Exemplary Instruction Commentary: Secondary Science

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1. Lessons shown in video

Video 1 is from Lesson 2. Video 2 and Video 3 are from Lesson 3.

2. Promoting a positive environment

There were a few ways I tried to develop mutual respect for students with varied needs and backgrounds. I tried to be encouraging of the students' responses during the discussions in Lesson 2. It was a bit of a leap for the students, so I wanted to make sure everyone's responses were heard and respected. One specific example took place at the 5:14 minute mark of Video 2, where the male student in the front row was talking, but the female in the front row with the white shirt had raised her hand to speak. I had nodded to her, and then the student in the black shirt started to talk after the girl in the white shirt had started talking. The male student in the front row had talked a lot during the discussion, and I wanted to hear from the female in the white shirt because she is a bit quieter. I made a small hand gesture to the male student in the front row to let the female in the white shirt speak. He saw it and seemed to understand.

The female in the white shirt then made her point. I wanted to be sure that the male student noticed that the female student had a right to speak in class as well. I also tried to give the male student a subtle gesture so that he wouldn't be embarrassed.

One initial way I tried to demonstrate a rapport with my students was to take part in the high school's spirit week. The day that Video 2 and Video 3 were filmed, the spirit theme for the day was local sports teams, which is why I am wearing a hockey jersey in the video. You can see a few of the students wearing local sports memorabilia throughout the classroom as well. This was one example where I tried to connect with the students who liked sports, and give common ground to build on. Another example of trying to create a rapport with the students is 0:05 in Video 1, where we first look at the students' data. I am trying to connect with them on an authentic level about their data, and explain how science is often full of bad data that you have to sift out. In this clip, I am also trying to use a relaxed demeanor and allow some humor into my teaching, while still attempting to keep them on track.

To demonstrate my responsiveness to students with varied needs and backgrounds, I tried to include things in my lesson for multiple audiences. For example, above in the example from Video 2 at 5:14 minutes I tried to make sure to call on someone who raised their hand.

Many students don't feel comfortable speaking out in a large classroom discussion, preferring more structure and turn-taking when offering their ideas. However, many students do prefer being able to just speak, without the formality of raising hands. An example of this type of classroom discussion can be found at 2:09 minutes until about 2:40 minutes of Video 1. In this section, I am asking the students a general question, then asking the students to comment on what they are seeing. You can hear in the video many are describing what they saw in their test tubes in the lab. There are also students who prefer some direct instruction, or for me to tell them the answer to a few questions. During discussions, I only like to do this after I feel I have gotten all I can from them. One example of direct instruction after a discussion is found at the end of Video 1. From around 8:12 on Video 1 through the end, I ask the class a few questions, and then state that there are a couple of other things they should

keep in mind when trying to explain outliers in their data. I stated that the heat could have contributed to the color change in the test tube with only starch during the lab discussed in Lesson 1 and Lesson 2.

To demonstrate how I challenged students to engage in learning, I will use Video 1 as an example. When I teach, I find that by just moving around the classroom can help students stay focused. You can see in Video 1 at 7:45, I am teaching from the left side of the classroom, whereas in Video 1 at 4:00, I am teaching in the middle isle between the desks. Walking around the classroom promotes more of a discussion based response from the students. When a teacher is up front for a discussion, it can seem like they are more removed and overseeing the discussion, but in a true discussion, everyone should be equal participants. Therefore I try to manage the discussion from among the students when possible. Video 1 further shows how I challenge my students from 3:12 until 5:25. Here, I am engaging my students in discussion to help them discover why the test tube from the lab that only had sucrose, Benedict's solution, and sucrose, indicated positive for monosaccharides. I was challenging the students to come up with the answer on their own, and by the about 5:25 they had figured it out. I then showed them the images of sucrose, glucose and fructose on the screen. I wanted to challenge the students to think for themselves, while still allowing most of the students to be unafraid of making mistakes and saying the wrong thing.

