The UTeach Observation Protocol (UTOP) for Mathematics and Science Training Guide and User Manual

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Overview of the UTOP

The UTeach Observation Protocol (UTOP) is an observational instrument that can be used to assess the overall quality of classroom instruction in math and science from kindergarten to the undergraduate level.[1] The UTOP was designed to allow individuals to evaluate teaching effectiveness while valuing different modes of instruction. We have specifically considered instruction in a spectrum from inquiry-based instruction to direct instruction.

The UTOP was created and piloted by faculty, master teachers, and research assistants in the UTeach College of Natural Sciences program at the University of Texas Austin.[2]

The development of UTOP was informed by the following resources:

- National Council for the Teaching of Mathematics: *Principles and Standards for School Mathematics*
- National Academy of Science: *National Science Education Standards*
- American Association for the Advancement of Science: *Project 2061, Benchmarks for Scientific Literacy*
- National Research Council: *How People Learn: Brain, Mind, Experience, and School* and *Knowing What Students Know*
- Arizona Collaborative for Excellence in the Preparation of Teachers: *Reformed Teaching Observation Protocol*

[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.

[2] Those involved in creating and piloting the UTOP include Mary Walker, Gail Dickinson, Mark Daniels, Denise Ekberg, Kelli Allen, Larry Abraham, Michael Marder, Candace Walkington, Prerna Arora, Jessica Gordon, and Shasta Ihorn. Audrey De Zeeuw and Paige Bauerkemper have assisted in further revisions.

- Horizon Research's *Inside the Classroom* Observation Protocol and study

Further revisions of the UTOP have been informed by the following:

- *Common Core State Standards for Mathematics* (2012)
- *Framework for K–12 Science Education* (2011)
- *Next Generation Science Standards Framework* (2012)
- Feedback from UTOP workshop training participants (July 2012–May 2013)

The UTOP is a criterion-referenced instrument, requiring training and recalibration to maintain the integrity and fair use of the instrument. This training guide is intended to provide resources to instruct, develop, and sustain inter-rater reliability. Interactive discussion of terminology used to define and describe each indicator is essential for groups of observers in order to ensure consensus and consistency in the rating process. As much as is humanly possible, raters' personal opinions and/or directive judgments and suggestions for improvements should not play a role in their choice of ratings; evidence for ratings must be based on what was observed or discussed in the classroom. The UTOP can be used to evaluate quality of instruction and provide meaningful feedback for improvement at any level of education, in a variety of settings. It is composed of 26 items rated on a 5-point Likert scale (1 to 5), with an NA (Not Applicable) rating option for a few items where sufficient information may not be accessible during the observation session.

As stated, the UTOP is intended for use by raters trained in its application. This training guide provides future raters with specific information relating to the various elements of the UTOP. Particularly, this guide aims to clarify the rating standards for each indicator in order to improve the accuracy and reliability of raters' ratings.

In addition, the UTOP is an instrument that is designed for use over multiple observations of a teacher's practices over the course of time—several weeks, at minimum—thereby reducing the impact of a low score on any other single indicator.

Procedures for Using the UTOP to Rate Lessons

I. Background Information

As the UTOP may be used by observers who, for research purposes, wish to remain "blind" to the educational experiences of the teacher being observed, the "Background Information" section of the UTOP does not ask for this kind of information about the teacher. Instead, this information will be collected through the use of the "Demographic Questionnaire," discussed in Section VI.

Teacher is the name of the teacher being observed.

School is observation site.

Date of observation refers to the date of the lesson observed.

Start and end time of observation refers to the time that the observed lesson began and ended.

Date of post-interview refers to the date that the post-observation teacher interview/survey was completed.

Subject observed should be the actual name of the course being taught during the observed lesson—for example, Biology, Algebra II, Physics.

Grade level is the actual grade level of the students in the class. For example, Algebra I is often taught to 9th-grade students. If the observed class is a 9th-grade Algebra I class, then record "9th grade" for grade level. Some courses target multiple grade levels. For example, Environmental Science may be 11th- and 12th-grade students. If this is the case, record all the grade levels present in the class to the best of your ability. This information is also collected in the teacher interview.

Course level is a place to note whether the course is advanced, gifted, AP, special education, or regular education. This information is also collected in the teacher interview.

Observer is the person conducting the observation and filling out this form.

II. Lesson Overview

Lesson Description

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.

Purposes of Lesson

a. Indicate the *major content area(s)* of the lesson or activity. This section aims to identify the main concepts within the subject that are addressed by the lesson. For example, a biology lesson on photosynthesis might be listed under "Life Science" with the key words "photosynthesis" and "plant structures." A mathematics lesson that uses results from a photosynthesis experiment to explore range, mean, median, and mode would be listed under mathematics because the intent is to teach about range, mean, median, and mode, not to teach photosynthesis. If cross-disciplinary content is the focus of the lesson, be sure to indicate all subject areas with specific descriptions.

b. Indicate no more than **five** observed *primary* purposes of the lesson or activity based on what was observed during the class period. Indicate no more than **five** intended *primary purposes* of the lesson or activity based on data collected in the post-observation teacher interview / survey.

Evidence of Lesson Preparation

When observers visit the classroom, they may be provided with or ask to be provided with copies of the teacher's lesson plan and other planning materials, including handouts, worksheets, formal assessments, etc. This section describes the teacher's preparation for the

lesson by detailing what documents are collected, without making the assumption that all lessons require the same amount of formally written materials. Additional information for this part of the UTOP may be obtained from reviewing the post-observation teacher interview/survey data.

Teaching Methods/Learning Activities

The important focus of this section is what the *students* are doing for significant periods of time in the lesson. For instance, if the lesson comprised a teacher lecture and individual work on practice problems, then the observer would check WG on "Teacher lecture > content development," and IND on "Reading/reflection/written communication about mathematics/science > Answered textbook/worksheet questions."

III. Rating Scales

Description of UTOP Sections

The UTOP is divided into four rating sections: Classroom Environment, Lesson Structure, Implementation, and Mathematics/Science Content.

The ***Classroom Environment*** section ***assesses the degree to which the classroom environment is conducive to the learning*** of mathematics and/or science, and how the teacher facilitates and creates this setting. This includes pre-existing structures (like classroom management routines and room setup) that the teacher has in place relating to management of the environment.

The ***Lesson Structure*** section assesses how well the teacher ***plans for and organizes*** the lesson, such as the sequence of learning activities during the class period, and the degree to which this organization facilitates the learning of mathematics and/or science. The focus in this section is on the potential for student engagement and learning as designed and set up by the teacher through the instructional strategies and activities the teacher chooses to employ—*not* the actual implementation of those strategies and activities.

The ***Implementation*** section assesses the instructional decisions, strategies, and practices the teacher ***actually employs*** during the lesson, how well the lesson activities flow, and whether the teacher ensures that all students remain engaged in and interact with the content and concepts that are the focus of the lesson. This section also assesses how critical and reflective the teacher is about his or her instruction ***after*** the lesson has concluded, through analysis of data collected by teacher interview/survey.

The ***Mathematics/Science Content*** section assesses the ***quality of the mathematics and/or science content*** being delivered by the teacher and constructed by students during the class period. Although there are indicators within this section that measure the teacher's content knowledge, the more important focus of this section is meant to address the quality of the content students are exposed to and grappling with during class. Content to be learned by the students includes that which is directly communicated by the teacher and developed through other means like lab activities, discussion, and independent practice. It is important to note that the synthesis rating descriptors (e.g., superficial content knowledge) are not meant to

assess the teacher's content knowledge but instead focus on the overall quality of the content students are learning during the class period.

Rating Lessons on the UTOP

To use the UTOP as intended, scores should be assigned only ***after*** the observation has taken place, and the rater has had an opportunity to review the video or field notes as needed to provide evidence for each rating assigned. The UTOP is rated on a 1 to 5 Likert scale, with an NA (Not Applicable) option for six items. Not Applicable (NA) is an appropriate rating score *only* for the five indicators that specifically mention an NA option:

> **1.2 Classroom Interactions:** Interactions reflected collegial working relationships among students.
>
> **2.6 Lesson Reflection:** The teacher was critical and reflective about his/her practice after the lesson, recognizing the strengths and weaknesses of their instruction.
>
> **3.6 Implementation Safety:** The teacher's instructional strategies included safe, environmentally appropriate, and ethical implementation of laboratory procedures and/or classroom activities.
>
> **4.4 Content Assessments:** Formal assessments used by teacher (if available) were consistent with content objectives (homework, lab sheets, tests, quizzes, etc.).
>
> **4.5 Content Abstraction:** Elements of mathematical/scientific abstraction were used appropriately.

All other indicators must be assigned 1 to 5 ratings, even if the rater feels the indicator is not applicable to the observed lesson. Rating boxes should not be left blank.

In general, the numerical values for the Likert scale on the UTOP can be interpreted as follows:

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

Each numerical value on the rating scale corresponds to two descriptors, one descriptor that measures the **frequency** of the occurrence of the indicator (observed rarely, observed often, etc.), and one descriptor that is intended to capture the **quality** of the implementation of that indicator (demonstrated poorly, demonstrated well, etc.).

For some indicators, only **one** of the descriptors may be appropriate. For instance, indicator 2.1 reads, "The lesson was well organized and structured." A measure of the frequency of the occurrence of this indicator would be inappropriate. In this case, the rater would need to refer only to the second set of descriptors that measure the quality of the lesson structure as described by the indicator.

For other indicators, descriptors of **both** frequency and quality may be appropriate. For instance, indicator 4.7 reads, "Appropriate connections were made to other areas of mathematics or science and/or to other disciplines (including non-school contexts)." When scoring this indicator, the rater should take into account the quality as well as the frequency of the connections the teacher is making.

With respect to scoring teachers on the **frequency** with which they implement indicators, it is important for the rater to remember that some lessons will include more opportunities to exhibit certain characteristics than others. How often the teacher demonstrates the characteristics of any indicator should be considered relative to the number of opportunities available.

Synthesis Ratings

Each of the four scored sections of the UTOP concludes with a ***Synthesis Rating*** that is intended to be an overall rating for each area. The synthesis rating boxes contain scores from 1 to 5 with corresponding descriptors.

The synthesis ratings are **not intended to be a mathematical average of the indicator scores** making up each section, but are designed to allow the rater to describe his or her overall impression, using a holistic view of the domain and providing a "human average" of the entire lesson. Evidence to support the score chosen can be typed in the open space after the Synthesis Ratings boxes.

Supporting Evidence

Immediately after each indicator in the UTOP, space is provided for raters to present ***specific supporting evidence*** for their scores. This is done so that raters and other researchers can understand why a specific score was given long after the observation has taken place, and so that raters can achieve inter-rater reliability by comparing and discussing the supporting evidence they used to obtain different numeric scores. Supporting evidence needs to be entered in for each indicator rating with no exceptions. Supporting evidence does not need to be entered for a synthesis rating but is recommended, particularly if the data is to be shared with the observed as feedback for professional development and improvement of practice.

In the next section, general descriptions for each possible rating are given for each indicator in order to promote consistency in the scoring across raters. Please carefully review the descriptions for each item prior to completing a UTOP observation.

Also provided in the next section are examples from specific lessons of each possible rating of each indicator. These examples show the types of supporting evidence that are typically cited for each level, as well as the typical format and level of detail of supporting evidence. Supporting evidence should be specific, factual (i.e., no personal opinions), and evidence-based, and can range between 2 and 6 sentences.

Indicators, Rubrics, and Examples

Classroom Environment—Section 1

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.

This indicator captures how well the classroom environment established by the teacher supports students in exploration of mathematical or scientific ideas and deep engagement in mathematical or scientific thinking. Such a classroom can be described as one in which students feel free to ask questions, engage in critical discussion, make predictions, suggest approaches to exploration or problem solving, and challenge statements of the teacher and other students in order to propose alternate methods or deepen understanding of fundamental concepts. It is also one in which the teacher devotes a sufficient amount of time to addressing students' questions, comments, misconceptions, and nascent ideas related to the subject matter.

In other words, there is a culture of learning. A classroom rated highly on this indicator creates multiple opportunities and provides rich evidence for student–student discussion and argumentation, with students encouraged to reflect on their own learning.

To rate this indicator, make note of instances during the lesson where you observe students generating ideas, questions, conjectures, or propositions. Keep in mind that giving a simple response to a direct teacher question is not really "generating an idea," and that asking a simple clarification question does not reflect deep student engagement with the mathematics and/or scientific content and concepts.

General Rubric

1. This item should be rated a 1 if there were no examples of students attempting to or being encouraged by the teacher to generate their own ideas, questions, conjectures, or propositions, and no significant intellectual engagement was observed.
2. This item should be rated a 2 if there were only occasional examples of students generating nascent ideas and questions, these contributions were of low quality, and the teacher did not respond in a manner to draw out the students' thinking.
3. This item should be rated a 3 if there were several examples of students generating nascent ideas, conjectures, and questions of medium quality during the lesson, and the teacher was making moves to encourage these contributions. However, the teacher missed several opportunities to elicit and elaborate on students' thinking in an open discussion.
4. This item should be rated a 4 if students generated ideas and questions of medium to high quality during the lesson and the teacher regularly made attempts to elicit further student thinking and encouraged other students to contribute. The students also offered some of their own conjectures or propositions, and these offerings demonstrated clear engagement with the content. Perhaps there was a missed opportunity by the teacher that could have facilitated deeper student learning.
5. This item should be rated a 5 if students were highly engaged in the content and consistently offered high-quality ideas, questions, propositions, and conjectures. The teacher facilitated these contributions throughout the majority of the class period, allowing for deep and meaningful student learning opportunities.

Specific Examples of Supporting Evidence

1. There were no ideas, conjectures, or propositions generated by students during this class. Only one student asked a question. The teacher worked at the board, moving from one step of the problem she posed to the next, only stopping to get the student input as necessary to ensure that the students were awake. The teacher showed students how to do each step of each problem or talked them through each part of the lab activity from beginning to end, not asking for students to predict what might happen before doing the activity or propose their own approach to solving the problems. The teacher did not elicit students' thoughts or strategies.
2. There was some evidence of students generating ideas, questions, or conjectures during the whole-class portions of the lesson. The students did seem to be talking about their assignment during the group work portion of the lesson, but the ideas generated were related to collecting data or the procedures for manipulating the variables in the equations or which step in the lab procedure was next, since the mathematics content and/or science activity was straightforward. Occasionally groups would call on the teacher when they had a question about whether they were "doing this right," and the teacher would respond with a simple "yes" or "no."
3. The students in this class seemed to be comfortable proposing and sharing their strategies and ideas for solving problems and were not afraid to make mistakes in front of the teacher or their classmates. There were some instances of students generating interesting questions and proposing original ideas about their work, and, although the teacher seemed to welcome these comments, she did not probe their ideas to encourage higher-level reasoning or get them to elaborate on their propositions/conjectures. One student discovered an important mathematical pattern, but he generated this conjecture on his own and was not prompted to share his idea with the whole class.
4. There was frequent evidence of the students explaining their reasoning to each other or the whole class and the teacher asking for multiple approaches and strategies. The teacher also asked for conjectures relating to how the mathematics and/or science content related to the world and human activity. At one point in the class, students questioned the teacher and challenged the strategies she was using to solve problems because they held some misconceptions about the underlying mathematics and science content. The teacher chose not to open this misconception for student discussion but instead carefully showed the students where they had "gone wrong" in their solution strategy. Overall, there was a congenial atmosphere for conjectures, questions, and ideas on how to solve mathematics problems or conduct scientific experiments, and many students were engaged.
5. The students in this classroom were constantly generating high-quality ideas, conjectures, and propositions. They frequently and persistently asked each other questions about solutions strategies and provided thoughtful comments to each other's propositions. They also backed up their own propositions using evidence and analysis of data, presenting graphs and charts or citing and sharing valid resources found on the Internet. Because the conversation was so free and rich, the teacher noted a recurring misunderstanding revealed in the student talk and, at that point, she stopped the class and used probing questions to facilitate an open discussion that unpacked the underlying misconception for the whole class or the small group.

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).

This indicator assesses the degree to which students have learned to be collegial, respectful, cooperative, and interactive when working in groups. In other words, this indicator captures how well the teacher has worked with the students on developing group-work ethics and skills that create and promote an environment of active collaboration. Evidence of collegial, productive working relationships among students includes collaborative discussions about topics relevant to the lesson and successful delegation of roles and responsibilities within each group. It's also evidenced by whether all group members are participating and contributing, reflecting on their learning, and staying focused on the given task.

This indicator can be rated as Not Applicable (NA) if the lesson did not include group work and the rater has no opportunity to observe student interactions. Sometimes a lesson includes group work but the duration is extremely short; **the benchmark used here is that if there were student–student interactions lasting greater than 3 minutes total over the entire lesson, this indicator must be rated**. This indicator must also be rated even if the teacher did not specifically tell students to work in groups. It should also be rated if the teacher told students to work in groups, but they did not follow his directions (which would earn a rating of "1").

