher had the students apply this expanded equation to determine the values for $h$ and $k$ and the radius, $r$, for a few sample problems [15:59–19:00]. The types of questions asked in the workshop, and later in the post-assessment, posed the same type of problem with different numbers, where the students practiced using the equation to determine center and radii for different circles, particularly those that were not centered on the origin [18:08–21:53].

| Rating | Indicator |
|---|---|
| **3** | **2.3 Lesson Assessments:** The structure of the lesson included opportunities for the instructor to gauge student understanding.<br>Description, Rubric, and Examples |

***Evidence***

The majority of the video (70%) was spent in a workshop where students were taught how to find the equation of a circle. As this class session consisted of an entire 90-minutes class session (see Lesson Graph for this video), the structure of the workshop was designed to allow for frequent, open-ended student and teacher interaction.

| Rating | Indicator |
|---|---|
| **3** | **2.4 Lesson Investigation:** The lesson included an investigative or problem-based approach to important concepts in mathematics or science.<br>Description, Rubric, and Examples |

***Evidence***

Although this 34-minute video was focused on a well-managed, teacher-centered workshop where the teacher demonstrated how to apply the equation of a circle to determine parameters that would be used later in the project development to establish a habitable zone for their solar system, outside of the workshop time students did progress through the project tasks and activities in a problem-based approach. The focus of the lesson was on important mathematics content that the students would need to use to accomplish the objectives of the project. Nonetheless, the video does not make explicitly obvious how much time was spent in student-driven investigation into the more challenging aspects of this project outside of the teacher-driven workshop.

| Rating | Indicator |
|---|---|
| **4** | **2.5 Lesson Resources:** The teacher obtained and employed resources appropriate for the lesson.<br>Description, Rubric, and Examples |

***Evidence***

The teacher projected a version of Geometer's Sketchpad to show students in the class how to apply the circle equation to solve for the parameters of the habitable zone in a solar system of their own design. During the demonstration, the teacher worked with the same technology that was available to students at their computer stations, but the students were limited to taking notes in their interactive notebooks. This lesson structure did allow the teacher to focus student attention on basic mathematical techniques in order to gain fluency with the equation of the circle. There may have been a small missed opportunity for students to use the technology in smaller groups to explore ideas on their own, but the technology might have proven a distraction if students were struggling with the basic algorithm, especially during this introductory workshop.

| Rating | Indicator |
| --- | --- |
| **4** | **2.6 Lesson Reflection:** The teacher was critical and reflective about his/her practice after the lesson, recognizing the strengths and weaknesses of his/her instruction.<br>** This indicator may be rated NA if you do not have access to a teacher interview or teacher commentary.*<br>Description, Rubric, and Examples |

***Evidence***

The teacher interviews for this particular project occurred at the end of the multi-week unit rather than after each individual lesson observed. However, it was evident that the teachers were reflective about some points from this lesson. The physics instructor acknowledged that "Algebra 2 drives the curriculum" ("Phylgebrics" is the title of this particular course, which combines subject matter from both Physics and Algebra 2). The physics teacher stated that for this particular project, the appropriate Algebra 2 content was conic sections. Therefore, the physics concept that fit best was Newton's gravitational force of attraction.

This lesson occurred on the fourth day of the project, after a two-day "soft launch" or introduction to the project. For this portion of the project, students were expected to draw three orbits for planets in a solar system — one that existed within a habitable zone where life could be sustained. When planning this lesson the instructors decided to review students on circle equations so that they could calculate the habitable zone. They wanted to "start the lesson with something students knew" and then decided that the introductory math content of the lesson "needed to cover circles first."

After this lesson, students would then move on to equations for ellipses and quadratic equations in conjunction with determining the gravitational attraction between the star and their planets, resulting in the orbits of the three planets in their solar system. As for the whole group instruction of this lesson, the math instructor said that whole group is not an ideal workshop as "students will fall off topic." His ideal workshop size is about 5 students, even if he has to conduct the same workshop multiple times in a class. However, sometimes a whole group workshop is necessary, as is the case in this lesson, to review and introduce students to the math content in their project.