Ensuring safety

In these particular videos, there little need for safety, however, I do try and maintain a safe environment for the students. This means that students aren't rough-housing in class, everyone is sitting down unless they have a reason to do otherwise. Also, in the lab the students are discussing, the students were required to wear goggles so that if any glass broke or hot water splashed, it wouldn't get in their eyes. Only one thing in the lab was somewhat dangerous.

Benedict's solution is a mild irritant to mucosal layers. However, the students put very small amounts in their test tubes, and the students wore goggles during this time as well. When not in use, the Benedict's solution stayed in the fume-hood where it would not be knocked over.

3. Engaging students in learning

For expression of the students' understanding of the learning targets, Video 3 has some good examples. Video 3 takes place during Lesson 3. At the beginning of Lesson 3, I gave the students the learning objectives and had them write them down in their own words. Then I asked a few to share their interpretations. It is important to have the students interact with the learning targets before the lesson, so they can see what to look for in the coming lesson. If the students can see what they are supposed to be learning, it will help them meet that goal of learning it.

At the end of Lesson 3, I presented my students with the following questions on the screen: "How do you think you did on these learning objectives?

Students will be able to:

Define enzyme and give at least 2 examples of enzymes

Describe the specificity the active site of an enzyme to their substrates"

I also asked the students some further questions to clarify their thinking, and to help them understand that I didn't want answers to the learning objectives, but how well they thought they learned them. Examples of those questions were:

"If you were tested on them today, how do you think you would do? "Were you able to stay focused?"

"What could you or I have done differently that would have helped you learn better?"

I then had the students respond with a think-pair-share activity, except I had the students write their "think" part down and hand it in to me before they left. I had the students write their responses so I could go over them later, but I heard some good things during the pair-share part as well. In Video 3, we see at 0:05 that the student in the black coat talks about how he would "do ok" with the information and would have to look at specificity a little bit more and study a bit more as well. Another example is at 1:37 where the girl in the white sweatshirt says that she "understood how enzymes break down macromolecules" but that most of the other stuff, specifically about the active site was a bit "fuzzy" with her, but that "with time they could be able to do it". The girl in the white sweatshirt also touched on why we need enzymes in order to b r e a k down macromolecules and digest them. So, quite a few students were able to understand the main concepts, and many had a few more questions on the topic.

Engaging students as they explain and justify claims

My instruction engaged students during a scientific inquiry in using data and science concepts to construct an evidence based explanation of a real world phenomenon by having the students p u t their data on the board for everyone to see and discuss. In Lesson 1, the students do a lab where they are putting different materials into test tubes and using an indicator to see what happens after those test tubes are incubated. The real world phenomenon is that in test tube 3, we put sucrase and sucrose, and they observed the Benedict's solution indicate positive for monosaccharides. Then in Lesson 2, when Video 1 takes place, we see the students put their data from the day before onto the board so the class can analyze multiple trials. From the start of Video 1, I go through the different classroom results with the students. I tried to ask questions only, and tried to directly tell them something only if they had come to the conclusion themselves. For example, in Video 1, at 3:11, I start to ask questions about test tube 3, the tube with sucrase and sucrose. The students describe what they see in the data. I ask them what colors they see and they respond with "yellow, orange, mango..." showing they are using the data. I then directly tell them that sucrose is a disaccharide. At 3:41 I ask them to give me what the indicator is indicating for, at which they respond: monosaccharides. These are some science concepts the students have learned and are bringing to the discussion. I then ask them the question of where did the monosaccharides, that the Benedict's solution is indicating for, come from? A couple of questions further, and one girl says sucrase breaks down sucrose (off s c r e e n) while the girl in the grey sweatshirt says the "starch breaks it up" on screen. The on screen girl eventually realizes that she wrote down and meant sucrase instead of starch. I then show them of the molecular structure of sucrose, glucose, and fructose, which they have seen in the past. All this points to the students taking scientific concepts they know, and combining it with the class data on the screen, to explain a real world phenomenon they see during their scientific inquiry from the lab. I then wanted to see if they had followed me and if they could all explain it themselves. So I gave them their conclusion rubric to complete as homework. I will comment on this later as well, but this is one area where I felt I could have done more to make sure the students really understood this. If I taught this again, I might have the students describe the process to their partners, to see if they could put what they had seen into words. I could have also had a few students repeat the explanation using data and scientific concepts back to me in their own words to see if most of them were able to truly follow the class discussion.