General Rubric

1. This item should be rated a 1 if there was group work assigned during the lesson, but the group work was highly unproductive. This could include behavior where the majority of the groups were socializing, off task, arguing, or ignoring each other, as well as regular instances of students copying off their group members' papers and/or certain group members doing all of the work.
2. This indicator should be rated a 2 if there was group work during the lesson, but some groups were unproductive, engaging in the off-task behaviors listed under the 1 rating. There could be occasional examples of productive group work for some groups but this was not consistent throughout the time allotted.
3. This indicator should be rated a 3 if there was group work during the lesson, and the groups were adequately productive throughout the group work time. There may be some examples of off-task conversation and group members not contributing.
4. This indicator should be rated a 4 if there was group work during the lesson and most of the groups worked together productively throughout this portion of the lesson. The groups were observed to discuss ideas and ask each other questions before seeking out the teacher, and the members themselves encouraged participation of all group members. There may still be an example of an unproductive group in the classroom, but the majority of students were working well together.
5. This indicator should be rated a 5 if there was group work during the lesson, and all groups worked together productively and were meaningfully engaged in the content and concepts of the lesson. All group members clearly understood and accepted their roles and were able to actively participate; groups discussed and explored ideas together, coming to a common understanding of the content and concepts.

Specific Examples of Supporting Evidence

1. The teacher told the students who understood the lesson to help the other members of their group complete the worksheet of assigned problems. However, no one in the groups did

this, and several groups were observed to be explicitly copying off of each other's papers. In other cases, the student group members chose not to collaborate at all, silently completing the worksheet individually. In another instance, several groups simply socialized without attempting to complete any of the assignment.

2. Although there were occasional examples of a few student groups working together well, other groups simply socialized. In one situation, the teacher stated that he did not believe a particular group was working together effectively and announced to the whole class that he would have to separate them, which caused some objections from the members of the group. These group members sat apart and were unproductive for the remainder of the class.
3. The students were assigned debate groups and tasked with planning for one group to debate another group with the class as an audience the following day. The groups worked together productively for most of the time, choosing who was responsible for what part of the debate, coordinating their arguments to some degree, and splitting up the time slots as necessary. Although most students worked quietly on their portion of the task, there were several ongoing instances of off-task socializing throughout the period.
4. The majority of students were successfully working in groups to prepare for and carry out a debate as assigned. In one group, two members sat back and simply watched their colleagues working together on developing their group's position paper and presentation. In all other groups, however, students were engaged discussing the content and asking each other questions to clarify their positions. All groups made sufficient progress, but the two non-participants never did engage.
5. Students talked eagerly about their team's debate position, shared resources located in the literature they had researched, and collegially helped each other prepare for each portion of the debate presentation by explaining and discussing how to present their key points. Several groups decided to carry out impromptu mock debate practice sessions and members of the group were observed sharing notes during the counterpoint section, providing evidence for argumentation to each other to enhance their position. Students assigned clearly defined group roles to each member, and each member accepted responsibility for their role. The students were aware that they would collectively assign each member a collaboration grade for their work, and they took this seriously. There were no instances of off-task behavior.

1.3 Classroom On-Task: The majority of students were on task throughout the class.

This indicator measures the proportion of time students in the class remained engaged in the day's learning activities. On-task behavior can include students participating in the lesson by asking questions and paying attention during a lecture, participating in class or small group discussions, providing answers to teacher questions, turning in assigned class work in a timely manner, and assisting other students. Raters should note any examples of off-task behavior, such as students being engaged in off-topic conversations, writing notes/text messages, putting their heads on the table, or doing work for another class. The usual benchmark used for this indicator is that if 75% of students appeared to be on task for most of the class period, the indicator should be rated as a 3. Higher or lower overall engagement would elicit numerical ratings as described in the General Rubric.

General Rubric

1. This item should be rated a 1 if less than half (0–49%) of students were on task, on average, throughout the class period. Please weight appropriately if many students were on

task for one portion of the lesson while few were on task for another portion, to obtain an overall estimate of the percentage. For this rating, there must be consistent off-task behavior that affects the majority of the class.

2. This item should be rated a 2 if at least half but less than three-quarters (50–74%) of students were on task, on average, throughout the class period. There were regular instances of off-task behavior that lasted for several minutes in this classroom.
3. This item should be rated a 3 if around three-quarters (75%) of students were on task, on average, throughout the class period. There were some instances off-task behavior that lasted for no more than a few minutes in this classroom.
4. This item should be rated a 4 if more than three-quarters (75–90%) of the students were on task, on average, throughout the class period. There were only occasional instances of off-task behavior in the classroom, and/or there were only a few students who were not fully participating in the lesson on occasion.
5. This item should be rated a 5 if most or all (90–100%) of the students were on task and engaged throughout the lesson. There were rare or no instances of off-task behavior in this classroom.

Specific Examples of Supporting Evidence

1. The majority of the students (more than 75%) were not on task throughout the class. Many students were being disruptive, fighting, yelling things across the room, moving around the room to socialize, having off-topic conversations, and sleeping or listening to music at their desks. There was one point when only three students were writing their answers on the worksheet while all of the other students were off task. Students in one corner of the room were making phone calls throughout the class period.
2. There were a number of instances of off-task behavior in this classroom. Many students (more than 50%) did not seem to be attempting the warm up at first, but as the class session progressed, the number of students on task increased to approximately 70% for several minutes. However, students were repeatedly observed stopping productive work to socialize with each other. One student was observed searching inappropriate and unrelated websites on a computer throughout the entire class period.
3. There was no significant evidence of off-task behavior, as most students (75% or more) were working productively most of the time during this lesson. The observer did note one student with her headphones on, listening to music while working independently at her desk. Not all students were observed to be copying down the teacher's explanation of the homework problems, but this could have been because they already understood the problems.
4. The majority of the students (75–90%) were observed taking down the notes the teacher was giving, and when the class was given the opportunity to work problems at their desks, most students actively engaged in the assignment and made legitimate attempts to work the problems. The observer did not find evidence for any major off-task behavior or students refusing to participate during this activity.
5. There was not any off-task behavior observed during this class. When students were presenting their lab results and analyses of their data, their classmates were attentive and considerate, asking focused questions for clarification that showed they were paying attention. One group continued to work on their own data analysis (drawing graphs of their results) during one of the presentations, but they did this in a non-disruptive way that demonstrated their concern for finishing their assignment more than off-task behavior. All

students were engaged in and thinking about the concepts and content for the length of the lesson.

1.4 Classroom Management: The teacher's classroom management strategies enhanced the classroom environment.

This indicator assesses the quality of the teacher's classroom management, in particular whether the teacher's management positively contributed to the students' learning in the classroom environment. Teacher behaviors that should be noted include setting clear behavioral expectations for students and making sure these expectations are met, foreseeing and preparing for inappropriate behavior that may occur during the course of the lesson, consistently and effectively dealing with off-task and inappropriate behavior, adopting successful time management strategies, and utilizing positive behavioral modification strategies when appropriate. Classroom management also includes teacher's selection of student group members and student seating to minimize distraction, how the teacher allowed students to move about the room during the lesson without affecting other students' ability to learn, and how the teacher called on students to speak or present their ideas in a whole-class setting.

Special notes for video analysis with the UTOP

As it can be difficult to see whether students are off task and need management on a video feed, when rating this indicator take into account the students you are able to see and hear. Keep in mind that when the teacher audio feed is all you can hear, relying on teacher verbal reprimands of student behavior may not be helpful when rating this indicator—some teachers will reprimand students constantly, even if their off-task behavior is minor, while other teachers will allow major off-task behaviors to go unacknowledged.

General Rubric

1. This item should be rated a 1 if the classroom was very poorly managed, the students did not listen to the teacher, and/or the teacher made little or no attempt to manage their behavior. The lack of classroom management significantly disrupted all aspects of the class session, making it difficult for students to learn.
2. This item should be rated a 2 if the classroom was not well managed but was still functional—students were not overtly disruptive or creating distractions for others even though the teacher was not clearly "in charge." The lack of clear direction or classroom management occasionally disrupted the lesson, sometimes making it difficult for students to learn.
3. This item should be rated a 3 if the classroom was managed adequately; there were some disruptions that the teacher may or may not have dealt with appropriately, but overall learning by the majority of students was not negatively affected by management issues. The teacher may have made some management moves to enhance the classroom environment so that all students were able to engage and learn, but the impact was only minimally beneficial.
4. This item should be rated a 4 if the classroom was well managed—the teacher's management actions were clear, enhancing the classroom environment, and positively affecting students' opportunity to learn. There may have been minor or very occasional disruptive behavior that the teacher did not handle appropriately, but it did not negatively affect the whole class.

5. This item should be rated a 5 if the classroom was managed excellently and ran smoothly—the teacher's management actions and routines significantly enhanced students' learning of the content. Classroom expectations, instructions, and routines were clear to all students at all times.

Specific Examples of Supporting Evidence

1. The teacher shouted instructions for the lesson and reprimands for off-task behavior continually while the students kept talking, essentially ignoring her requests for attention and engagement. There were numerous instances of off-task behavior and socializing during this lesson that the teacher did not or was unable to manage. The teacher remained at the front of the classroom behind the demonstration desk, did not circulate while students were working, and did not attempt to address the disruptive and distracted behaviors observed throughout.
2. The teacher allowed the students to engage in whatever activity or behaviors they chose, without direction or correction to facilitate and enhance the classroom environment. Although there were no major disruptive behaviors observed, there was also no successful productive collaboration between students focused on the assigned activity, and many students were not on task or participating. There were a few notable and inappropriate exchanges that distracted students or demonstrated disrespect for the classroom culture.
3. At the beginning of the activity, the teacher explicitly discussed and/or reminded students of the classroom behavior expectations. The teacher sometimes referred back to these expectations when some students got loud or disruptive during the class period, and this seemed to work adequately as a management tool for redirection for most of the groups (75%). However, there was some off-task behavior that the teacher did not manage, such as some groups socializing and taking a long time to get started working. Some of the students in these off-task groups missed opportunities to learn and became disengaged or only re-engaged when the teacher stood over their group.
4. The teacher managed the class by having students work in small groups and moved frequently so she could interact with each group individually. The teacher gave the students a clear overview of what was expected of them—both orally and by referring to the set of "classroom culture" rules and expectations posted on the wall. The teacher assigned each group member a role that they were responsible for and made clear the expectation that they would work collaboratively. There were no major behavior problems or disruptions, but there was very occasional and minor off-task behavior. In one instance, the teacher informed members of a group that it was important that they be respectful and allow each group member to actively contribute, but occasionally some more assertive group members took over, leaving other group members marginalized. In this particular instance, the teacher was unaware of the situation and unable to redirect the group dynamic.
5. Having established a culture of respect and making classroom expectations clear to students, the teacher dealt quickly and effectively with behavior problems (and potential behavior problems). The teacher's strategies were accepted and well practiced, as evidenced by student responses to her management of their behavior and student requests. In whole-group discussions or when other student groups were presenting their ideas, the teacher made it clear to students that they needed to raise their hands to give an answer or ask a question and that talking over each other was not polite. The teacher moved fluidly around the classroom for the entire period, monitoring the behavior of her students. At the end of the class period, the teacher gave students clear and detailed expectations for how

they would conclude the class. The teacher managed the groups' behaviors continually by encouraging each member of the group to work respectfully and collaboratively to accomplish their work.

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.

This indicator assesses how well the setup of the classroom promoted the intended goals of the lesson and enhanced the classroom environment. Both the organization of student seating as well as the availability of necessary materials should be considered. This indicator can be evidenced by examining the accessibility of materials needed for the lesson activities, such as computer technology, calculators, books, laboratory and safety equipment, worksheets, etc. This indicator also considers accessibility—students' ability to hear and see whatever was written on the board or presented on a projection screen, etc. The rater should also consider the ease with which the teacher was able to access each student and how well the students' physical locations allowed them to participate fully in lesson (whether it was in a small classroom or large lecture hall). The indicator can be used to assess whether the teacher devoted an appropriate amount of preparation time to setting up materials, and how well the physical setup facilitated student collaboration when appropriate. We recognize that the setup of the classroom may not always be under the teacher's control; however, raters should rate the classroom setup without concern for this degree of control, as student access to these classroom materials and structures can have a significant impact on student learning.

General Rubric

1. This item should be rated with a 1 if there were one or more major classroom setup or organizational issues that significantly disrupted the ability of students to focus on and learn the content of the lesson. This may be something that was not under the teacher's control but still should be recorded with this instrument.
2. This item should be rated with a 2 if there were several minor classroom setup or organization issues that caused a few small disruptions to the lesson, and some students' ability to fully participate was affected negatively.
3. This item should be rated a 3 if there were no classroom setup or organizational issues that disrupted or distracted the majority (50–75%) of students from participating in the activities of the lesson—the classroom was appropriately arranged for the lesson.
4. This item should be rated a 4 if the classroom was well-organized and the teacher's actions relating to the setup of the classroom enhanced most (75–90%) students' interaction with materials or each other as required for the activity. There may be a small missed opportunity where a few students were affected in their ability to participate for a short period of time.
5. This item should be rated a 5 if the organization of the classroom was excellent and the setup for the lesson clearly and positively enhanced each student's learning and created opportunity for engagement and full participation. There was specific evidence that the teacher made moves to ensure this, and there were no instances of students' being affected negatively by the setup of the classroom.

Specific Examples of Supporting Evidence

1. The teacher did not appear to have organized the classroom at all—as the students entered the classroom, they moved their desks away from the front, and half of the class even had

their backs to the board where the teacher was showing the students how to solve a math problem. The teacher was unable to circulate due to the haphazard placement of desks and a collection of boxes and shelves that blocked portions of the classroom so that he had difficulty monitoring student work.

2. Although the teacher asked the students to work in groups of three, the desks were not positioned to facilitate such collaboration—the students in a group in the back of the classroom were seated around a large table, and the demonstration bench that was in the front of the classroom prevented some groups of students from moving their desks into groups of three, so many chose to work in pairs. The students at the large table had to talk loudly to be heard and had difficulty communicating with each other during the day's group activity as a result.
3. There were several small, movable tables that could seat pairs of students who were spread out across the classroom. These tables could be regrouped to allow for groups of four, although some students (about 25% at any one time) would have to turn around in their chairs to see the computer projection screen and lab demonstration desk. Overall, the students were able to collaborate with their group and access materials successfully.
4. The classroom setup worked well for this lesson—the students were seated in groups of four spread out around the room, and all could view the center of the room and watch the teacher to show her visual aids. However, one of the visual aids was very small, which made it difficult for a few students (about 15%) to follow what she was doing for a small portion of the lesson. The teacher was able to circulate during the group work portion of the lesson successfully.
5. The students were seated with their assigned groups, which were tables that were spread across the room. The room was very large and open, and the teachers could move around and talk with each member of the groups frequently. The lesson required that different groups conduct different activities across the classroom at the same time. Each group could access computers as needed and had excellent workspace for active collaboration. When a lab activity was conducted, all students had access to a well-stocked supply table including appropriate safety equipment.

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).

This indicator assesses the degree to which the classroom environment was unbiased related to race, ethnicity, religion, gender, sexual orientation, physical abilities, English language learners, and students with learning differences, etc. Evidence of this indicator can be obtained by reviewing the wording and formatting of classroom handouts and/or presentation methods for the whole class as well as small groups, and/or by analyzing strategies and opportunities created to ensure participation by all students, and/or by the teacher's handling of unacceptable comments made by students. Additional evidence of this indicator can be gained by analyzing the degree to which the teacher took the diversity and individual needs of his or her students into account when planning and teaching the lesson and how the teacher facilitated a respectful and open classroom environment and culture of learning where all students were comfortable sharing their ideas. This indicator is also evidenced by the way the teacher dealt with students who struggled with mathematics or science content and concepts, including how the teacher scaffolded and supported their learning, and how the teacher worked to include all students and their divergent ways of thinking in class discussions and activities.

General Rubric

1. This item should be rated a 1 if the rater noted a major issue relating to equity, access, or diversity that significantly negatively impacted the classroom environment and all students' opportunities to learn.
2. This item should be rated a 2 if the rater noted one or two minor issues relating to equity, access, and diversity that may have had a small negative impact on students' opportunities to learn. The teacher may have attempted some positive modifications to take into account issues of equity, access, and diversity, but ultimately these modifications were not successful.
3. This item should be rated a 3 if there were no major issues and no explicit moves made by the teacher relating to equity, access, and diversity, and the classroom environment was not positively or negatively impacted. This item also may be rated a 3 if there was no clear need for or evidence regarding issues of equity, access, and diversity in the classroom observed during the lesson.
4. This item should be rated a 4 if there was no evidence of actions the teacher took relating to equity, access, and diversity that negatively impacted the classroom environment, and, overall, the teacher's actions relating to this indicator had a positive impact on the classroom environment. There may have been a small missed opportunity to provide equitable access to the content or recognize and adapt for a students' individual needs.
5. This item should be rated as a 5 if there is evidence that the teacher explicitly took into account issues of equity, access, and diversity in the classroom throughout the lesson so that all students were equitably engaged, had easy access to lesson content and materials, and were treated with respect by all throughout the class session. In other words, the classroom environment clearly reflected thorough attention to equity, access, and diversity of all students.