At the end of the video, the instructors discovered that students were struggling with expressing their solar system distances in the common units — solar radii instead of astronomical units. This conversion was necessary for creating correctly scaled drawings of their solar system. In the post-observation interview, the physics teacher recognized this difficulty and stated, “This is something we need to work on going forward, a lot of confusion among the units and what they are and what they mean.”

**Synthesis Rating for Lesson Structure**

| **Lesson was *very poorly* structured to assist student learning.** | **Lesson was *poorly* structured to assist student learning.** | **Lesson was *adequately* structured to assist student learning.** | **Lesson was *well* structured to assist student learning.** | **Lesson was *expertly* structured to assist student learning.** |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

## 3. Implementation

| Rating | Indicator |
|---|---|
| 3 | **3.1 Implementation Questioning:** The teacher used questioning strategies to encourage participation, check on skill development, and facilitate intellectual engagement and productive interaction with students about important science and mathematics content and concepts.<br>Description, Rubric, and Examples |

### *Evidence*

At the beginning of the workshop [3:13–4:19], the teacher asked probing questions such as “What is special about the radius of a circle?” During this introduction, the instructor continuously asked “What else?” to probe students’ prerequisite understanding of properties of a circle. The teacher repeatedly asked, “Does that make sense?” [5:08–5:11, 17:00–17:30] throughout the workshop to check for student understanding. For example, when the teacher asked, “Do you have enough or do you need more help?” [20:27], one student replied, “No, I need more help!” and the teacher obliged by going through another sample problem.

Although the teacher began the workshop with a probing question, asking the special characteristics of the radius of the circle [3:13–4:19], he seemed to be trying to get to one specific answer (i.e., the length of the radius of a circle never changes). The majority of the questions asked by the teacher were of procedural and factual nature. For example, the teacher asked, “What’s this?” — pointing to the triangle inscribed within the circle; the students responded, “A triangle” [5:50–5:56]. Next the teacher asked, “Is there anything special about this triangle?” Students responded, “A right triangle.” Then the teacher followed up this question with “What do you know about right triangles?” In unison, many students responded by rote, “($a^2 + b^2 = c^2$).” This type of fact-based questioning is typical of most of the workshop session.

At 22:38–23:27, the teacher managed to entertain one student’s alternative approach to determining the length of the radius (the hypotenuse of the right triangle inscribed in the circle) while demonstrating the conventional approach on the projection screen. The student asked, “Can we just go one squared plus one squared plus . . . equals . . . ?” [The length of the hypotenuse or *r*, the radius] While continuing to write, the teacher asked the student, “Why one squared?” and the student explained, “We can find the diagonal of each little grid, then just add that all the way. Am I right?” [22:50]. As the teacher finished writing out his approach, he agreed, “Yeah, you could take 3 of those . . . and find what that diagonal, but you’ve got 3 of them.”

| Rating | Indicator |
|---|---|
| **3** | **3.2 Implementation Involvement:** The teacher involved all students in the lesson (calling on non-volunteers, facilitating student–student interaction, checking in with hesitant learners, etc.).<br><br>Description, Rubric, and Examples |

***Evidence***

During the workshop, the teacher did not call on specific students, but instead let them share out when they knew the answer [09:47–12:15]. The rapport between the teacher and the students made it clear that anyone could ask or answer a question, and the implementation of this practice resulted in several students suggesting answers quietly while a few students volunteered their responses loudly enough for the whole class and the teacher to hear and follow up with additional questions. After this introductory workshop, however, the teachers walked around and talked with all groups and engaged with the majority of students. However, in a few instances when students weren't engaged, questions were not addressed to them in attempt to re-engage them in the conversation. For example, a student was listening to headphones and the instructor did not direct any questions to her to check for her involvement [29:06–29:19].

| Rating | Indicator |
|---|---|
| **4** | **3.3 Implementation Modification:** The teacher used formative assessment effectively to be aware of the progress of all students and modified the lesson appropriately when formative assessment demonstrated that students did not understand.<br><br>Description, Rubric, and Examples |