Link to prior knowledge and assets

The students had dealt with Benedict's solution during the previous semester with my mentor teacher, so I made sure to have them tell me what it indicates for. We see this at 1:20 on Video 1. I also asked them for some examples of monosaccharides. The students had also learned t h e difference between disaccharides, monosaccharides, and polysaccharides, so I asked them questions such as identifying what kind of saccharide a starch is. Here I asked the students at 6:13 on Video 1, and most knew it was a polysaccharide. We brainstormed together as to why the Benedict's solution indicated positive for a polysaccharide. To do so I tried to connect my instruction to personal experiences they have had. Toward the end of Video 1, I tried to help them understand

that heat can generate a chemical change. At 8:24 of Video 1, I ask the students how applied heat affects eggs, and they respond that it causes eggs to harden. We then made the jump that heat could have affected our results and caused the Benedict's s o l u t i o n to indicate positively in the test tube with starch.

We also see some great examples of personal applications to science from Video 2 as well. At 0:02 of Video 2, we see the board where it talks about Lactose intolerance. Lactose intolerance is fairly common in our culture, so the example problem is designed to help the students better understand enzymes and connect the role of enzymes to something familiar. The student in the white sweatshirt in the third row that asks a question at 4:48 on Video 2, states that her sister is partially lactose intolerant, and that she takes an enzyme pill. I was then able to explain that the enzyme that her sister takes is most likely lactase.

4. Deepen student learning

I pulled from student responses to generate better comprehension of the scientific concepts, practices and inquiry mainly by using questioning techniques in these lessons. By presenting a topic, then asking them questions in a discussion format, multiple student responses came out, and I was able to build on some of them as well. One example of a student response of a science concept is found in Video 2. The questions I had asked to the class were: "Lactose intolerance is a condition in which a person can't break down the sugar lactose. What kind of enzyme problem might these people be having? Could they take something to help them break down lactose?" During another period, a student had asked, after we discussed that these individuals can take a lactase pill, why a person couldn't simply inject lactase into their body. I liked the question, so I repeated it to my class in Video 2 at 3:28. After asking this question to my class, the girl in the white sweatshirt at 4:48 asked about her sister and the enzyme pill she would have to take before she ate. I was then able to build on that question and say that her sister most likely take Lactase enzymes, and that it does work to take them before you eat, but that almost every chemical in our bodies has a shelf life, and that she has to continue to take it.

An example of how I used student responses to develop understandings of scientific principles, inquiry, and the phenomenon being investigated is in Video 1 and takes place during the lab data analysis in Lesson 2. At 1:08 on Video 1, I ask the students the simple question: "into test tube 1, what did we add?" The students then responded that they had only added water and sucrase. I also asked what our indicator indicates. The students said monosaccharides, and then I described the color change. I then, at 2:02, asked if they had added any saccharides to test tube 1, and they said no. I then asked the question of whether test tube one matched what we thought it should at 2:09. In general they came to a consensus based on the data and what they knew, that it made sense. We see here that this is an example of asking questions, eliciting student responses and then building on those responses to further their learning.

Organizing and analyzing data

In Lesson 1, the students were to take note of the color change of their test tubes after Benedict's Solution was heated in their test tubes. Then in Lesson 2, I wrote 6 columns for 6 lab groups, and 5 rows one for each test tube. I then had the students write on the chart on the board the color each of their solutions after they were heated. This allowed the students to see everyone's data, letting them make a more informed choice with multiple trials. I then had facilitated looking for patterns by asking the questions about each test tube one at a time. An example of this is in Video 1 at 5:40 and when I start by asking them what they added into test tubes 4 and 5. When they said the contents, I asked them to focus on test tube 4, and asked them what kind of saccharide starch was, and then asked them what results they see in test tube 4. When they said orange, we then explored why there was a color change. One student at 7:12 said contamination. You can't hear her say that, but I repeated it a second later. I also continued saying that a student had mentioned it at 7:32. This led us into further discussion as we looked into possible problems that might have caused the benedict's solution to indicate positive in the presence of a polysaccharide and absence of a monosaccharide.