Specific Examples of Supporting Evidence

1. The teacher was openly disrespectful to students who did not readily respond to his questions with the "correct" answer, resulting in an environment where there was very little participation or risk-taking. The teacher concentrated his attention on many negative interactions with the male students who were not working as directed, while ignoring the girls in his class who were attempting to solve the problems and repeatedly raised their hands for help.
2. In a class that included several English language learners, the teacher separated these students into groups by themselves though the rest of the class had many other students who could serve as English language resources for the non-native speakers. The teacher worked diligently with the ELL group but, because his ability to communicate was limited, these students had a difficult time completing the worksheet. Meanwhile, the English speakers worked semi-productively in their own groups, not able to get the teachers' attention when they were stuck. Some of the English-speaking student groups were able to solve some problems and helped each other, but the level of success throughout the class session was low.
3. Students were arranged in cooperative learning groups, but the assignment required each individual to complete the same activity and no roles for each group member's accountability were in evidence. Nonetheless, most students appeared able to complete the work with little assistance from each other or the teacher. The classroom environment was

open and relaxed, and students appeared comfortable expressing themselves and their ideas to each other without teacher facilitation or direction to do so.

4. The teacher relied heavily on cooperative learning and student-to-student coaching of the English language learners by bilingual students in this mixed-ability classroom. The teacher had created a word wall with translations of the day's new vocabulary words into Spanish. A variety of students at different levels and from different backgrounds were observed to participate in several aspects of the lesson, presenting problem solutions to the whole class or explaining their thinking and problem approaches in small groups. There was one pair of students, however, who were unable to engage in the final presentations due to their lack of communication skills, and they chose not to do so.
5. The students in this class were gifted, and the format of the class and the project they were working took into account issues of access for gifted students. The students had the resources needed and freedom to explore and grapple with challenging content, while still working collaboratively with other students. It also allowed all of the students to engage in the sophisticated practice of justifying ideas with evidence and data, and the teacher encouraged and facilitated student-to-student argumentation and debate about the results and conjectures presented.

Lesson Structure—Section 2

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).

This indicator describes how deeply the teacher thought about the structure of the lesson by considering what content and concepts the students needed to learn and what pedagogical approaches would be most appropriate. This indicator can be evidenced by whether the teacher anticipated students' questions or misconceptions, had methods prepared to address these issues, and reflected those methods in the lesson design. This indicator can also be demonstrated by examining the quality of the learning activities chosen by the teacher, including whether they promoted learning of content objectives, whether they took into account students' prior knowledge and ability to engage with both procedural and conceptual aspects of the lesson, and whether they were appropriate for the time constraints of the lesson. The rater should also assess whether the lesson had a clear sense of purpose and clearly stated objectives. Finally, the rater should take into account the sequence of the lesson as a whole, and whether it had appropriate and reasonable engagement, learning, and wrap up activities.

General Rubric

1. This item should be rated a 1 if the lesson was structured such that there was little or no productive, learning-focused interaction between teacher and students, and/or the content objectives of the lesson were unclear or inappropriate to the developmental level of the students, and/or the sequence of the lesson was disorganized, and/or there was a major problem with the organization or framing of the lesson that significantly and negatively impacted student learning during the majority (75–100%) of the class period.
2. This item should be rated a 2 if the lesson was only occasionally structured to engage students in learning-focused activities and/or the purpose/objectives were not communicated clearly, and/or there were some problems with the organization of the lesson that negatively impacted student learning during approximately 50% of the time allotted for the lesson.

3. This item should be rated a 3 if the lesson's structure and organization were adequate for the majority of time allotted (50–75%). The lesson may not have been structured perfectly, and there may have been a part of the lesson that was disorganized or confusing to the students, but the lesson sequence generally kept students engaged and moving from one portion to the next in a reasonable manner, and students generally seemed to understand the purpose of the lesson and what they were to do to accomplish this purpose.
4. This item should be rated a 4 if the lesson was well structured and well organized. A well-structured lesson would be a developmentally appropriate, well-designed sequence of learning activities that kept students engaged in the content and had a clear sense of purpose throughout the vast majority of the class time (75–90%). However, there may have been a minor missed opportunity or minor organizational issue present during the lesson that wasted student time for learning.
5. This item should be rated a 5 if the structure and organization of the lesson was excellent. The lesson was structured to take into account or build prior knowledge of the topic and was well paced with a thoughtfully chosen sequence of learning activities, and the teacher had anticipated the pedagogical approaches that would be most effective in engaging the students throughout the entire class period.

Specific Examples of Supporting Evidence

1. The teacher structured this lesson such that he worked problems out of the textbook on the overhead projector for entire class, students were expected to take notes silently, and then the class was assigned to work problems independently from the textbook as homework. The teacher did not have questions prepared to check for student understanding and did not plan for student involvement or input. There was no structured introduction or wrap up plan.
2. The teacher structured this class period as open or "free time," with students determining their own pace and what work they needed to do without any specific directions from the teacher. The teacher's structure did include an introduction where the expectations for what the students needed to include in their work samples were stated explicitly and the teacher occasionally reinforced these expectations during the class session and when he announced it was "time to hand in your work" at the end of class.
3. This lesson structure included a warm up, followed by time allotted for students to work in groups on an activity, and then a wrap up/review at the end of class. The progression from the warm up into the main activity was thoughtfully planned to review some basic concepts, followed by the lab activity that would take the application of this knowledge to the next level as an exploration. The wrap up was sequenced as an extension of the lesson activity but also to provide students with guidance to draw appropriate conclusions from their data analysis. The teacher's introduction to the lab activity portion of the lesson could have been better structured—the teacher's plans had him talking through the lab procedures at the front of the classroom while students listened and took notes. He did not prepare written directions with pictures modeling or demonstrating how to handle the equipment needed to conduct the experiment, and this led to some confusion for students when setting up the lab activity.
4. The teacher had the agenda on the overhead when the students arrived. The teacher began with a Know/Need to Know/Learn activity and explained the day's task. The lesson was well thought out, and the instructions and expected outcomes were clear. It was designed to be engaging to students and to allow them to grapple with the content. The teacher had prepared and gave the students a well-thought-out rubric describing each aspect of the

day's assignment and how their performance would be evaluated, but some definitions of quality were difficult for some students to grasp, and they spent a small amount of their work time arguing about these meanings in their groups. At the end of the lesson, the teacher brought the class back together, and they reflected on what they had learned during the lesson.

5. The lesson was structured to begin with a pre-assessment, where student teams were challenged to use claims, evidence, and reasoning to predict causes of pollution in a local river. This introductory segment was followed by an engaging video from a local news station that was stopped periodically by the teacher, who had prepared handouts with probing questions to further challenge students' predictions and assumptions. The students were told to take notes from the video, using the handout provided, that would develop their evidence or counterpoints to other students' claims about the causes of pollution. The teacher had also prepared additional questions to use during the video at key points when he stopped it to emphasize certain facts and opinions by the experts interviewed. The lesson structure then had the teacher leading the students into a rapid-fire debate round where teams continued to argue their positions. This structure worked well and kept the students engaged and on task. The students voted on which team won the debate as the wrap up to the lesson.

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).

This indicator measures the degree to which the lesson was structured to allow students to grapple with relevant mathematics or science concepts and become engaged in learning. This engagement may happen through discovery, exploration or laboratory activities, but this is not a necessary condition of the indicator. For example, a well-structured lecture can enhance students' abilities to engage with the content if it's communicated clearly, timely, connected to students' prior knowledge, experiences, and interests, and allows students to actively participate during the lesson. This type of lesson is contrasted with a structure that focuses only on techniques for exam preparation. A lesson rated highly on this indicator is structured to allow students to *understand* and *engage with* both underlying concepts and problem-solving procedures/processes rather than simply *perform* the procedures *without* exploring what concepts these procedures are built upon. In a lesson rated highly on this indicator, the lesson will be structured such that students will build meaning and have ownership of important mathematical or scientific ideas.

General Rubric

1. This item should be rated a 1 if the structure of the lesson did not allow students to either engage with or explore concepts in mathematics or science.
2. This item should be rated a 2 if the structure of the lesson occasionally or sporadically (only 20–30% of the time) allowed for student engagement in mathematics or science concepts.
3. This item should be rated a 3 if the structure of the lesson allowed students to engage with and/or explore the mathematics or science content, but these opportunities were only in place during the lesson approximately 50% of the time.
4. This item should be rated a 4 if the structure of the lesson allowed students to engage with and/or explore mathematics or science concepts for most of the class period (80–90% of

the time). There may have been a minor missed opportunity or small portion of the lesson that was not designed to be as engaging.

5. This item should be rated a 5 if during most (greater than 90%) of the class period, the structure of the lesson allowed students to engage with *and* explore important mathematics or science concepts. This was a continuous and explicit focus of the teacher's plan, and the structure and sequence were clearly designed to ensure that students remained engaged throughout the entire class period.

Specific Examples of Supporting Evidence

1. During the class period, the teacher's plan was to introduce the students to a simple mathematical procedure while they silently and independently took notes at their desks. The teacher modeled a number of instances of this procedure on the overhead projector while the students copied them down in their notes. The structure of the lesson did not provide for any mechanism for students to engage with or explore the content—the problems being worked were closed-ended, and the teacher's plan was to explicitly model every step. The only type of questions the teacher had prepared to ask the students was for the number that the teacher would write in the next step of the problem she solved for them on the overhead.
2. During the warm up portion of the lesson, the teacher's introductory lesson structure did not elicit elements of student engagement or exploration. During the group work portion of the lesson, the students were assigned a relatively engaging investigation, but the math concepts were secondary to the main objectives for the lesson; the focus and the majority of time spent was on procedures, "cookbook" lab processes, and collecting data. The lesson structure did not provide opportunities for students to become engaged with or even made aware of the mathematical ideas central to this lesson or the scientific concepts underpinning the phenomena they were to observe and explore.
3. The movie clips the teacher showed and the sound files the teacher played were clearly chosen and sequenced appropriately to allow students to engage with central concepts of the lesson. The design of the worksheet also allowed students to engage with and further explore the content using interesting, real-world pictures, scenarios, and phenomena they could recognize or had prior experience with. However, the lesson segments that reverted to student note-taking followed by teacher-centered demonstrations of procedures or manipulatives were a missed opportunity for students to engage with or explore the concepts on their own—they were non-interactive for approximately half of the class time.
4. The lesson design incorporated instructional strategies that included giving challenging problem-solving tasks to the students and having students solve them either as a whole class using multiple strategies or in small groups as the teacher circulated and provided feedback. At the end of the class, the students were able to further explore and explain their understanding of the content by creating their own problems for other students to solve. The sequence of the lesson used a real-world application launch activity that enhanced students' ability to engage in the content, although this was not brought up again in the lesson segments that followed throughout the lesson.
5. The instructional strategies included group and then whole-class discussions over a story/scenario about a student that was trying to solve a dilemma using mathematics—the small amount and poor quality of recreational space that schools in poor neighborhoods have compared to schools in rich neighborhoods. Students were engaged in the story and discussed how it related to their lives and experiences. The teacher's plan was to use these discussions to introduce a unit that would result in a group project—to develop a plan for a

space-efficient and high-quality playground for a school in their community. The project was clearly designed to create opportunity for students to explore multiple approaches by conducting research using books and computers and engaging in discussion with their peers and the teacher. Following this introductory segment, and in completing the project, students would be challenged to apply mathematics and science concepts in a manner that gave them a lot of freedom to explore their ideas and be creative.

2.3 Lesson Assessments: The structure of the lesson included opportunities for the instructor to gauge student understanding.

This indicator captures how well the teacher structured the lesson to include opportunities to monitor student understanding of the content, both formally and informally. This can be as simple as the teacher allowing times when he/she can walk around and assess the work of individual students or groups, or the teacher carefully preparing formative assessment questions, both written and oral, to gauge student understanding. This can also be evidenced by a lesson that is structured to allow time for a lot of "student talk" around important concepts, such that the teacher can get a clear picture of what students understand. A lesson that would not score well on this indicator would be structured as predominantly teacher-driven with no or few opportunities planned for the teacher to get an idea of what students understand.

General Rubric

1. This item should be rated a 1 if there was little or no time structured into the lesson to assess student understanding—the teacher led the entire lesson with no or little student input regarding their thinking about key mathematics or science concepts.
2. This item should be rated a 2 if there were only occasional or sporadic places in the lesson where there was an opportunity for the teacher to assess or observe what students were thinking, talking about, or doing—perhaps the teacher planned time to elicit a couple of quality student contributions or did some assessment of a few students thinking based on their written work occasionally during the class period.
3. This item should be rated a 3 if there were some opportunities clearly designed for in the lesson structure to allow the teacher to gauge student understanding, and there was evidence that the teacher purposefully created appropriate structures or methods for students to express their thinking. However, there may have been a few minor missed opportunities to check in with some students and/or groups.
4. This item should be rated a 4 if there were regular or frequent opportunities for the teacher to gauge student understanding, based on the way the teacher had structured the lesson. The teacher had planned for a number and variety of methods and opportunities for students to explore, propose, share, and refine their thinking.
5. This item should be rated a 5 if the lesson was structured as clearly student-centered—students were consistently and constantly trying out ideas and expressing their understanding of key mathematics and science concepts throughout the majority of the lesson. The teacher planned the lesson so that students spent the entire class period exploring, proposing ideas, sharing, and refining their thinking.

Specific Examples of Supporting Evidence (Science)

1. The teacher's lesson plan was for him to read through the information listed in a table printed in the Chemistry textbook entitled "The activity series of the metals" while students took notes at their desks. The teacher did not plan to elaborate on the text by offering examples, explanations, or context. The teacher did not anticipate student

questions and did not prepare or plan to ask question of students to check for understanding.

2. The teacher's plan was to present a table entitled "The activity series of the metals" on the overhead, and then write several balanced chemical equations illustrating how certain reactants would form specific products. This introductory segment was to be followed up by a few minutes for students to ask any questions they might have but the teacher did not prepare any questions to probe their thinking about the material presented. The students were then given a worksheet that had them predict the products of a reaction between two elements by looking at the table and seeing which metal was more "active" than another.
3. The lesson structure was based on teacher demonstrations of single replacement reactions. The lesson was structured to start with the teacher telling the students what reactants she was going to use, then asking them to make a prediction in their lab notebook about what products could be produced, using the "Activity series of the metals" table. After students had made their predictions, the teacher would mix the chemicals together in a watch glass on the overhead and students could observe what took place. The lesson structure allowed some time for her to walk around the room with the flask containing the reactants so the students could observe what was happening in each case. This structure also allowed her to observe what some of the students were writing/drawing in their lab notebooks. The teacher had prepared several questions to ask students to prompt thinking about what they were seeing and how they might determine what products were being formed, such as "What do bubbles on the metal indicate?" However, the number of activities planned did not allow enough time for her to check on every group or every student once they began mixing their chemicals.
4. The teacher designed a lab activity where the students would conduct an investigation to illustrate how chemists determined the relative reactivity of metals as arranged in the "Activity series of the metals" table. She prepared a data table with a matrix listing several metals and aqueous metal salt solutions for the students and then asked them to choose a metal and a salt solution from the list and predict what might happen based on the relative position of the reactants in the table. Before allowing the students to begin mixing the reactants, the teacher allowed time to check in on each group in order to review their predictions and ask them to explain why they thought the products would be as they predicted. Then the students were allotted time to carry out the experiment by combining the appropriate materials in the test tube and observing the results, discussing with each other the evidence they used to determine if their predictions were correct, and, finally, writing up their results and conclusions in their lab notebooks.
5. The teacher had the students conduct the investigation described in the previous paragraph, but the final planned lesson activity was given for homework—the students were challenged to read a newspaper article describing the restoration of the Statue of Liberty and suggest what possible chemical reactions might have occurred in the first place between the copper plating and iron support bars that caused the structure to deteriorate. Student groups would present their ideas for discussion to the class on the following day.

Specific Examples of Supporting Evidence (Mathematics)

1. The math worksheet given during this class was not structured to uncover any important concepts. The questions on the worksheet were random and disconnected; the answers were all multiple choice format, facilitating guessing; and the teacher did not plan time to ask questions that could promote the students' conceptual understanding.