***Evidence***

At the beginning of class [0:33] the instructor walked around to each group and formally assessed that they had completed required tasks or activities by hand. This seemed to be an established strategy that the instructor used daily to quickly assess students' responses to the warm-up activities and to take quick formative notes on students' progress on the project [0:08–1:41]. This also seemed to serve as ongoing formative assessment on their progress toward the completion of the project challenges. Students also frequently self-assessed using the rubric "stamps" and information posted electronically to follow their progress on the project [2:58–3:07].

During the workshop, the instructor asked many questions to assess their understanding, such as, "Does that make sense?" "How would this $x$ and $y$ relate if this circle was centered around zero, zero?" "Is everybody with me so far?" "How does our radius relate to those?" "What's special about this triangle?" [4:50–6:10]. Many of these questions were fact-based or procedural and did not probe more deeply to see if students understood conceptually what they were doing. When the students expressed that they were unable to complete the sample problems individually after seeing an example during the workshop, the instructor modified the lesson by showing them how to solve each of these problems in the whole class setting [22:14–26:01].

During the group work time, the students continued to self-assess their progress through the project by referring to the project rubric. The teacher circulated regularly and provided feedback, explaining in detail when students had met the requirement or describing what specific modifications or additions they needed in order to meet the requirements [28:34–29:25].

While checking in with one group and discovering that several students struggled with converting from Astronomical Units (AU) to solar radii, the instructor asked that one student per group come to the front for an emergency workshop [31:55]. The instructor realized that the reference table provided students led them to calculate two critical distances in different units — the radii of their planets in solar radii and the distance between the inner and outer limits of their habitable zone in AU [32:14–34:00].

The instructor called up a single group member representative to attend a just-in-time workshop session to learn how to carry out the conversion between AUs to solar radii, allowing the rest of their group to remain engaged with other components of the project work. This modification to the instruction addressed the difficulties students would encounter with differing units of distance when trying to create scaled drawings of their solar systems.

| Rating | Indicator |
|---|---|
| **3** | **3.4 Implementation Timing:** An appropriate amount of time was devoted to each part of the lesson.<br><br>Description, Rubric, and Examples |

***Evidence***

The workshop in this edited video accounted for approximately 70% of the time. The workshop time allotment appeared appropriate for the introduction of the application and manipulation of the circle equation as evidenced by students' actively taking notes and continuing to ask for assistance when they did not understand how to proceed independently.

Since the entire class session was 90 minutes, it can only be assumed that the brief footage of students working in their groups just prior to and after the workshop continued during the part of the class session that is not on video [0:04–3:07, 27:16–31:54]. During the video, however, students appeared to stay engaged and use the time provided to complete productive work on the assigned tasks and activities, receive feedback from their instructors, and discuss the work that they were doing collaboratively. It was difficult to assign an exact score to this indicator due to the editing of the video.

| Rating | Indicator |
|---|---|
| **4** | **3.5 Implementation Connections:** The instructional strategies and activities used in this lesson clearly connected to students' prior knowledge and experience.<br>Description, Rubric, and Examples |

***Evidence***

At the beginning of the workshop [3:13–4:19], the teacher asked students about special properties of the radius of a circle. Students learn mathematical ideas about circles in middle school, then develop a deeper understanding of circles in Geometry, a course students in this class of Algebra 2 would have completed. This question and several following during the workshop helped connect the new content to be developed to students' prerequisite knowledge.

While deriving the equation of a circle, the teacher led students to connect the equation to the Pythagorean Theorem [5:55], relating how they could use the ability to calculate the lengths of the sides of the triangle inscribed in the circle to the radius. At 9:37, one student asked if they had "done this before" and the teacher confirmed that it is a review of previous content, but "it's been a while" and we need to "refresh you." The teacher also stated that this information would help them "deal with the ellipses later." Although not explicit in the video clip, it was the need to apply equations for ellipses that would allow the students to draw the orbits of the planets in their solar system.