Also, in Video 1, I had mentioned at 0:04 that I liked their data because it was so imperfect; which is a lot like

data scientists often get. With this, I let them look at their data with more freedom; not worrying that they got something wrong, but trying to see what they could learn from it.

In these various ways, I tried to facilitate their understanding. The sequence I went through: with asking what we put in, whether it should cause Benedict's solution to indicate for monosaccharides, and asking whether it did indicate positive or negative, and why, is the sequence I went through for all of the test tubes. This way I could walk them through the reasoning a research scientist would have to work through.

5. Analysis of teaching

The central focus for my lesson sequence was "Explain the purpose of enzymes in our bodies, and justify with evidence that you know how they work, and how are they regulated." I felt like I needed to help my students get more practice in order to really explain the purpose of enzymes, and to justify that they know how enzymes work and how they are regulated. For my students with 504 plans that cause them to miss school, I felt that I gave them the support they needed. They seemed to be able to come in and get the information they needed to be successful from me or from classmates. For example, one of the students wasn't there in Video 1. I had her come and talk to me when she was ready and get the information she needed. We also let her turn in her lab conclusion later than the others so she would have the time to process the material. She had also taken the test at the end of the unit, but felt unprepared for it. To help her, we let her retake the test after she had come in and received a bit more help to make sure she fully understood the material. I don't have the evidence included in this packet, but I can say that she did much better on her test the second time she took it. For my student who was an English language learner, I felt I had the academic language well laid out in power point slides. I also had the important questions that the class was to discuss on the projector, and I read them to the class to make sure she had the best chance to understand the questions. We see that I wrote the questions for the lesson pictured in Video 2 at 0:02 on the screen. By the time the person had started recording, I had already read the questions aloud. But all of the follow up questions, and the questions the other students had asked may have been hard for the student who was an English language learner to follow. One thing I could have done was to write or summarize questions or discussion points that came up on the whiteboard so she could have had more time to read and understand them.

I also felt like I could have changed things for the high achieving students. During the lab analysis in Video 1, I felt I should have taken a bit more of a step back. If I had let the class struggle with the questions for a little longer, the high achieving students could possibly have reached the answer on their own, allowing the rest of the students in the class to learn some of the concepts from their peers instead of just from my leading them to the answer. For example, in Video 1, there was a section from 3:28 to 3:50 where I told my students the contents of the test tube that we only put in disaccharides and that it looked like it was indicating positive. I directly gave them all the information before I asked them a question on test tube 3. I feel that I should have given the students more freedom to identify the patterns themselves, instead of me spelling it out for them so clearly. This is especially true because there was a group of high achieving students in that class, and I wanted to give them the opportunity to find the patterns and share what they found with the class so that students are learning from their classmates and developing understanding together.

Changes for improvement

For the student who is an English language learner, Gunderson, Murphy Odo, and D'Dilva (2013) state that good textbooks for English language learners "present the material in different formats, such as illustrations, maps, graphs, charts, number lines, and diagrams. Indeed, the material is written in different styles: exposition, description, argumentation, narration" (p.48).

As a teacher, I can include more of these differing formats to get the information across. By drawing more diagrams or writing discussion topics on the board, the student who is an English language learner will have more access to the material, and a higher chance to be successful and take part in the discussions.

For the high achieving students, Lewis and Doorlag (2011) discuss how it is important to develop problem solving. With these students, I would need to make sure I back off in the f u t u r e so that my students can problem solve as much as is reasonable before I jump in and give them the answer. In this way the other students will benefit by learning scientific concepts from their peers, instead of their teacher feeding them all the answers.