2. During the post-observational interview/survey, the teacher stated, "The materials for this lesson came straight from the Instructional Program Guides (IPGs)" provided by the department chair, which included the student worksheet and the "correct" answers. The teacher said he prepared for the lesson by going over the expected answers and thinking of an introduction because the material was "dry." The design of the lesson with the introduction did not contain any questions to elicit student thinking or prior knowledge, and the majority of class time was structured with the teacher at the board solving the problems from the student worksheet. The teacher said he "expected the students to copy these problems down into their notes" for future reference. Little time was allotted for the teacher to move around the room and check on what the students wrote in their notebooks.
3. The structure of this lesson definitely created some opportunities that allowed students to express their thinking and uncover important concepts relating to linear equations and linear inequalities while exploring an engaging and challenging activity. The warm up introduced and probed for student prior knowledge, and then a wrap up reviewed and strengthened the foundational ideas students worked through on linear equations. There were a few times when some students were unable to continue with the activity because they did not seem to understand what they needed to do and the teacher did not have enough time to address their specific questions.
4. The structure of this lesson was successful in providing opportunities for students to think, share, and reflect on their ideas as they uncovered math concepts while carrying out the activity. In addition, the student groups took presenting in front of the class seriously and asked each group member to explain some aspect of the math behind the poster they had made so that they could clearly communicate it to others. The teacher also questioned and challenged the students during their presentations in order to facilitate content being uncovered. The only way the structure of the lesson could have been improved is if the students had been required to question other presenting groups or be involved in the presentations in some way.
5. The teacher said that her objective for this lesson was to use properties of similar triangles and proportions to solve for unknown measurements. She constantly encouraged students to show their work and justify their answers, and she structured the lesson so that the parts with whole-class discussion were broken up by individual or group problem solving. This structure seemed very effective at eliciting each student's ideas and conjectures and receiving thought-provoking feedback from the teacher and/or other students.

2.4 Lesson Investigation: The lesson included an investigative or problem-based approach to important concepts in mathematics or science.

The item assesses the degree to which investigative or problem-based instruction is successfully incorporated into the lesson. In a problem-based approach, the teacher challenges students by presenting real-world problems or realistic dilemmas to solve—often fraught with complexities requiring multiple approaches—in an effort to engage students in higher-order thinking, creativity, and innovation. An example of a problem-based lesson would be the teacher presenting a scenario to students where they are given a variety of data plans from multiple cell phone carriers and need to compare the trade-offs of features using linear functions. An investigative approach is used when students are challenged to discover important mathematical or scientific ideas, procedures, and principles through some kind of inquiry, which can be guided to open-ended in structure. An example of an investigatory science lesson would be one where students are expected to investigate causes of water pollution in a local ecosystem by determining what data need to be collected, what equipment to use to collect the data, what statistical techniques to use to analyze the date, etc.

With this indicator, it is important to assess not only if the activity was *designed* to be investigative or problem-based, but also whether it is *enacted* that way. For example, the teacher may lead the class through a problem-based scenario step-by-step with little student interaction or freedom to work on ideas or conjectures of their own, so the teacher is really just presenting an example in a lecture rather than engaging the students in problem-based learning.

It is also important when rating this indicator to distinguish between "problem-based" approaches and simply giving a bunch of problems superficially set in "real-world" contexts. In order for a lesson to be truly "investigative" or "problem-based," there must be a larger purpose or overarching conceptual understanding that unites and gives purpose to many smaller mathematics or science problems or tasks. For example, if students were solving a variety of real-world problems using fractions to calculate food portions, this would not necessarily be a true "problem-based" lesson. However, if students were solving these problems with the larger purpose of designing a business plan for a catering company that would deliver a profit ratio that would ensure sustainability, this would then be a problem-based scenario.

Although it may seem inappropriate to penalize a teacher for not incorporating these instructional strategies into every single lesson, it is important that we identify the degree to which these behaviors are present. If there are absolutely no elements of investigation or problem-based instruction in the observed lesson, this indicator should be rated a 1. The indicator should be rated a 1 in this situation even if you feel such instructional strategies would not be appropriate or possible for this particular lesson.

General Rubric

1. This item should be rated a 1 if there were no elements of investigation or problem-based learning in the lesson.
2. This item should be rated a 2 if there was only a minor example of investigative or problem-based learning in the lesson, and it was not a focus of the lesson.
3. This item should be rated a 3 if elements of investigative and/or problem-based learning were designed to occur with moderate frequency, and/or if the problem-based or investigative activities were of moderate quality.
4. This item should be rated a 4 if the majority of the lesson design employed an investigative or problem-based approach and the activities planned were of medium to good quality. However, there may be a small missed opportunity on the part of the teacher to incorporate more aspects of investigation or problem-based learning into the lesson.
5. This item should be rated a 5 if the lesson was clearly designed with an investigation and problem-based approach, and the learning activities chosen were of high quality.

Specific Examples of Supporting Evidence (Science)

1. The lesson structure did not include any elements of investigation or problem-based activities. The students were given a worksheet with a diagram of the water cycle and asked to fill in blanks using their textbook as a reference.
2. The lesson structure contained a few elements of an investigative approach to discover the properties of water that form the fundamental basis for the water cycle—that water changes from a solid to a liquid to a gas under differing conditions of temperature and pressure. Students were provided with phase diagrams of water and asked to correlate this information with the water cycle diagram.

3. The lesson was designed with an introductory lab activity where students were expected to determine the temperature of water as it changed from solid to liquid to gas and to draw phase diagrams based on the data they collected. The teacher then played a video "cartoon" showing the molecular structures and interactions of H_2O as it changed phases. After the video, students were asked to add similar cartoon drawings of the H_2O molecules to their water cycle diagrams.
4. The lesson was designed to begin with an investigation into the physical properties of two different substances—H_2O and lauric acid ($C_{12}H_{24}O_2$)—to determine the respective melting points. Student groups were then challenged to draw cartoons of each of these two molecules and describe their interactions during the melting and freezing process.
5. The lesson was designed to begin with an investigation into the physical properties of two different substances—H_2O and lauric acid ($C_{12}H_{24}O_2$)—to determine the respective melting points. Student groups were then challenged to draw cartoons of each of these two molecules and describe their interactions during the melting and freezing process. Finally, the groups were challenged to describe how a "water-cycle" with a liquid that had the physical properties of lauric acid would be different from what currently exists on Earth.

Specific Examples of Supporting Evidence (Mathematics)

1. The lesson structure did not include any elements of investigation or problem-based activities. The teacher provided the students with a handout that listed several different representations of functions. The teacher solved example problems at the board, illustrating each of the different representations listed on the student handout while the students took notes independently at their desks.
2. The teacher made an attempt at making this lesson problem-based by framing the students' work on the algebra worksheets as something they had to write for an imaginary company that wanted to investigate how the motion of projectiles could be approximated by quadratic functions; however, the teacher did not call attention to this prompt after the introduction and it was not mentioned again during the observation.
3. At the beginning of the lesson, the teacher had students investigate the structural properties of linear functions by giving them cards with a linear function (i.e., $y = 2x + 10$) and having them come up with a real-life scenario that the function could model.
4. In this math lesson, after students received a brief introduction on the use of formulas for calculating permutations and combinations, students were given a problem-based scenario where, if they needed to unlock a variety of different types of combination and permutation locks quickly, they had to decide which lock(s) would be easiest to crack. The calculations were not straightforward, and students explored this activity for the majority of the class period.
5. Students spent the entire class period working on a problem-based scenario where they had to design a playground for their community with limits on resources—money and time. This design challenge required the students to integrate both mathematics and science content and concepts.

2.5 Lesson Resources: The teacher obtained and employed resources appropriate for the lesson.

Resources can include visual or presentation tools, such as PowerPoint, white boards, photos, videos, models, or visual organizers. Resources can also consist of the materials the students are supplied with during the lesson, such as calculators, computers, laboratory materials and

equipment (including safety equipment), textbooks, manipulatives, construction paper, scissors, tape, etc. Other resources can be worksheets, quizzes, lab sheets, etc., that the teacher plans to use as part of the lesson. When rating this indicator, particular attention should be paid to the ways in which the teacher uses all kinds of technology or lab and/or safety equipment appropriately to enhance student learning.

This indicator captures the degree to which the teacher has chosen and uses appropriate resources to successfully implement the lesson. The evidence gathered should demonstrate that the teacher carefully selected resources that enhance the learning opportunities of the students, while avoiding resources that serve as distractions (i.e., the addition of unneeded or irrelevant manipulatives to a lesson or showing videos that are visually appealing or interesting but unconnected to learning objectives) or compromise the lesson's objectives (i.e., allowing students to use calculators to produce trend lines instead of having them draw their own graphs and think through the most relevant function based on the data collected). We recognize that the resources allotted to a classroom may not always be under the teacher's control. However, raters should rate the quality and use of resources without concern for the degree of control the teacher had over what he/she was given.

General Rubric

1. This item should be rated a 1 if one or more of the resources chosen for the lesson was highly inappropriate or negatively impacted student opportunity to learn.
2. This item should be rated a 2 if one or more of the resources chosen for the lesson occasionally negatively impacted student opportunity to learn, and/or if there were clearly more appropriate and effective resources that could have been chosen.
3. This item should be rated a 3 if the resources were adequate for the purposes of instruction. None of the resources disrupted student learning, but none of the resources noticeably enhanced learning through their use and implementation.
4. This item should be rated a 4 if there was evidence that the specific resources selected by the teacher were appropriate and enhanced student learning. There may have been a small missed opportunity or minor problem with resource use or there may have been a small instance of limited access to the resources appropriate for each stage of the lesson.
5. This item should be rated a 5 if there was significant evidence that the teacher had carefully selected resources to enhance student learning and that these resources were effective, accessible, and appropriate for this purpose.

Specific Examples of Supporting Evidence (Science)

1. The lesson was designed to introduce the biology class to the molecular structure of DNA and build understanding about the concept of heredity, and the teacher showed a video about the migration of sea turtles in the Atlantic Ocean. Although entertaining, the video made no references to the structure of DNA as the fundamental basis for heredity.
2. The resources chosen by the teacher for the lesson on DNA structure and the process of replication included materials for making a model with different-colored paper clips, which the teacher put together on the overhead projector while students took notes at their desks. It was difficult for students to see the different colors on the overhead and many seemed confused by the "rules" the teacher was using to construct her demonstration model.

3. The resources chosen by the teacher for the lesson on DNA structure were some modeling kits that allowed students to construct double strands of DNA, open them up, and prepare messenger RNA strands from the DNA templates. The teacher had prepared instruction sheets with clear diagrams for the students to see how to put the pieces of the model together.
4. The resources chosen by the teacher for the lesson on DNA structure were some modeling kits that allowed students to construct double-stranded DNA molecules and the correlated messenger RNA strands from these templates. In addition to instructions for the model kits, the teacher also provided a short video clip showing replication and transcription processes.
5. The resources for this lesson on the structure of DNA and the biochemical processes of heredity were as those described in number 4 above, but the teacher also provided students with a simulation of DNA replication and transcription that they could use to create their own coded sequences and create their own corresponding mRNA strands. Students could choose which (or both) modeling systems to use to explore and develop their understanding of this concept.

Specific Examples of Supporting Evidence (Mathematics)

1. During this mathematics lesson, the teacher brought the students to a computer lab to do research for a project using graphing software. During the 20 minutes where the teacher explained the instructions and expectations and reviewed relevant concepts, many students surfed the web at their computers. This continued after the introduction was completed and when students were given time for independent work. The teacher explicitly allowed students who finished early to play video games on their computer, and these students were very disruptive to others who were not yet finished.
2. This was a seventh-grade class, and the teacher reviewed decimal addition and subtraction using base-10 blocks. This did not seem like an appropriate resource for the level of the students, and a few students were playing with their blocks without paying attention to the teacher.
3. The resources chosen for this algebra lesson were an overhead projection device and a marker board, which were used by the teacher as she delivered a lecture and went over selected problems. The students seemed able to read and understand the work the teacher was going over and took notes dutifully. From time to time, the teacher called on students to come up to show their work on the overhead projection system, which the students readily volunteered to do.
4. For a lesson on surface area, the teacher had chosen a variety of everyday objects that represented important three-dimensional solids. The teacher also prepared and handed out cut-out paper shapes for each group of students to "unfold" to see how they could figure out the formula for surface area for each shape. For example, students were challenged to calculate and cut out the material needed for a label for a soda can using the formula for the surface area of a cylinder. Overall, these resources were quite engaging for students, although a lot of students used the provided markers to spend time decorating their label rather than listening to the teacher.
5. The students were making presentations for a multi-day mathematics project they had been working on. The teacher had a variety of resources like paper, markers, graph paper, etc., so they could make physical posters, but the teacher also provided students access to computers with software so they could create digital presentations with graphics and

embedded videos. The technology resources also allowed the students to use some simulation software for exploration and presentation. These resources chosen by the teacher provided to them multiple ways to communicate their results in the most clear and informative way possible. The students were developing very high-quality presentations as a result.

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.

This indicator is evidenced by the teacher's response to post-lesson interview questions such as "What were the strengths/weaknesses of the lesson?" and "If you had a chance to teach this lesson to the same group of students, what would you do differently? Why?" This indicator measures the degree to which the teacher is reflective and critical about the overall planning and structuring of the lesson as well as the instructional decision-making during the lesson. The teacher should be able to identify some of the strengths and weaknesses of the observed lesson that were identified by you when using the UTOP. Keep in mind that the UTOP *does* assess instructional choices like resource use, classroom management, and time management.

This item is rated Not Applicable (NA) if there is no post-interview or reflection data available with the lesson.

General Rubric

1. This item should be rated a 1 if the teacher did not discuss or recognize any strengths or weaknesses of instruction.
2. This item should be rated a 2 if the teacher identified strengths and weaknesses that were unimportant and/or that were only related to tangential or insignificant procedural elements of the lesson. These strengths and weaknesses were unrelated to what is assessed on the UTOP.
3. This item should be rated a 3 if the teacher discussed and recognized one or two important strengths of instruction captured by the UTOP, but perhaps did not acknowledge or recognize any of the major weaknesses.
4. This item should be rated a 4 if the teacher recognized a fair portion (but not all) of the strengths and weaknesses the rater identified.
5. This item should be rated a 5 if the teacher recognized many of the strengths and weaknesses of the lesson that the rater recognized while evaluating the lesson with the UTOP. This item should also be rated a 5 if the teacher recognized the most important strengths and weaknesses of the lesson.

Specific Examples of Supporting Evidence

1. As a strength of his lesson, the teacher described that students were showing understanding and raising their hands to give steps when prompted. The observer did not note evidence of students showing understanding in the UTOP, and the limited ways in which students were able to express their ideas and participate was actually a weakness. The teacher said his lesson did not have any weaknesses—he would do the same thing again.
2. The teacher noted as a weakness that he should have had instructions for the lab activity prepared for his lesson; however, there were much more significant and important issues with this lesson that he did not identify. He also noted that, as a strength of the lesson, a

few students were allowed to come to the board to write their responses to the post-lab problems, but he had offered no follow-up questions to get them to explain what they produced and did not see the point in this kind of questioning: "They got it right, for the most part." In addition, he felt another strength of the lesson was that he allowed the students to "move around" the classroom; however, simply allowing students to move is not significant in and of itself.

3. The teacher said a strength of his lesson was that it was very "content focused," and he had a specific lesson plan prepared. His level of preparation included some questions he had ready to use when students got "stuck" and was a strength of the lesson. He says that if he were to teach the lesson again, he'd make greater use of whiteboards, yet this was not noted as a particular weakness—his resources and interaction levels allowed students to work productively.
4. The teacher described a strength of his lesson as the students being able to work at their own pace, not his. This was a strength, and the UTOP evidence for Indicators 2.4 and 3.3 supported this assertion. The teacher said that, as a weakness, a few of the students finished quickly and became bored, and he should have been prepared to challenge them further or encouraged them to continue participation by helping others. This was a weakness and was noted in evidence collected with Indicator 1.3.
5. The teacher said a strength of his lesson was student engagement in the simulation of a lab investigation that required students to rapidly try out different initial conditions and observe what happens in each case, which was definitely the most important strength. He said a weakness was that there was too much teacher talk and the students didn't seem to have a chance to process their data by the end of the class and get to a deeper understanding of the fundamental concept. This was definitely the most important weakness, as described in the evidence for Indicator 3.4.

Implementation—Section 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.

Questioning strategies can be successfully employed by teachers in order to manage student attention, encourage intellectual engagement, and ensure active participation in the lesson activity. Questioning strategies can also develop students' procedural skills by helping to remind or cue them to steps in a known process or to scaffold the development and use of an accepted explanation, laboratory procedure, or mathematical model. Questioning strategies can serve as a way to engage students in the review of concepts the class has already covered, reminding them of what they learned in recent activities or lectures. Questioning may also be used to introduce students to the focus and purpose of the lesson, especially when new concepts or ideas are to be explored and when the teacher needs to draw upon students' prior knowledge. Effective questioning strategies include appropriately using "wait time," and validating all responses to maintain rapport in a low-risk, collegial classroom environment.

The types of questions a teacher may use range from simple procedural checks on understanding to more challenging probes that force students to think critically and to synthesize what they already know and apply it to novel situations. Intellectually engaging and challenging questions can be used to facilitate students' development of conceptual understanding as well as identify prior conceptions and uncover misconceptions by

investigating incorrect answers though follow-up questioning. This indicator assesses the degree to which the teacher uses appropriate questioning strategies for any and all of these purposes.