During the workshop, the teacher frequently asked questions trying to connect to content previously learned in Algebra 2. For example, at 6:28–6:44] the instructor asked what the students remembered about *h*, the horizontal shift for figures drawn off the origin (0,0) of the coordinate system. This built on prerequisite learning that all students should have had, and yet only one student was heard volunteering the needed information.

| Rating | Indicator |
|---|---|
| **NA** | **3.6 Implementation Safety:** The teacher's instructional strategies included safe, environmentally appropriate, and ethical implementation of laboratory procedures and/or classroom activities.<br>**This indicator may be rated NA if there were no relevant activities during the lesson.*<br>Description, Rubric, and Examples |

***Evidence***

There were no activities requiring instructional strategies related to safety.

**Synthesis Rating for Implementation**

| ***Very poor*** **lesson implementation** | ***Poor*** **lesson implementation** | ***Adequate*** **lesson implementation** | ***Good*** **lesson implementation** | ***Excellent*** **lesson implementation** |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

## *4. Mathematics/Science Content*

| Rating | Indicator |
|---|---|
| 3 | **4.1 Content Significance:** The mathematics or science content chosen was significant, worthwhile, and developmentally appropriate for this course (includes the content standards covered, as well as examples and activities chosen by the teacher).<br>Description, Rubric, and Examples |

***Evidence***

The mathematics content focused on in this workshop was a review of the derivation and application of the equation of a circle centered at the origin and at horizontal displacement (*h, k*) and given the radius. According to the Texas Essential Knowledge and Skills (TEKS) for High School Geometry [Standard G.12(E)], students should be able to "show that the equation of a circle with center at the origin and radius $r$ is $x^2 + y^2 = r^2$ and determine the equation for the graph of a circle with radius $r$ and center $(h, k)$, $(x - h)^2 + (y - k)^2 = r^2$." Although this content is not part of the Algebra II standards, it is needed prerequisite content for students to be able to use to move forward into new content on conic sections (i.e., ellipses). Students in this Algebra 2/Physics class should have completed Geometry in the previous year.

The primary focus of the science content explored by students in this video segment was somewhat limited due to the editing. Most of the teacher–student interaction with concepts focused on the calculation and conversion of solar system distances, such as the radius of their planets and the inner and outer dimensions of the habitable zone. Although being able to "describe and calculate how the magnitude of the gravitational force between two objects depends on their masses and the distance between their centers" is a high school Physics standard, the procedural application of a conversion factor to accurately complete the distance calculations is a necessary prerequisite, albeit lower-level, skill to completing the more challenging aspects of this project.

| Rating | Indicator |
|---|---|
| 4 | **4.2 Content Fluency:** Content communicated through direct and non-direct instruction by the teacher is consistent with deep knowledge and fluency with the mathematics or science concepts of the lesson (e.g., fluent use of examples, discussions, and explanations of concepts, etc.).<br>Description, Rubric, and Examples |

***Evidence***

Most of the information that the teacher presented through the technology using Geometers Sketchpad was clear. However, there were a few instances where what the teacher was showing students may have been confusing. For example [8:00], the teacher drew the terms *h* and *k* of the shifted center on the axes of the coordinate system to show students how to find the values of the center point of the circle (*h, k*). Although it is correct that the distance from zero in the horizontal direction is *h*, and the distance is *k* in the vertical direction, writing these terms on the corresponding *x*- and *y*-axes may have led to some confusion for the students. In fact, after presenting this derivation, the teacher checked for understanding by asking, “Ok, what does the *k* stand for?” [15:21]. A student responded, “The *y*-value?” and the teacher clarified, “Yes, but it stands for the *y*-value of our center of the circle.” The teacher helped derive the equation of a circle, then gave students the steps to work through in order to come up with the equation of a circle given a radius and center.

| Rating | Indicator |
|---|---|
| 4 | **4.3 Content Accuracy:** Teacher written and verbal content information was accurate.<br>Description, Rubric, and Examples |

***Evidence***

The information presented by the teacher in the circle equation workshop was accurate. The teacher demonstrated the importance of accuracy for the students in one exchange [19:50] when writing down the solution for calculating the value of the radius by dividing the diameter in half in a practice problem: 11/2 = 5/5. A student asked, “Is it all right if you just put 6?” and the teacher responded, “Well, it’s not 6! If you say it’s a radius of 6, that’s going to give you a different equation.” The teacher explained that, in general, students should not round their answers unless given specific instructions to do so.