General Rubric

1. This item should be rated a 1 if the teacher used little or no appropriate questioning strategies that engaged students with important science or mathematics content or concepts at any level during the lesson.
2. This item should be rated a 2 if the teacher occasionally or sporadically questioned a few students to refocus attention, encourage participation, or check on skill development, but there were no instances of questions that challenged students to think critically about important science content or concepts.
3. This item should be rated a 3 if the teacher regularly used questioning techniques to encourage and maintain participation and to check on skill development and progress with the lesson activity during some portions of the lesson, especially the introduction and wrap up. The teacher asked appropriate procedural and factual questions about important science or mathematics content or concepts but rarely challenged student thinking with question probes for deeper understandings or misconceptions.
4. This item should be rated a 4 if the teacher frequently used questioning techniques to encourage and maintain participation and develop skills throughout the class period. Some questions were asked that probed student thinking about important science content or concepts, uncovering alternative or misconceptions that were then appropriately used by the teacher to get students to reflect and expand further on this content or concepts.
5. This item should be rated a 5 if the teacher consistently and continually used multi-level questioning strategies to encourage and maintain participation and to check on skill development and students' progress with the lesson activity throughout the class period. In addition, the majority of questions asked probed students' thinking about important science content or concepts deeply, challenging preconceptions and assumptions and pushing students to develop new knowledge or novel applications.

Specific Examples of Supporting Evidence

1. There were few to no examples of appropriate questioning strategies used in this lesson. For example, in chemistry class, the teacher called out the atomic number of an element on the periodic chart and called on students in alphabetical order, expecting them to read the name of element out loud to the class. If a student did not respond with the correct name or pronunciation, the teacher ignored the response and moved on to the next student. The teacher used no wait time and, when frustrated by the hesitation of the students' response time, simply read the name of the element himself. Even if other students called out responses, the teacher continued without acknowledging what the students were saying.
2. The majority of the teacher's questions were closed-ended and structured to ensure that the students responded with the one and only correct answer. For example, in chemistry class, the teacher called out the name of an element from the periodic table and asked students to state the number of protons and electrons for the element. If students gave incorrect responses, the teacher corrected them but missed multiple opportunities to ask follow-up questions of students about their mistakes to see what misconceptions might have led to their error. One student asked if the number of protons had to equal the number of neutrons "like hydrogen," and the teacher responded, "No, we'll get to that later." The teacher did not consistently use an adequate amount of wait time and talked extremely fast

so that all elements in the periodic table could be covered in the amount of time allotted for this part of the lesson.

3. The teacher asked the students a lot of questions to prompt interaction and response, but the questions were frequently more procedural than conceptual. For example, in chemistry class, the teacher assigned each group of three students to draw graphs of atomic and ionic radii of all member elements of a specific group on the periodic table and write a narrative comparing their graphs and discussing how these elemental periodic properties differ. The teacher did maintain the student-focused integrity of the group learning activity by asking questions rather than telling them the expected answers, but much of his questioning dealt with directing the students to complete the steps for graphing the data, rather than probing for student ideas about the underlying explanations for the periodic trends the activity was designed to uncover.
4. The teacher checked in with each group and asked them questions about the activity and the reasoning behind their actions or solutions for the task assigned. For example, in chemistry class, after reviewing the graphs of atomic and ionic radii created by each group in the assignment described above, the teacher followed up by asking students to draw scaled models of the elements as neutral atoms and as charged ions. If a student group appeared stumped, the teacher sometimes gave the students more information than necessary for them to move forward with their modeling instead of asking questions to probe more deeply about what they actually knew and why they hesitated to draw what they were thinking. Overall, the teacher asked thought-provoking, higher-level questions of all of the groups when checking in with them, and some groups of students were able to draw fairly accurate representations of atoms in the neutral and ionic states.
5. The teacher purposefully and consistently used multiple probing questions to allow students to express incomplete understandings or alternative points of view or misconceptions. For example, in the chemistry class task described above, the teacher asked each group of three students to split up and compare their graphs and drawings of atomic and ionic elemental representation with another group's set of elemental representations. The teacher encouraged students to critique and question their classmates' work in response to and extending upon their ideas. He used follow-up, probing questions about these student-derived explanations and representations in order to develop the "big picture" of periodic trends across each elemental group and period for the whole class. The teacher relied on direct instruction only when absolutely necessary, instead using student-derived artifacts with questioning strategies to skillfully guide students to explore, explain, and develop their own explanations about how fundamental concepts of periodicity form the basis for the organization of the periodic table.

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.).

This item assesses the degree to which the teacher actively works to ensure that all students are participating and intellectually engaged in the lesson. This indicator can be evidenced by the teacher encouraging students who are not volunteering to participate, providing multiple entry points into the lesson for students with different knowledge levels and allowing various modes of participation (whole class, small group, individual work), or walking around the room and verbally engaging students in an effort to monitor class participation. If the teacher simply calls on several volunteers to give short, factual answers, it is not considered evidence for high scores on this indicator—the teacher should be involving students whether they volunteer or not and should be finding important and authentic ways for them to contribute. During times when

the teacher is not directly teaching, this indicator can be evidenced by the his or her movement about the classroom to interact with and spend time with all students, not just the ones actively asking for assistance.

General Rubric

1. This item should be rated a 1 if the teacher did not attempt to involve all students in the lesson. This means the teacher only called on volunteers during whole-class portions of the lesson, and only checked in with groups who specifically requested help during group-work portions of the lesson.
2. This item should be rated a 2 if the teacher occasionally or sporadically made an attempt to involve all students in the lesson. Perhaps the teacher occasionally called on non-volunteers, or only checked in with some groups not requesting help when she had responded to all other student requests for assistance.
3. This item should be rated a 3 if the teacher made moves to involve all students in the lesson but ultimately did not do enough such that all students were able to participate. This item should also be rated a 3 if the teacher is not seen making any specific moves to involve all students in the lesson, but all students seem to be involved anyway. The teacher may have made moves previously (throughout the school year) to set up and ensure a classroom culture where all students actively participate.
4. This item should be rated a 4 if the teacher made clear attempts to involve a wide variety of students in the lesson and was actively working to ensure the participation of all students. Occasionally, the teacher may have missed an opportunity to maintain participation with struggling students who stopped working, or the teacher may not have appropriately challenged uninvolved students who finished early during some portion of the lesson.
5. This item should be rated a 5 if, throughout the lesson, the teacher was actively and consistently working to involve, challenge, and maintain intellectual engagement and participation in the lesson activities with every student, including shy students, hesitant learners, bored/disruptive students, struggling students, and students with special needs.

Specific Examples of Supporting Evidence

1. The teacher made no attempt to involve all students in the lesson. She heard only from volunteers, and a number of students who were not engaged or did not understand what to do stopped participating. During the group-work portion of the lesson when students were filling out responses on a worksheet, the teacher assisted only groups near the front who asked for help. She said a few times that everyone in the group needed to be able to understand and carry out the information the class was writing down on the worksheet, but no attempts were made to check on each group member's progress, and some students were continuously off-task.
2. Most of the time, the teacher focused her attention on only those students who were being disruptive or off-task. Occasionally, the teacher interacted with or called on a non-volunteer or group who appeared to be working, but the interaction was superficial and provided little information about what the students thought or knew. The teacher did not attempt to monitor the progress of all students or to check on their understanding of the content; she was too busy managing off-task behavior and trying to push the class through the steps of the activity before the class session ended. Some groups of students were left on their own to fill out a worksheet and, when confused, raised their hands to ask the teacher a question, but her back was turned and she was therefore not able to answer them.

3. The majority of students were involved in the lesson, functioning without direct intervention or encouragement by the teacher. The teacher had created a classroom environment and implemented a lesson activity that led to an adequate number of students completing a worksheet defining and describing a list of biological adaptations. Throughout the lesson, the teacher walked around to monitor various groups, asking questions to check for completion and redirecting off-task behavior. However, she didn't engage directly with a couple of struggling students who subsequently disengaged and stopped working. In addition, one student who finished the worksheet quickly worked on assignments for another class, and the teacher didn't make specific attempts to challenge the student to expand his understanding beyond the completion of the worksheet.
4. The teacher circulated throughout the classroom constantly and spoke with different students in each group, asking them multiple-level questions—from procedural to conceptual—to check for completion and understanding of their work. The students were assigned meaningful group roles, so they all were required to contribute to the activity in different ways. For example, in this lesson about biological adaptions, the teacher challenged each group to discuss possible evolutionary advantages for different adaptations involving camouflage and mimicry and then create a visual display to summarize what they had learned to share with the whole class.
5. The teacher used a specific strategy during this class period to get all students, especially the quiet or shy students, to share their solutions and reasoning. First, students discussed their ideas in pairs or groups so that they could get feedback from their peers. The students were assigned meaningful group roles and held each other responsible for the work of the group. Next, the teacher listened to the group's discussions, probed each member of the group, and validated their thinking before inviting each to share their ideas in front of the class. The teacher frequently called on non-volunteers in non-threatening ways and encouraged all to explain their reasoning throughout, purposefully and successfully involving all students in the lesson.

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.

This indicator assesses the degree to which the teacher uses formative assessment techniques to gain awareness of his or her students' progress and understanding and makes appropriate adjustments and modifications to address student instructional needs throughout the progression of the lesson. Evidence of this item can be observed during the class or directly obtained by asking the teacher about lesson modifications during a post-observation interview. An effective teacher may utilize a variety of formative assessments of student progress, including written assessments like quizzes, warm ups, journals, and reflections, as well as informal assessments, such as any evaluation based on discussion, questioning, and observation.

This indicator assesses how effectively the teacher monitors the student's progress in order to further inform his or her instructional needs. The observer should analyze the various assessments used by the teacher, examine how the assessments influenced the teaching in the classroom, and determine how the information gained was used by the teacher to alter or adapt instruction "in the moment" to change either the path of the lesson or the time devoted to a specific portion of the lesson. This indicator should capture the frequency and the quality of the teacher's formative assessments and modifications made based on the information gained throughout the class session.

General Rubric

1. This item should be rated a 1 if the teacher did not attempt to formatively assess student understanding during the lesson. This item should also be rated a 1 if it was clear that modifications to the lesson were needed to support student understanding, but the teacher did not make modifications.
2. This item should be rated a 2 if the teacher made only occasional or sporadic attempts to formatively assess student understanding.
3. This item should be rated a 3 if the teacher made regular attempts at formative assessment, but some of these attempts were of poor quality and the teacher missed opportunities to fully elicit student understanding. The teacher should have made some modifications to the lesson based on formative assessment of student understanding, and these modifications may have been somewhat successful. This item should also be rated a 3 if the teacher made no modifications to the lesson, but the teacher's formative assessments suggested that no modifications were needed.
4. This item should be rated a 4 if the teacher consistently used formative assessments to monitor student progress during the lesson, and these assessments were of sufficient quantity to allow the teacher to obtain a clear picture of student understanding. The teacher also adjusted the lesson based on formative assessment as appropriate throughout the class period. There may have been a small missed opportunity to modify the lesson or a modification that was not completely successful.
5. This item should be rated a 5 if the teacher consistently used high-quality formative assessment throughout the class period to monitor student understanding and was able to modify his or her teaching or carefully target instruction based on the results of this assessment. The teacher successfully and consistently adjusted the lesson based on formative assessment of student understanding as appropriate throughout the class period.

Specific Examples of Supporting Evidence

1. The teacher did not circulate during the portion of the lesson when the students were working in groups, and no instructional modification was evident. At the front of the room, the teacher seemed to be spending most of his time working on his computer or preparing for the next class. The teacher moved from the front of the room only in one instance—to a group that loudly and disruptively demanded his help and were unwilling to come to him.
2. During the introduction and warm up, the teacher called on a few students to repeat the instructions for the day's activity to check for understanding of the procedures. Once students began working in groups, the teacher circulated infrequently and was not able to assess progress or monitor student thinking in each group, so there was little evidence of modification of instruction based on formative assessment. The teacher did assist students who came up to the front and explicitly asked for help, but the teacher's responses were limited to repeating the instructions and showing students the procedural steps to complete the problems on the worksheet. Students who did not seek the teacher out did not get assessed and received no modification of instruction to meet their specific learning needs.
3. The teacher regularly checked on each group's progress on a worksheet of practice problems and verified that their work was correct at each checkpoint before groups continued to the next section. Sometimes the teacher quickly stamped correct answers for completion but did not take the opportunity to ask the students questions to probe their rationale for solving problems. Sometimes the teacher asked scaffolding questions to help

students who struggled with the steps in the problem-solving procedure; when students asked questions, the teacher responded with another question that guided students to the correct process. Most of the time, the teacher asked only lower-order procedural questions of the students, then checked off that they'd completed their work and moved on to the next group. There was little evidence of altering or modifying instruction when students were clearly frustrated and unable to solve the problems, and the teacher missed opportunities to ask questions that would unpack their misconceptions or gaps in knowledge.

4. The teacher consistently circulated the room to assess student progress, probing with questions that got students to articulate their thinking about how the geometric shape of the H_2O molecule contributed to hydrogen-bonding in water. After reviewing the students' attempts to diagram the intermolecular interactions in water, the teacher decided to call one member of each group to join her at the front of the room for a brief tutorial. The teacher showed these students how to construct a geometrically appropriate model of the water molecule, then sent them back to their groups with model kits to share what they learned. The teacher continued monitoring students' representations and asking questions that demonstrated that many students could now accurately draw and describe in words how and why hydrogen-bonding occurred in water.
5. The teacher implemented the lesson activity described above that required students to draw and describe in words how the shape of the H_2O molecule contributed to hydrogen-bonding in water. Noting that most students were able to correctly complete this part of the assignment, the teacher challenged completers to draw a picture of what the water would look like if a salt such as NaCl were added to the solution. While the completers worked on this, the teacher gathered those who were still confused back at the front desk and showed them a short video on her computer that illustrated how H_2O molecules interacted in the liquid state. After the video, the students were able to draw and describe in their own words how the shape of the water molecule contributed to hydrogen-bonding. The teacher continued circulating, monitoring student work and asking probing questions throughout the period. Depending on the student responses, the teacher alternated between molecular models and video simulations to scaffold student learning.

3.4 Implementation Timing: An appropriate amount of time was devoted to each part of the lesson.

This indicator analyzes the pace and flow of the lesson. It is important to note whether the amount of time devoted to each part of the lesson is sufficient, with portions of the lesson neither becoming overly repetitive nor being rushed through. This indicator should be evidenced by examining the progress of the students (i.e., whether their needs are being met by the pace of the instruction) and the amount of time dedicated to important and less crucial aspects of the lesson (e.g., most of the time devoted to a lab activity should allow the students to carry out the investigation rather than the teacher giving procedural directions). Even if the lesson is an extended inquiry that is designed to continue for several days, some time for introduction at the beginning and wrap up and reflection at the end of the class period is appropriate.

General Rubric

1. This item should be rated a 1 if there was a significant amount of wasted time during the class period where students were unengaged or off task, or if there was another major timing issue that disrupted student learning.

2. This item should be rated a 2 if there were several instances of wasted time during the class period where students were off task, and/or if an appropriate amount of time was not devoted to key portions of the lesson, leading to confusion or frustration on the part of the students.
3. This item should be rated a 3 if there were no major timing issues or wasted time during the lesson, but perhaps an appropriate amount of time was not devoted to more important parts of the lesson, like the time allotted for student lab work was not sufficient, or the wrap up portion of the lesson was missing. A few students disengaged early or were left trying to finish when the bell rang.
4. This item should be rated a 4 if sufficient amounts of time were devoted to the most important portions of the lesson and appropriate amounts of time for introduction, instructions, and wrap up were evidenced because most of the students were engaged and productively on-task throughout the lesson. There may have been one instance of wasted time, or one portion of the lesson might have been slightly more rushed or allotted more time than it should have been, but the overall flow and timing allowed most students to accomplish the work of the lesson activity.
5. This item should be rated a 5 if the appropriate amount of time was devoted to all portions of the lesson, including introduction, instructions, and wrap up. All students were productively on-task, as there were no instances of wasted time during this lesson, and all parts of the lesson proceeded at an appropriate pace.

Specific Examples of Supporting Evidence

1. The teacher began the class by copying an example problem on the overhead directly from the chemistry textbook, showing the steps to solving a stoichiometry problem. Several students raised their hands to ask questions, but the teacher did not call on them and told them to just copy the problem into their notes. A few students at the back of the room called out "Why are we doing this?" but the teacher ignored them. After 45 minutes of copying sample problems, most students had closed their notebooks and disengaged—chatting with each other, applying make-up, or sleeping. This continued until the bell rang and the students simply gathered their belongings and walked out the door.
2. The teacher assigned a different stoichiometry problem to each student group and told them to write out their work, step by step, on an overhead transparency so that they could present their solutions to the class. The teacher took 25 minutes at the beginning of the class period getting the student groups organized. Once the groups started working, the teacher circulated to monitor progress but spent a lot of time at two of the six groups, repeating the directions and leading each student through each step of the calculation. Groups who were not in contact with the teacher were unable to start the calculation and disengaged quickly, becoming frustrated. As a result, the class ended before all student groups had a chance to present.
3. The teacher spent five minutes at the beginning of the class demonstrating how to solve a stoichiometry problem and then referred students to the text where additional solved problems were illustrated. The time devoted to introduction, group work, and student presentation portions of this lesson seemed to be adequate for most students, but when one group finished early, the teacher did not challenge them with another task. One group monopolized most of the teacher's time, so that not all groups were able to present their solutions and the teacher did not have time to summarize or provide a wrap up at the end of class.

4. As the students entered the classroom, the teacher handed them a group assignment and sent them to a pre-arranged set of desks to work. As soon as the class started, the teacher showed the students how to solve a stoichiometry problem on the board, labeling each step in the multi-step problem. The teacher used an overhead timer and announced that the groups would have five minutes to complete each problem assigned to their group, then they would begin presenting their work and explaining their rationale for their solution to the whole class. The teacher moved to monitor each group's work frequently, keeping students engaged and on-task while moving on to the next group within 30 seconds. Although all groups managed to present their work to the whole class, time ran out and the teacher offered no wrap up of the content taught during this lesson.
5. Students entered the classroom and took seats in previously assigned groups. The teacher briefly demonstrated the steps to solving a stoichiometry problem and then gave groups different problem sets to solve and poster paper on which to write their solutions for presentation in a gallery walk. The teacher used an overhead timer and announced that the groups would have five minutes to complete each problem assigned to their group, then they would begin presenting their work by posting their papers around the classroom. The teacher allowed early finishers to tutor slower student groups and help them complete their work. The teacher explained how the gallery would work and the students took turns explaining their rationale for their solution to other students who came by their posters. All student groups had time to share their understanding during the gallery walk, and the teacher used the last group's work to summarize for the whole class the steps to solving stoichiometry problems.

3.5 Implementation Connections: The instructional strategies and activities used in this lesson clearly connected to students' prior knowledge and experience.

This indicator captures the degree to which the classroom instruction takes into consideration the students' prior knowledge of mathematics or science concepts or students' experiences with mathematics or science in their everyday lives. The teacher may begin a lesson by explicitly connecting concepts the students have already learned to concepts the class will be exploring that day. Alternatively, the teacher may wait until a particular point during the course of a lesson where it becomes important—i.e., there is a "need to know"—to remind students of how a concept they're learning relates to prior content, in that class or other classes.

The teacher might purposely solicit students' prior knowledge or their experiences with science or math concepts that appear in everyday life to launch a lesson on science or mathematics. To score highly on this indicator, the teacher must not only make efforts to elicit students' prior knowledge and experience, but he or she also must use this prior knowledge to reach the objectives or enrich the students' interest and understanding of the concepts being taught.

General Rubric

1. This item should be rated a 1 if there was no evidence of the teacher making any attempt at connecting instruction to students' prior knowledge and experiences.
2. This item should be rated a 2 if the teacher made a small or passing reference to a previously learned mathematics/science concept and/or students' everyday experiences with science or mathematics.
3. This item should be rated a 3 if the teacher made at least one explicit attempt to draw upon students' prior knowledge of previously learned mathematics/science concept and students' everyday experiences with science or mathematics, seeking and getting input from students in the class.

4. This item should be rated a 4 if the teacher made several attempts throughout the class period to draw upon students' prior knowledge of previously learned mathematics/science concepts and students' everyday experiences with science or mathematics, getting input from a majority of students in the class.
5. This item should be rated a 5 if the lesson was built purposefully and explicitly from the perspective of the students' prior knowledge of the concepts being covered. This included both their prior school knowledge of related mathematics or science concepts, and their prior knowledge of using or experiencing the concepts in everyday life. In addition, the teacher made a significant effort to get input from all students related to their experiences and prior knowledge with the mathematics and science content and concepts explored in the lesson. This item should also be rated a 5 if the teacher engaged the class in an extended discussion relating to their prior knowledge and experience, making it a focus of instruction.

Specific Examples of Supporting Evidence

1. In this lesson, the biology teacher put a transparency detailing the biomolecules of the Krebs cycle on the overhead and instructed the students to copy the figure into their notebooks. No attempt was made to place the information in a larger context or connect to previous lessons on metabolic pathways.
2. In this biology lesson about energy production from the chemical interactions of biomolecules in the Krebs cycle, the instructor simply stated that the purpose of this metabolic pathway was "to produce ATP." When a student asked why an organism needed ATP, the instructor stated emphatically, "I know you know this! I'm sure it was covered in eighth grade!"
3. In a lesson about biomolecules, the instructor attempted to understand students' prior knowledge about the role of metabolic pathways in energy production by starting the class with a discussion about what the students ate for breakfast, the number of calories consumed, and which portions of their meal were composed of proteins, lipids, and carbohydrates. Although this discussion was a fair effort to identify student prior knowledge and establish a context for learning about the biochemical processes in glycolysis and the Krebs cycle, it was not developed further, even though there were multiple instances where the continuation of this discussion would be appropriate.
4. In the lesson about energy production from biochemical pathways of glycolysis and Krebs cycle described above, the teacher repeatedly came back to the "What did you have for breakfast?" scenario to help students understand how these pathways not only produced energy needed for life but also many basic carbon molecules that formed precursors to the proteins, carbohydrates, and lipids used to construct important components of cells and tissues. The teacher told the students that they could use a chart in the appendix of their text to determine the calories produced from the food they ate.
5. In the lesson about energy production from biochemical pathways of glycolysis and Kreb's cycle described above, the instructor used the "What did you have for breakfast?" scenario to keep students' attention focused on how each step in these pathways not only produced energy needed for life but also many basic carbon molecules that formed precursors to the proteins, carbohydrates and lipids used to construct important components of cells and tissues as well as the foods they consumed. After asking each student to calculate the calories produced by the food they ate that morning, she then connected the kind of biomolecule to the calories produced upon digestion through interaction with different points on these metabolic pathways.

3.6 Implementation Safety: The teacher's instructional strategies included safe, environmentally appropriate, and ethical implementation of laboratory procedures and/or classroom activities.

This indicator measures the degree to which the teacher models and enforces safe, environmentally appropriate, and ethical practices during field and laboratory investigations and other classroom activities. Evidence for an acceptable rating on this indicator includes the teacher providing effective safety instruction (i.e., an explanation of when and why students should wear safety goggles or how students should dispose of chemical wastes), carefully supervising lab activities, properly maintaining laboratory and classroom equipment, and promoting virtues of honesty, benevolence, and respect for all organisms, including their fellow students. If the teachers are asked about the classroom setup during a post-observation interview, they may describe how they arranged the lab materials in a certain way in order to better monitor lab safety (i.e., ensured that chemicals requiring handling with gloves or in a fume hood were used only with gloves or in the fume hood).

An unacceptable rating on this indicator should be given if the teacher does not provide the students with the necessary safety equipment; fails to ensure that students are aware of safe, environmentally appropriate, and ethical practices; leaves the students unsupervised at any point during a lab or classroom activity; or allows the students to conduct unsafe, environmentally inappropriate (i.e., improper handling or disposal of materials), or unethical practices (i.e., being disrespectful to the teacher, a student, or another living organism or engaging in activities that endanger others).

Even though most classroom activities require students to behave in an ethical manner with their peers and teachers, an NA may be chosen if a laboratory or classroom activity where this indicator would be relevant is not part of the lesson being observed.

General Rubric

1. This item should be rated a 1 if there was evidence of any significant safety violation or inappropriate behavior that endangered or resulted in unethical treatment of the students or teacher in the classroom, and the teacher did not handle this situation appropriately. The teacher did not monitor or correct safety violations or unethical behavior.
2. This item should be rated a 2 if there were several minor instances of a safety violation or ethically inappropriate behavior that **were not** quickly and successfully corrected by the teacher.
3. This item should be rated a 3 if there are some minor instances of a safety violation or ethically inappropriate behavior, most of which **were** quickly and successfully corrected by the teacher. A few instances of safety violations or ethically inappropriate behavior may have been ignored or gone unseen by the teacher.
4. This item should be rated a 4 if there were very few instances of ethical/safety neglect, because the teacher had clearly established classroom safety/ethical practices and consistently monitored the classroom, enforcing these policies.
5. This item should be rated a 5 if there were no instances of safety violations or ethically inappropriate behaviors because the teacher had clearly established practices and consistently monitored the classroom, explicitly reminding students of why these policies are necessary and modeling safe/ethical practices (i.e., wearing safety goggles at all times in the lab setting).

Specific Examples of Supporting Evidence

1. During this chemistry lab, the teacher left the classroom while students were using Bunsen burners to conduct "flame tests" in order to identify the color of various metal salt solutions placed in the flame. Students were left unsupervised without instruction in proper safety precautions, and they were not wearing goggles, gloves, or lab aprons. Upon returning to the room, the teacher did not monitor the lab area and then ignored the students as they poured the chemical liquid waste down the drain of the classroom sink and disposed of chemically contaminated paper towels in the classroom trash can, not in the solid and liquid chemical waste containers under the fume hood.
2. During this chemistry lab where students placed acidic solutions of metal salts into a Bunsen burner flame to observe color changes (i.e., the "flame test"), the teacher moved among the lab groups to demonstrate how to handle and then dispose of all the materials safely. Several students removed their goggles to "get a better look" at the colors in the flame, and the teacher, not wearing goggles himself, did not insist that they put them back on. In addition, once they were finished or when the bell rang, many groups ignored previous instructions and poured their unused acidic metal salt solutions down the common classroom drain, not the liquid chemical waste disposal in the fume hood.
3. During this chemistry lab where students placed acidic solutions of metal salts into a Bunsen burner flame to observe color changes (i.e., the "flame test"), the teacher moved among the lab groups to demonstrate how to handle and then dispose of all the materials safely. Although the teacher continually monitored student group work, reminding them to keep their goggles on, keep long hair pulled back and away from the flame, and handle chemicals carefully with gloves, a few students continually removed their goggles and refused to put them back on because "They get all fogged up and I can't see!" The teacher was not wearing goggles himself, and he ignored this group after correcting them once. As the bell rang, the teacher called out to all groups to send a member back to the fume hood with their unused solutions for proper disposal in the chemical waste container.
4. During this chemistry lab where students placed acidic solutions of metal salts into a Bunsen burner flame to observe color changes (i.e., the "flame test"), the teacher demonstrated the safe procedures at the front of the classroom before allowing students to begin work. While students were working, the teacher moved among the lab groups to further demonstrate how to handle and dispose of all chemicals, continually monitored for safety violations, reminding students to keep their goggles on, keep long hair pulled back and away from the flame, and handle chemicals carefully with gloves. When a few students continually removed their goggles and refused to put them back on because "They get all fogged up and I can't see!" the teacher removed the students from the lab activity until they were wiling to follow the rules. Before the bell rang, the teacher called out to all groups to send a member back to the fume hood with their unused solutions for proper disposal in the chemical waste container.
5. During this chemistry lab where students placed acidic solutions of metal salts into a Bunsen burner flame to observe color changes (i.e., the "flame test"), the teacher demonstrated and explained the purpose for the necessary safe procedures at the front of the classroom before allowing students to begin work. While students were working, the teacher, wearing goggles and gloves, moved among the lab groups to further demonstrate how to handle and dispose of all chemicals, continually monitored for safety violations, reminding students to keep their goggles on, keep long hair pulled back and away from the flame, and handle chemicals carefully with gloves. Students followed the safety rules throughout the lab activity. In addition, the teacher stopped the class activity five minutes

before the end of class and monitored each group's proper disposal of unused chemical solutions and solid waste.

Mathematics and Science Content—Section 4

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).

In this item, the emphasis on *worthwhile* captures the degree to which important mathematical or scientific ideas are central to the lesson. Since the significance of content is highly context-specific and based upon the intended goals of the course being observed, the rater should rely on his or her judgment as an expert in the content area in order to determine whether the content was truly worthwhile for the students. Further, the rater should use knowledge of applicable national and state standards, as well as the developmental appropriateness (i.e., whether it is appropriate for the grade level of the class) of the content presented. Beyond just considering the content's connectedness to accountability standards, the rater should consider the significance of the examples and activities the teacher used to cover these standards, and whether these examples incorporate worthwhile mathematical or scientific concepts appropriately.

General Rubric

1. This item should be rated a 1 if the content covered and/or tasks, examples, or activities chosen by the teacher were unrelated to the science or mathematics content of the course.
2. This item should be rated a 2 if the content covered and/or tasks, examples, or activities chosen by the teacher were distantly or only sometimes related to the science or mathematics content of the course. This item should also be rated a 2 if the content chosen was developmentally inappropriate—either too low-level or too advanced for the students.
3. This item should be rated a 3 if the content covered was significant and relevant to the science or mathematics content of the course, but the presentation, tasks, examples, or activities chosen were prescriptive, superficial, or contrived and did not allow the students to make meaningful connections to mathematical or scientific ideas. This item should also be rated a 3 if the content covered was focused toward general standardized test preparation in mathematics or science for the grade level rather than the specific content objectives of the course.
4. This item should be rated a 4 if the content covered and/or tasks, examples, or activities chosen by the teacher were clearly related to the significant science or mathematics content of the course, and the tasks, examples, or activities that were used allowed for some student development of worthwhile connections to the mathematical or scientific ideas.
5. This item should be rated a 5 if the content covered and/or tasks, examples, or activities chosen by the teacher were clearly and explicitly related to significant science and mathematics concepts in ways that allowed students to gain a deeper understanding and make worthwhile connections to the mathematical or scientific ideas.

Specific Examples of Supporting Evidence (Mathematics)

1. This teacher showed the movie *A Beautiful Mind* to the class while she sat at her desk.
2. The teacher covered Algebra II concepts with beginning Algebra I students. She said she wanted to see what would happen if she tried to cover this more advanced material. The students were confused and had difficulty participating in the lesson.
3. The topics covered during this class period did not relate to this high school course. The content was over topics from previous courses, including elementary and middle school courses. The teacher said that students needed to know this content for their state standardized test and to continue successfully in mathematics classes.
4. The teacher's objectives for this lesson were to demonstrate some specific concepts in geometry. This material is assessed on state tests and is in the curriculum and has a few applications to the real world. However, the teacher mentioned that these concepts were not central to the discipline and were not often used for anything.
5. During this algebra lesson, the teacher first reviewed some foundational concepts on linear functions and then had students explore quadratic functions in a project-based context. The teacher accentuated that using quadratic functions to accomplish the goals of the project was an authentic and useful mathematical skill for the students to learn. The teacher made it clear that the project was designed directly from the state standards for quadratic functions, and that that the department had used these standards to come up with an engaging and rigorous project.

Specific Examples of Supporting Evidence (Science)

1. The teacher showed the movie *Jurassic Park* to the 9th-grade biology class while she sat at her desk not interacting with the students. No guidelines for viewing or discussion of how the movie related to the content, concepts, or specific objectives of the course were provided. Some students watched the movie, while others had their heads down on their desks or chatted/texted each other.
2. The teacher challenged her Biology I students to write essays on a prompt from a released AP Biology test: "Biological systems utilize free energy and molecular building blocks to grow, to reproduce, and to maintain dynamic homeostasis." The teacher told the students that she wanted to see what would happen if they tried to work on this more advanced material without any introduction or explanations to scaffold the content. Although a few students worked diligently, most of the students were openly confused and had difficulty participating in the activity.
3. The teacher told the students that the objectives for this lesson were for them to be able to identify and describe the characteristics of living things. The material is aligned with state standards, and questions on the high-stakes state tests often ask students to demonstrate mastery of this objective. Although the distinction between living and non-living is relevant and important to the discipline of biology, the students were observed simply copying notes from a PowerPoint presentation. Both students and the teacher asked questions that were focused on logistics, such as, "Should we put these notes in our Biology folder and turn them in to you at the end of class?" [student] or "What are the 7 characteristics of life?" [Teacher read the seven characteristics of life from the slide to illustrate what information the students should be putting into their notes].
4. The teacher provided each student pair with a copy of the seven characteristics of life (listed here: http://www.teachersdomain.org/resource/tdc02.sci.life.colt.nonliving). The

students were instructed to compare and match each characteristic of life with a list of 21 living and non-living things ranging from cell phones to tadpoles by drawing lines on a worksheet. Students shared their results but did not discuss reasons why they made the choices they did.

5. The teacher provided each student pair with a copy of the seven characteristics of life: (listed here: http://www.teachersdomain.org/resource/tdc02.sci.life.colt.nonliving. The students were instructed to compare and match each characteristic of life with a list of 21 living and non-living things ranging from cell phones to tadpoles. Students shared their results in a lively and interactive debate.

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.).

This indicator assesses the degree to which the teacher demonstrates deep knowledge and fluidity with the content, as evidenced by the teacher giving detailed and clear explanations, using the big ideas of the content area as a unifying theme, calling attention to applications of the concepts being taught, and fluidly using examples and connections within the subject area. The teacher's depth of subject matter knowledge can also be assessed by observing how his or her understanding of student mistakes, common misconceptions, or alternative ways of thinking about and solving problems is used to help build student knowledge. The teacher's fluency with the discipline can also be evidenced by skillful facilitation of group discussions using probing questions to guide students' thinking, as well as the ability to give clear and, if needed, multiple examples and to use different methods for the explanation of concepts.