The teacher emphasized the need for accuracy with students in another exchange [23:27–24:15] when asking, “What’s our radius?” and pointing to the term $\sqrt{18}$. Several students had used their calculators to compute this square root and called out their answers. The teacher replied, “That’s a decimal value. What our exact radius?” The students’ responses were not clearly heard, but the teacher insisted on using exact values and went on to show the students how to simply the expression (from $\sqrt{18}$ to $3\sqrt{2}$) stating, “I’d say you are approximating. The square root of 18 is exactly our radius.” In another example, the teacher demonstrated particular care in presenting accurate information [25:58] when he corrected a mistake he had written and when describing the *h* and *k* values for the center of the circle in a practice problem.

| Rating | Indicator |
|---|---|
| 3 | **4.4 Content Assessments:** Formal assessments used by teacher (if available) were consistent with content objectives (homework, lab sheets, tests, quizzes, etc.).<br>**It’s possible that this indicator was not applicable to the observed lesson. You may rate NA in this case.*<br>Description, Rubric, and Examples |

***Evidence***

The formal assessment (homework) for the circle equation workshop assigned by the teacher [26:05] was a multiple-choice assignment that covered problems similar to the ones done together during the class while taking notes in their journals. This assignment was to be completed by students prior to the next class, but many students were able to begin work on it during the class [27:08–28:30].

In this assessment, students were asked to practice calculations and to simplify the equations as demonstrated in the workshop examples. The assignment aligned with the objectives for this part of the project — as needed prerequisite knowledge from the state standard for Geometry, "show that the equation of a circle with center at the origin and radius $r$ is $x^2 + y^2 = r^2$ and determine the equation for the graph of a circle with radius $r$ and center $(h, k)$, $(x - h)^2 + (y - k)^2 = r^2$."

However, the assignment information provided failed to explicitly connect to the Algebra II content on conic sections presented during the introduction to the unit or the concepts students would learn to apply when creating the ellipses that represent the orbits of the planets in their solar systems.

| Rating | Indicator |
|---|---|
| 4 | **4.5 Content Abstraction:** Elements of mathematical/scientific abstraction were used appropriately (e.g., multiple forms of representation in science and mathematics classes include verbal, graphic, symbolic, visualizations, simulations, models of systems and structures that are not directly observable in real time or by the naked eye, etc.).<br>**It's possible that this indicator was not applicable to the observed lesson. You may rate NA in this case.*<br>Description, Rubric, and Examples |

***Evidence***

The teacher began the Circle workshop with abstraction, moving between a graphical representation of a circle to the symbolic representation of the circle equation. The teacher used the technology to sketch the graph of a circle and was able to write directly on this representation as needed to illustrate how students would find the value of each term in the equation.

After starting with the simplest case, a circle centered at the origin, the teacher moved quickly on to explain what changes occurred when considering a circle horizontally and/or vertically shifted to be centered at $(h, k)$ [3:12–7:21]. This seemed confusing for several students, resulting in one student asking [7:18], "Whenever it's not sitting at (0,0), that's the equation you use?" The teacher explained and showed that, "When it's centered at (0,0), this a 0 [pointing to the $h$ value] and this is 0 [pointing to the $k$ value], so they just go away."

Since this was a refresher and an introduction to material students had experienced in a prior course, Geometry, if the first example started with integer values, instead of the symbols (*h, k*), it might have been easier for students to make the appropriate connections between the different representations (equation, graph, etc.). For example, when the teacher asked what is the length of the base of the right triangle inscribed in the circle, he expected students to respond with symbolic values. Instead, a student responded that it would be 4 because he was counting the number of units across the length [4:23–5:09].