General Rubric

1. This item should be rated a 1 if there was a significant issue with the teacher's understanding and/or communication of the content that negatively impacted student learning during the class period.
2. This item should be rated a 2 if there were several smaller issues with the teacher's understanding and/or communication of the content that sometimes had a negative impact on student learning.
3. This item should be rated a 3 if there were no issues with the teacher's understanding of the content and its accuracy, but the teacher was not always fluid or did not try to present the content in multiple ways. When students appeared confused, the teacher was unable to reteach the content in a completely clear, understandable, and/or transparent way such that most students understood.
4. This item should be rated a 4 if the teacher clearly understood the content and how to successfully communicate the content to most students in the class. The teacher used multiple examples and strategies to engage students with the content. The teacher's depth of content knowledge enhanced student learning.
5. This item should be rated a 5 if the teacher clearly understood the content and how to successfully communicate the content to *all* students in the class. The teacher was able to present interesting and relevant examples, explain concepts in multiple ways, facilitate discussions, connect the content to the big ideas of the discipline, use advanced questioning strategies to guide student learning, and identify and use common

misconceptions or alternative ideas as learning tools. The teacher's depth of content knowledge greatly enhanced student learning.

Specific Examples of Supporting Evidence (Science)

1. The teacher's lecture on using balanced chemical equations to solve stoichiometry problems was very confusing; he kept changing what he was saying and correcting himself and was constantly referring to the example from the teacher's guide, which he had presented on the overhead projector. The teacher did not check if the students understood, and, even though some of the students called out questions or made suggestions about how to solve the problem, the teacher did not appear to listen or respond to them.
2. The teacher was able to go through and discuss each step of the example stoichiometry problem on the overhead projector—using a pre-printed overhead master from the teacher's guide materials provided by the publisher. However, when the students asked the teacher to explain a homework problem on the board, the teacher confused himself and the students because he forgot to balance the chemical equation before setting up the stoichiometric ratios of reactants to products.
3. The teacher illustrated how to solve stoichiometry problems step-by-step at the board, starting with balancing chemical equations, predicting the appropriate products given certain reactants, and then applying correct stoichiometric ratios to calculate masses of products that could be formed. The teacher was able to answer students' questions by using another problem, starting from the beginning each time and carrying out each step in sequence. Some students seemed unable to predict appropriate products when given reactants, and the teacher did not address this by connecting to their previous work on identifying types of chemical reactions; he simply repeated, with emphasis, each step that he had written on the board.
4. Before beginning to illustrate how to solve stoichiometry problems step-by-step on the board with the whole class, the teacher had each group of students complete a warm up activity that connected to their prior work with predicting products of reactions and refreshed their ability to characterize types of chemical reactions from the reactants given. Once most of the students successfully demonstrated this skill, the teacher had each group write a balanced chemical equation for a different set of reactants, then go to the board to solve for the mass of products that could be produced, step-by-step. The teacher monitored each group's work, facilitated with questions to those working at the board and those watching in class, and then used the student examples to explain and correct any mistakes.
5. The teacher began this lesson on solving stoichiometry problems with a warm up activity that connected to and assessed the students' ability to predict products of a reaction by recognizing and characterizing the type of chemical reactions possible given specific products and conditions. Once most of the students successfully demonstrated this skill, the teacher introduced the concept of stoichiometric ratios as recipes for chemical reactions by describing how she modified a recipe for chocolate chip cookies when she only had one-half the amount of chocolate chips to use. The teacher had each group write a balanced chemical equation for a different set of reactants and go to the board to solve for the mass of products that could be produced, step-by-step. The teacher monitored each group's work, facilitated with questions to those working at the board and those watching in class, and then used the student examples to explain and correct any mistakes.

Specific Examples of Supporting Evidence (Mathematics)

1. This teacher's lecture was very confusing. The teacher kept changing what he was saying and correcting himself and was constantly referring to his notes. The teacher did not check whether the students understood, and his explanations were disorganized and unclear.
2. The teacher was able to clearly communicate the procedures for operations on matrices but had a lot of trouble addressing students' questions about the process responding when students said they didn't understand.
3. The teacher's board work was clear. The teacher showed all of the steps and began each problem by writing down the equation that was going to be used to solve the problem. The teacher gave the students an algorithm/list of steps for solving linear inequalities. The teacher's examples were sometimes difficult to connect to the lesson. For example, the teacher gave a real-life example of a concept that didn't make sense.
4. The teacher seemed competent to deliver the content, give real-world examples, and field occasional question from the students, even if the question was not something directly related to the day's prepared content. The teacher seemed to have a lot of knowledge about the applications of what being taught and integrated this discussion throughout the lesson.
5. The teacher was consistently able to explain the concepts of the lesson in more than one way and often did this even without being prompted to by students. He regularly used real-world applications to make the content more understandable, fluidly moving between examples and strategies, and was able to clear up student misconceptions and incomplete understandings without any issues or hesitance.

4.3 Content Accuracy: Teacher written and verbal content information was accurate.

Written content information can include information provided by the teacher on tests, quizzes, worksheets, handouts, dry erase boards, PowerPoint presentations, overheads, etc. Verbal content information is anything the teacher says out loud during the class period. Since it is essential that content information be communicated in a clear, accurate, and unproblematic manner, this item assesses the teacher's ability to provide accurate written and verbal content information.

In mathematics, an example of ambiguous or unclear written content that would be applicable to this indicator would be if the teacher used the same letter to represent two different variables in the same problem. If no errors, ambiguities, or other issues are observed in the written or verbal content information of the lesson, this indicator should be rated as a 5. If there are errors with the written or verbal content of the lesson, the rating for this indicator may be reduced based on the severity of the violation of content accuracy and/or the level of ambiguity. When considering worksheets, it does not matter whether teachers actually wrote the content information themselves; they are responsible for the accuracy and clarity of the written content communicated during the class period. This indicator does not include written content in a textbook. As shown on the rubric, it is important to note whether the mistake was caught and corrected when determining a rating.

General Rubric

1. This item should be rated a 1 if there was a major instance of incorrect written or verbal content information communicated by the teacher that was not corrected, and this mistake had a large negative impact on student learning.

2. This item should be rated a 2 if there was a major instance of incorrect written or verbal content information that the teacher caught and corrected, or if there were a number of minor written or verbal content mistakes, inconsistencies, and/or ambiguities that negatively impacted learning.
3. This item should be rated a 3 if there were minor written or verbal content issues, and the teacher did not correct or catch all of them.
4. This item should be rated a 4 if there were only minor content mistakes or ambiguities that were corrected by the teacher.
5. This item should be rated a 5 if there were no examples of incorrect or ambiguous written or verbal content information communicated by the teacher during the class period.

Specific Examples of Supporting Evidence

1. During the observation, the teacher wrote the equation for the slope of a linear function as the change in x divided by the change in y, and then worked the problem set on the board using this formula.
2. The teacher made one major mistake on the board that was eventually caught. When a student brought it up, the teacher seemed to know what the student was talking about and was then willing to address the mistake.
3. The teacher gave the students a handout with problems that she immediately realized did not correspond to the day's objectives and then attempted to alter the problems. The alterations had some mistakes in them, and the students were left confused, as these mistakes were not noticed.
4. There was a mistake in the test review where the teacher had written out the answers to the problems and had written the wrong letter. The teacher corrected this mistake with the class, and all other written content information was accurate.
5. The examples the teacher worked on the board were correct. The handouts were clear and well organized. There were no examples of written inaccuracies during this lesson.

4.4 Content Assessments: Formal assessments used by teacher (if available) were consistent with content objectives (homework, lab sheets, tests, quizzes, etc.).

A formal assessment is interpreted as any work by the student that the teacher either collects for later evaluation or checks for correctness during the class period. Formal assessments can include homework assignments, group assignments, lab sheets, tests, quizzes, and worksheets, as well as teacher rubrics for student presentations, papers, or projects. This indicator measures how well the formal assessments are aligned with the objectives of the instruction. The degree to which the content is covered, in what depth, and with what emphases should all be considered when evaluating the quality of the formal assessments.

An NA should be chosen in the case where the teacher uses no formal assessments during the lesson.

General Rubric

1. This item should be rated a 1 if there was a formal assessment during the lesson, but this formal assessment was highly inappropriate and not matched with the content objectives.
2. This item should be rated a 2 if there was a formal assessment during the lesson, but the assessment was poorly designed or not entirely consistent with content objectives.

3. This item should be rated a 3 if there was a formal assessment during the lesson, and this formal assessment was generally appropriate and matched with content objectives.
4. This item should be rated a 4 if there was a formal assessment during the lesson, and this formal assessment was well designed to evaluate student understanding of important mathematical and scientific concepts that had been central components of instruction in the classroom.
5. This item should be rated a 5 if there was a formal assessment during the lesson, and this formal assessment was well designed to evaluate student understanding of important mathematical and scientific concepts that had been central components of instruction in the classroom. The assessment was also designed to push students' thinking to the next level and provide opportunities for challenge and additional learning.

Specific Examples of Supporting Evidence

1. The worksheet the teacher gave out to students was filled with mistakes, and the students complained that they had not really covered any of the material on it before. The teacher insisted that the students keep working and refer to their textbooks when they had issues, but most students simply stopped working.
2. The quiz that the teacher gave out in class seemed to be too difficult for students, and many students raised their hands and said they didn't understand. The teacher responded by having the class do the quiz as a whole-class activity.
3. The teacher announced to the students that the classwork from this class period would be a formal assessment and told them they would have to turn it in. The textbook-based questions seemed to be adequately in line with her instructional objectives of having the students identify the properties of the tangent function, although the complicated algebra involved caused confusion and frustration for some students. Nonetheless, the teacher provided support for these students and answered their questions so they could complete the exercises.
4. The lab sheets were consistent with the instructional objectives of having the students design and conduct experiments to explore the effect of temperature on the solubility of different metal salts. As a guided inquiry, the lab sheets were designed to help provide clear instructions for students about the steps in the procedure but left open choices about some variables, like temperatures of the solvent to use. Most students were able to collect the data, create graphs, and describe the difference in solubility curves for each metal salt tested. Some students needed a little additional guidance/motivation, which the teacher was able to provide as she monitored and checked the work of each lab group during the class.
5. During this class, students worked on one part of a larger project—an instructional video for the high school band presenting and explaining a merchandising plan for spirit t-shirts to be sold at football games. In this class session, the students were writing up the first draft of the video storyboard, which contained a graphic showing the costs of materials and labor and the relationship between the prices that could be charged and the profit that could be made. The teacher also said to the observing team that for the freshman, she likes having little pieces due along the way, like the assignment today, so they can keep up with everything that will go into the video. These were excellent means of assessing students formally in project-based instruction.

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.).

This indicator captures how well the teacher facilitates conceptual understanding by representing relationships or patterns in abstract or symbolic ways. Moving toward abstraction can assist students in understanding the content as a coherent and integrated whole, as opposed to a set of facts, procedures, or vocabulary terms. Abstraction can lead students to see the "big picture" and connections between important concepts in the discipline. In science, abstraction is often represented by the modeling of complex systems or simulations that synthesize complex interactions from the molecular to ecological levels. In a mathematics lesson about linear relationships between variables, after focusing on several cases where the variables have fixed values, the teacher might scaffold the students to generalize their understanding of the relationship by writing the linear equation using symbols.

A rating of 3 is the default score for this indicator, if you notice nothing especially good or especially poor about the use of abstraction. It is important when awarding a high score (4 or 5) on this indicator is to consider whether the abstraction is being used for a relevant and useful purpose; for example, are students writing an equation because it's part of a school exercise, or are they writing an equation to help them accomplish some larger, more authentic goal?

An NA is an appropriate rating for lessons where abstraction of or generalization to complex systems does not arise for appropriate reasons related to the lesson purposes; for example, if the class is focused on data collection for a lab activity, it is unlikely at that point in the learning sequence that abstraction would be appropriate. Thus if abstractions were not included in the lesson, but you feel this lack of inclusion was an appropriate instructional decision, rate this indicator NA.

Math-Specific Instructions

This indicator captures how well the teacher facilitates conceptual understanding by representing relationships or patterns in abstract or symbolic ways. The teacher may use multiple representations—such as verbal, tabular, graphical, and symbolic—to better allow students to understand concepts and connections between multiple representations. Finally, the teacher should, if appropriate, ensure that students understand what symbols and other abstract representations really "mean" through explicit discussion. In middle school lessons, abstraction can arise in a variety of ways. For example, any formula that has variables in it (such as area = length * width) is considered an element of abstraction, because you can plug concrete, specific values (like $L = 2$ and $W = 3$) into this general equation. This indicator is considered applicable to the observed lesson when (1) a letter or another representation (like an icon) is used to stand for an unknown value, or (2) a general relationship (like an equation) is shown for which many specific cases would hold true.

Science-Specific Instructions

This indicator captures how well the teacher facilitates deeper understanding by choosing tasks or lab inquiries that prompt students to make connections between important concepts beyond the immediate scope of the lesson. For example, a teacher might use an interactive computer simulation to facilitate student understanding of the relationship between the hydrologic cycle and the phase changes and physical properties of H_2O. With such an activity, it is important that the teacher make explicit that this is a model of a complex process in time and space (i.e., that the changes depicted in this water cycle occur in extremely short periods of time on the molecular level but also happen over the course of geologic time on the macroscopic scale).

General Rubric

1. This item should be rated a 1 if there was a major issue with the teacher's use of abstraction that had a negative impact on student learning during the class period.
2. This item should be rated a 2 if the teacher neglected important explanation and discussion of abstraction that was being used during the class period, and this missed opportunity had a negative impact on student learning.
3. This item should be rated a 3 if the teacher's use of abstraction was adequate—the teacher allowed for some discussion or explanation and did not use abstraction inappropriately.
4. This item should be rated a 4 if abstraction was used during the class period for a relevant and useful purpose. The teacher explicitly engaged students in some discussion of the meaning of the representation and/or successfully connected different representational forms. Perhaps there was a small missed opportunity with respect to facilitating some students' understanding of abstraction.
5. This item should be rated a 5 if abstraction was being used for a relevant and useful purpose, like modeling, supporting an argument for a scientific theory or mathematical proof, or progressively generalizing important ideas, AND if the teacher engaged students in a discussion of the meaning and purpose of the representation. The abstractions were presented in a way such that they were understandable and accessible to all students in the class.

Specific Examples of Supporting Evidence

1. The teacher introduced the students to several new procedures that were written as symbolic equations. There was no discussion of why the procedures worked or what the numbers and symbols meant. The students were confused and repeatedly made mistakes applying the procedures.
2. This was an algebra lesson on comparing different cell phone plans. Students were explicitly asked to generate symbolic equations representing each cell phone plan; however, the teacher told the class to skip this part of the activity.
3. Abstraction seemed to be adequately used in this lesson. The notes about the different representations of functions clearly connected the symbolic equation to its meaning in terms of graphs, tables, and verbal descriptions of independent and dependent variables.
4. Students were collecting data and then using their graphing calculator to determine a line of best fit. Using the equation for the line of best fit, students would then make predictions for different values of the independent and dependent variables. The students were using their symbolic representations for a very practical and relevant purpose, and the teacher briefly discussed with students what the slope and intercept of their line meant. However, this discussion of the symbolic representation could have been more accentuated.
5. Students were working on minimizing a function given a system of linear and quadratic inequalities as constraints, and the symbolic expressions were well integrated, with the students coming up with the inequalities symbolically from verbal information and graphing them. Symbolism was also very prevalent and appropriately used during the warm up and wrap up. At all points of the lesson, the abstractions were connected well to what they meant and were being employed for the realistic purpose of mathematical modeling.

4.6 Content Relevance: During the lesson, it was made explicit to students why the content is important to learn.

This indicator assesses the degree to which the teacher explicitly places the content into the big picture of the associated discipline, making it clear why these concepts are significant and important to learn. This indicator may be evidenced by the teacher discussing the significance of the content with the students during the class period or giving the students activities that explicitly bring out the big picture and/or significance of the material and facilitate students' understanding of why this content is fundamental. One example of such a strategy would be focusing student work for a given week through several guiding questions about why the class is learning the content. If the teacher simply gives the students some problems that happen to be contextualized, this is not the same thing as engaging students in a discussion about why they are learning the content, and thus is not important evidence for this indicator. Also, simply telling students that they need to learn the content for future classes, future topics in this class, or for a test is not what we are trying to capture with this indicator.

Although it may seem inappropriate to penalize a teacher for not incorporating this indicator into every single lesson, it is important that we identify the degree to which these behaviors are present. If there is absolutely no mention or discussion of why the content being covered during the lesson is important to learn, this indicator should be rated as a 1. The indicator should be rated a 1 in this situation even if you feel such discussion would not be appropriate or possible for this particular lesson.