The teacher eventually led the students into an application of the Pythagorean Theorem but continued to use symbols to derive the two types of circle equations they would use to solve practice problems later in the workshop session. After the derivation, the teacher worked through several practice problems with integer values for the center and the radius so that students could solve similar problems on their own. Ultimately, the symbolic equation derived for an expression in *y* would be used to generate graphs of the concentric circles needed for their sketches of the habitable zones of their solar systems.

| Rating | Indicator |
|---|---|
| 2 | **4.6 Content Relevance:** During the lesson, it was made explicit to students why the content is important to learn.<br><br>Description, Rubric, and Examples |

***Evidence***

This single lesson was situated within a larger multi-week project where the students would design a solar system that could sustain life. One of the requirements for this project was that students include the equations of two circles that define the inner and outer limits of the habitable zone for their solar system — a region where a planet could exist that could sustain life forms.

There is a brief mention of the relevance of this circle equation workshop [9:37] when a student asked, “Have we ever done this before?” The teacher replied, “Yes, we have done this before” and explained that it was a long time ago and they designed this workshop to “refresh you on this part and then we’ll get into the other ellipses later” [9:45]. Although this content was relevant for students to learn in terms of the project, the relevance was only captured minimally in the video segment.

| Rating | Indicator |
|---|---|
| 3 | **4.7 Content Interconnections:** Appropriate connections were made to other areas of mathematics or science and/or to other disciplines (including non-school contexts).<br><br>Description, Rubric, and Examples |

***Evidence***

As stated in the evidence for Indicator 4.6 above, the lesson was situated within a larger project in which students would need to define the circle equations for the inner and outer dimensions of the habitable zone of their solar system. The entire project — in fact the entire course curriculum — was based on integrating learning standards for High School Physics and Algebra II.

Although the connections between these two disciplines were not overtly discussed in this video segment, the instructors had prepared and students to continually refer to a project rubric checklist where the content topics, tasks, and activities for each subject — Physics and Algebra II — were explicitly described. I

n addition to the content connections between Physics and Algebra II, a group of students demonstrated how they used and seemed to make connections to previously learned Biology concepts while debating among group mates about how to describe the conditions necessary to support life on earth [30:13–31:54].

Although the teacher may not have engaged in an extended discussion relating the all the possible connections between these subjects in this video segment, there were multiple instances where the students discussed components of the project that integrated mathematics and science content and concepts appropriately.

| Rating | Indicator |
|---|---|
| **1** | **4.8 Content Societal Impact:** During the lesson, there was discussion about the content topic's role in history or current events.<br>Description, Rubric, and Examples |

***Evidence***

The role of circle equations in history or current events was not brought up in this lesson. In addition, there was no reference to the overarching importance or societal impact of the project's goals in the Project Rubric checklist tasks or activities.

**Synthesis Rating for Mathematics/Science Content**

| **Students learning *inaccurate* content knowledge** | **Students learning *superficial* content knowledge** | **Students learning *adequate* content knowledge** | **Students learning *good* content knowledge** | **Students learning *deep, fluid* content knowledge** |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

## IV. SUMMARY COMMENTS

Information included in the "Summary Comments" section of the UTOP provides readers with a snapshot of the observer's evaluation of the quality of the lesson. When filling in this section, the observer should consider all available information concerning the lesson and its context and purpose, as well as his or her own judgment of the relative importance of the ratings given. The summary is intended to be freeform and can also include comments that did not fit into any of the preceding sections.

## FIELD NOTES

Use this space to take field notes, capture comments from student–student or student–teacher conversations, describe the physical, socio-emotional, or cultural environment of the classroom interactions, and so on. Field notes can be edited and inserted into the Evidence boxes under each indicator to illustrate your rationale for assigning a particular score for that indicator.

**Be sure to REMOVE all notes prior to sharing with anyone!**