General Rubric

1. This item should be rated a 1 if there were no instances of it being made explicit to students why the content is important to learn.
2. This item should be rated a 2 if the teacher made only a brief reference to the importance of the content, and there was no elaboration or discussion. This item should also be rated a 2 if the teacher did not explicitly discuss content significance, but the significance was clearly implicit or obvious in the work students were doing.
3. This item should be rated a 3 if the teacher made some moves to tie in the significance of the content during the class period, perhaps mentioning it more than one time.
4. This item should be rated a 4 if the teacher engaged students in a discussion of why the content was important to learn.
5. This item should be rated a 5 if the importance of the content was a central theme that was discussed and expanded upon throughout the class period.

Specific Examples of Supporting Evidence (Science)

1. This lesson was focused on describing how genetic mutations occur; however, the teacher made no attempt to explain why it was important to learn about mutations or where they might have impact on students' health.
2. The teacher built on the previous day's lesson on the chemical structure of DNA by discussing how ionizing radiation can change this chemistry by creating free radicals that can react with the biomolecule. However, the teacher did not discuss where such ionizing radiation could be found in nature or what the chances are for it to produce significant damage.
3. The teacher had a guiding question on the board for the week: "How much radiation does your body absorb in one year?" The lesson focused on the types of nuclear decay that

produce radiation. The teacher referred back the question on the board at two points—once when a student asked about the relative differences in strength of penetration of alpha, beta, and gamma radiation and once when the teacher had the students go to an EPA website where they could calculate their personal radiation dosage on an annual basis. Although the activity was engaging and clearly relevant, the teacher did not make explicit how radiation dosage impacted students' health and well being or how it connected to their previous study of the chemistry of genetic mutations.

4. The teacher used the guiding question "How much radiation does your body absorb in one year?" to engage students in a multi-day investigation of the chemistry of DNA and how ionizing radiation can create genetic mutations that lead to cancer. This lesson had students calculating their personal radiation dosage using an EPA website as described above. Once the students completed the calculation, the teacher had the students repeat it assuming that they smoked a pack of cigarettes a day. Then the students and the teacher carried out an animated discussion of the multiple impacts on health that are created by absorbing this large amount of ionizing radiation.
5. To motivate students to learn the chemistry of the DNA molecule and the impact that mutations to it have on health, the teacher had students break up into groups and investigate how ionizing radiation from different radioisotopes can be absorbed in the body and what happens when they are. They were challenged to answer a driving question: "What impact will a nuclear waste facility have on our town's health and economy?" The teacher told the students that they would have to prepare to present the results of their research to the City Council who was considering whether they should allow a nuclear waste facility just outside the city limits. On the day this class was observed, student groups were actively researching online; for example, one group was reading how high levels of iodine-131 from the fall-out of the Chernobyl reactor explosion increased the levels of thyroid cancer in children exposed.

Specific Examples of Supporting Evidence (Mathematics)

1. This lesson was on learning to multiply and divide decimals; however, the teacher did not connect the lesson to why it was important to learn how to conduct operations on decimals.
2. This was a lesson on graphing on the coordinate plane. The teacher briefly mentioned that creating graphs of equations is something mathematicians do to make predictions but did not elaborate on this during the class period.
3. The teacher had a guiding question on the board for the week, which was "How can we model change over time using real world data?" The teacher mentioned the question on the board at two points—once when the students were talking about the activity they did timing themselves running different distances and once when the students were working a problem on the movement of a boat.
4. This geometry teacher launched a lesson on finding surface area by showing a conformer map of the world, in which area was distorted to preserve the shapes of the countries. The teacher briefly discussed this map with students, discussing with them what the issues are when we try to make a "net" of a three-dimensional shape like a sphere, and how this has implications for creating maps of the world.
5. The teacher told the students that the project they were starting was an opportunity for them to actually do mathematics. Their assignment was to plan a concert in their community using concepts they learned from algebra and geometry to create the layout for

the venue, create a merchandizing plan, etc. The teacher discussed with students how algebra and geometry concepts are used every day by businesses, and students spent the class period exploring authentic reasons why it is important to learn algebra and geometry.

4.7 Content Interconnections: Appropriate connections were made to other areas of mathematics or science and/or to other disciplines.

Connecting mathematical and scientific concepts across the disciplines tends to generalize the content and make it more coherent. A mathematics lesson on graphing quadratic equations might connect with related principles of physics. A science lesson on water cycles might connect with global warming and its economic impact on our nation. This indicator assesses the degree to which the teacher connected the mathematics or science content in the lesson to other areas of mathematics or science, or to other disciplines. For example, an algebra lesson on linear functions might connect to supply and demand in economics; a motion geometry lesson on rotation might be connected to linear functions in algebra. A chemistry lesson on the solvent properties of water might connect to an environmental science lesson on pollution of ground water from industrial wastes, the politics that gave rise to the establishment of federal agencies such as the EPA, and how understanding the chemical behavior of solvents and contaminants is applied to prevent or clean up such contamination.

Although it may seem inappropriate to penalize a teacher for not incorporating these types of connections into every single lesson they teach, it is important that we identify the degree to which these behaviors are present. If absolutely no connections between the concepts being learned and other disciplines or other areas of mathematics/science are made during the class period, this indicator should be rated a 1. The indicator should be rated a 1 in this situation even if you feel such connections would not be appropriate or possible for this particular lesson.

General Rubric

1. This item should be rated a 1 if no connections were made to other areas of mathematics/science or other academic disciplines, or if connections were made that were inappropriate or incorrect.
2. This item should be rated a 2 if a minor connection was made to another area of mathematics/science or other academic disciplines, but the teacher did not explicitly discuss this connection with the class.
3. This item should be rated a 3 if the teacher connected the content being learned to another area of mathematics/science or other academic disciplines, and if the teacher explicitly brought this connection to students' attention.
4. This item should be rated a 4 if the teacher included one or more connections between the content and other areas of mathematics/science or other academic disciplines, or problems that professionals actually encounter, AND the teacher engaged the students in an extended discussion or activity relating to these connections.
5. This item should be rated a 5 if, throughout the class period, the content was taught in the context of its use in other academic disciplines, other areas of mathematics/science, or in the work of professionals, AND the teacher clearly demonstrated deep knowledge about how the content is used in those areas.

Specific Examples of Supporting Evidence (Science)

1. In this lesson, students were shown step-by-step how to plug numbers from a table of hydrogen ion concentrations into a formula stored in their calculators in order to come up

with the pH of an aqueous solution. There was no attempt made by the teacher to explain where the formula came from or to connect these calculations to other topics covered in the chemistry course, other sciences, or to other disciplines.

2. In this lesson, the teacher named each variable in the formula for calculating the pH of a solution and gave the students a worksheet of practice problems; some problems provided the hydrogen ion concentration and required solving for pH while others provided the pH and asked the students to calculate the hydrogen ion concentration. The worksheet had "before 1947 and after 2007" pictures of a dead fish on the shore of a lake that had been acidified by acid rain, but the teacher made only a passing reference to "what a shame" it was to see such damage.
3. The teacher opened this lesson with a short video that showed how various reactive forms of nitrogen could be produced by chemical reactions from industrial operations, over-fertilization with ammonia, and fossil fuel combustion. The video concluded with a graph showing the correlation between the rise in reactive nitrogen in the environment and the increase in acidification of soil, lakes, and atmosphere. Then the teacher provided the students with a worksheet that had them calculate the pH of different natural water, air, and soil samples where tests had determined the hydrogen ion concentration in each.
4. After showing the video described above, the teacher provided students with a diagram of the "nitrogen cycle" and discussed how the processes depicted accomplished a natural balance for nitrogen in the environment. Several students offered opinions about "how bad the chemical industry is to dump excess nitrous oxides into the atmosphere" or "how we need to stop burning fossil fuels to generate electricity." The teacher accepted all opinions as valid but suggested that eliminating the chemical industry or all fossil fuel power plants tomorrow would not be realistic. She asked the students to solve several problems given either hydrogen ion concentrations or pH of soil, water, and atmospheric data from the EPA website.
5. The teacher opened class with a video described above, and then provided students with a diagram of the nitrogen cycle, including chemical names, general formulas, and some reactions that occur at each phase. The teacher assigned a different component of the nitrogen cycle to each group of students, and then had them use the EPA website and other web resources to research reactive forms of nitrogen and the chemical reactions they impact in the nitrogen cycle. Not only did the students have to calculate the pH of soil, water, or atmospheric samples from EPA—test data of hydrogen ion concentration—they were challenged to calculate pH and determine what would happen with the reactions in their component of the cycle if the hydrogen ion concentrations increased 10-fold, 20-fold or 50-fold. The teacher prompted students to remember what they had learned in a previous unit on chemical equilibrium and dynamics when making their predictions of impact.

Specific Examples of Supporting Evidence (Mathematics)

1. In this lesson, students procedurally learned how to multiply matrices. There was no connection to other areas of mathematics or to other disciplines.
2. This was a lesson on quadratic functions, and there were two application problems that connected to motion in physics with a ball being thrown into the air. However, the teacher worked these problems just like any other problems on quadratic functions, mainly ignoring the context and its connection to another discipline.

3. The teacher connected the content in this algebra class to concepts in economics by doing a launch activity where he showed supply and demand lines. The remainder of the problems the students worked was not anchored in a context.
4. In this lesson, concepts from algebra were applied to concepts in physics by looking at Boolean algebra in circuits; the class did an activity where they explored some circuits.
5. This project was situated in the context of making a variety of math- and science-related decisions about building an outdoor theater for the community. Students integrated concepts from physics, geometry, biology, and algebra into a large design project.

4.8 Content Societal Impact: During the lesson, there was discussion about the content topic's role in history, current events, or relevant "real-world" problems.

Concepts in mathematics and science are continuously being developed, validated, revisited, and modified based on human society's changing body of knowledge, as events unfold in the world. This indicator assesses the degree to which the teacher discusses or helps students develop their thinking about the historical development of concepts in mathematics and science, as well as how concepts from mathematics and science are important to current events, current human activity, and current decision-making.

For example, an introduction of the Pythagorean Theorem could include a discussion of whether Pythagoras should have truly been credited with this discovery, or if there is evidence that Babylonian mathematicians understood the relationship previously. Or in a science classroom unit on Evolutionary Theory, students are introduced not only to Darwin's research that led to his concept of natural selection but also to the ideas of other scientists who proposed alternative mechanisms for speciation and adaptation. A lesson about calculating the area of irregular shapes in geometry could incorporate a discussion about map projections and issues of social justice that arise when determining whether to preserve size or shape of countries when flattening a globe onto a two-dimensional map.

Students could also use mathematics to understand current issues and decisions; one example would be investigating debt, interest, and amortization when discussing exponential functions during an economic downturn. In the study of both science and mathematics, students need to understand that the body of knowledge representing these disciplines is the work of human beings who have conducted research while being influenced by their personal habits of mind, the culture in which they lived, recognition of the needs of their society, and the technologies available to them to solve problems.

This indicator also assesses whether the teacher connects mathematics or science concepts to non-school (i.e., "real world") contexts. For example, a lesson on linear functions might be framed in terms of the students examining different cell phone plans. A biology lesson on energy production from carbohydrate metabolism might open up a discussion about the pros and cons of using artificial sweeteners or the rise in obesity in children due to nutritional choices.

Although it may seem inappropriate to penalize a teacher for not incorporating these connections into every single lesson, it is important that we identify the degree to which these behaviors are present. If absolutely no connections between mathematics/science concepts and human events are made during the class period, this indicator should be rated as a 1. The indicator should be rated a 1 in this situation even if you feel such connections would not be appropriate or possible for this particular lesson. If there was some mention of history or current events during the lesson, this indicator should be rated between a 1 and a 5, depending

on the quality of the discussion, the depth of knowledge of the teacher about these issues, the timeliness and relevance of the discussion, and the level of student interest.

General Rubric

1. This item should be rated a 1 if there was no discussion about the content topic's role in history, current events, or relevant real-world problems during the class period, or if there was a discussion, but it was inappropriate or incorrect.
2. This item should be rated a 2 if a connection was made to history, current events, or relevant real-world problems that the teacher did not specifically mention or call attention to (i.e., it was written on a worksheet), or if the teacher made a *general* and brief comment about a possible connection to history or current events that was not expanded upon.
3. This item should be rated a 3 if the teacher explicitly called attention to how the content was specifically connected to history, current events, or relevant real-world problems but did not fully expand upon this idea with the class that leads to student learning.
4. This item should be rated a 4 if the teacher explicitly called attention to how the content was connected to history, current events, or relevant real-world problems and engaged the class in an extended discussion of this connection.
5. This item should be rated a 5 if, throughout the class period, the students were doing activities and/or having discussions related to the content topic's role in history, current events, or relevant real-world problems and if the teacher clearly demonstrated deep knowledge about how this topic was connected to history or current events or in the solution of real-world problems.

Specific Examples of Supporting Evidence (Science)

1. In this lesson, the teacher wrote the chemical reaction for the Haber-Bosch process for the industrial production of ammonia and then demonstrated how to balance the equation. No mention of the historical significance or economic impact of this process was made.
2. In this lesson, the teacher wrote the chemical reaction for the Haber-Bosch process on the board and asked the students to balance the equation, mentioning that it is used for the commercial production of ammonia, a component of fertilizers. No further mention of the historical significance or economic impact of this process was made.
3. The teacher began the class with a short video showing the many commercial and military uses for ammonia, the end product of the Haber-Bosch process. The teacher then wrote the chemical reaction on the board, asked the students to balance the equation, and then challenged them to calculate how much of each reactant would be required to produce the 131×10^6 metric tons of ammonia that were produced in 2010.
4. The teacher began the class with the video showing many uses for ammonia produced by the Haber-Bosch process and then broke the class up into groups for further investigations about the impact of this economically significant product, historically and in current times, for military (explosives) and agribusiness (fertilizers) uses. For example, some groups were to collect information on all the chemical reactions required to produce ammonia (beyond just the Haber-Bosch process) and to describe how these resources have been located, mined, harvested, or otherwise produced throughout the last century up to today.
5. The teacher conducted the class in much the same manner as item 4 above describes but added that student groups had to also conduct research on the scientists who developed these chemical processes and how their socio-political circumstances influenced their

work. For example, one student group researched how Fritz Haber's initial studies were or were not influenced by World War I British embargo on German shipping access to and from Chile, then the main supplier of guano, which was the raw material for ammonia production at that time.

Specific Examples of Supporting Evidence (Mathematics)

1. The connection of the content to history or current events was not explicitly discussed by the teacher at all; the topic was multiplying matrices.
2. The teacher mentioned to the class how proofs are used by mathematicians even today to build new knowledge in their field, connecting this to the proofs the students were doing in class. However, it was just a passing comment, not a focus or a discussion.
3. This was an algebra lesson on comparing cell phone plans and making an advertisement for a cell phone company. Thus the activity was connected to the ads students see in the media regarding different cell phone plans, and the teacher explicitly called attention to this fact at one point. However, this idea was not expanded upon.
4. The teacher began a lesson on exponential growth by showing population growth rates for the surrounding county, which had experienced sharp increases over the past several years. The teacher discussed the data with students, and then the class moved into unrelated activities.
5. The project the students were working on throughout the class period focused on a current event in the students' city—a large charity event. Students were taking on roles of various people involved in organizing the event, from salespeople to lighting technicians to caterers, using math and science concepts as part of their role in this event.

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.

V. Post-Observational Teacher Interview/Survey

The Post-Observational Teacher Interview can be carried out face-to-face, via video-conferencing, through email or other online communication, or over the phone, and should take place very soon after the observation.

The Post-Observational Teacher Survey can be administered electronically if there is no opportunity to conduct the interview face-to-face. If the observer intends to remain blind to the educational background of the teacher while the interview is being conducted, it is important to instruct the teacher, prior to the interview, not to reveal this information directly or indirectly.

The responses the observer obtains to the interview questions may often overlap considerably, as a teacher may answer some questions partially or fully before the question formally comes up in the interview protocol. The teacher may also add more to his/her explanation of one question

while answering a later question. For this reason, it is important to look at the entire interview when examining the answer to any single question. The observer also needs to make a judgment about whether to ask a question if the teacher has already answered it during a different portion of the interview.

During the interview, teachers may refer to and elaborate on what occurred in other related lessons they have taught. It is important to remember to take into account the teacher's comments only as they relate to the lesson that was actually observed, unless otherwise indicated in the manual. The Post-Observational Teacher Interview may also be used as an opportunity for the teacher being observed to reflect on his or her own practice. The goals and interests of interviewer will influence the degree to which this reflection is encouraged and facilitated.

VI. Teacher Demographic Questionnaire

Relevant information relating to the teacher's background and professional and educational experiences that was not collected earlier (to allow observers to remain "blind" to this information if they wished) is collected in a demographic questionnaire. Examples of this information include the teacher's age, race/ethnicity, school, classes and grades taught, education, years teaching, and relevant professional experiences.