The Masterclass: Learning How to Give and Receive Critique

Schedule	15 minutes: Introduction to the masterclass 30 minutes: Masterclass 10 minutes: Small groups 10 minutes: Debrief

Materials	internet connection speakers a/v projector large whiteboard (or chalkboard) at the front of the room small whiteboards at student tables (or equivalent)

Set-up	begin with students seated to work individually. They will later move into small groups, then a whole group conversation, and work at computers. "What We Know" reading should be uploaded to a Google Doc per instructions below

Background:
We noticed early on in our classes that students treated diagrams as rough sketches. Few were very precise or disciplined in constructing and interpreting diagrams. While this can make sense early on — students' ideas are not that precise, so the diagrams are not either — we believe that constructing diagrams with care can help to clarify ideas, and is a powerful way of making their ideas increasingly precise.

One way to build that clarity and precision is through peer feedback, and yet, when we asked students to review and critique one another's diagrams, they had difficulty providing specific, critical feedback that took the author's ideas into account.

Our goal for students through this lesson is not only to improve their diagrams, but:
(1) To value receiving feedback as a critical part of constructing scientific ideas.
(2) To become skilled at soliciting and receiving feedback. In particular, while there is a time and place for quick feedback on nascent ideas, we are interested here in students putting their best work forward for critique, and incorporating that feedback into their work.
(3) To learn how to provide useful feedback to their peers. In particular, how to help the author develop and clarify their own ideas, and not simply say "what I would have done is…".

These goals are not an explicit goal in many science classes. Students are used to first learning how a problem is to be solved, and then completing a problem set that offers variations on that problem-solving theme. If they are wrong, they may receive a solution set that details what they should have done. Rarely are they asked to articulate the choices that they made in solving the problem and receive feedback on those choices.

For some students, they may participate in a feedback process informally as they work in study groups — indeed, these informal mechanisms can be very powerful ways that students develop as scientists. But many students, particularly those who are not science majors, do not or cannot participate in study groups outside of class, or work in study groups that are not adept at providing feedback - this practice is not a part of their repertoire, and a hidden part of science.

In other fields, this feedback process is an explicit, formal part of instruction and practice. Students (and practitioners) routinely share their work with peers, teachers and experts in a public process of critique and feedback. And in those settings, students become familiar with soliciting, receiving and employing feedback. A writers' workshop, a music masterclass, an art critique, an architecture charette, reviewing tape in team sports — are all designed to provide a relatively public forum for feedback and improvement.

In our classes, we have adapted the technique of a music masterclass. In a masterclass, an expert teaches a private lesson with an audience, usually on a particular piece of music that the student has prepared. We work through a diagram with one student at the board in front of the class. Typically this will be several weeks into the semester, when students have enough of a grasp of the ideas that they can discuss them with the instructor. The diagram should be one that all students have worked on as part of an assignment. An example from a masterclass we led is at the end of this lesson plan.

Prior to leading the masterclass, we first select a video or videos of a masterclass for students to watch. We have several favorites described below, but you should feel free to search online for videos that you find compelling.

1. This masterclass by Maxim Vengerov, https://www.youtube.com/watch?v=7BwXRDi7ifo, is useful for the very close attention he pays to each individual note. The student rarely plays more than a few bars of music before being stopped. In our masterclass, we pause students often as they construct their diagrams, asking targeted questions at every step along the way.
2. This excerpt from a lengthy masterclass by Barenboim is a favorite for articulating the role of the instructor and the role of the student: https://www.youtube.com/watch?v=m_WS3-T0Et0. The student is asked what the text (the musical score) says, and why he has made the particular interpretation that he has made. Without a strong justification, the master (Barenboim) notes "that [rationale] is not good enough." As he elicits more of the pianists' reasoning, he notes, "Maybe I can help you achieve more of what you want yourself." (The pianist, wanting to emphasize the lack of resolution, plays a note loudly; Barenboim ultimately says that playing it softly will create even more emphasis. Unfortunately, the video never shows the student - Kadouch - playing this note more softly.)
3. This video shows a complete masterclass with a much younger student, who is asked (at 9:38) "show me how you would practice those two bars." https://www.youtube.com/watch?v=YVRC3LsZyTE Again, there is a close attention to short passages of music, but here the instructor asks not how she plays this passage, but how she *practices* — as that comes out later in how she performs. Similarly, you might ask a student in a masterclass setting to describe how they approach a particular question or homework assignment. At 11:20 in this same video, Barton Pine notes that we need to "not… listen to a group of notes collectively… we actually have to listen to every single note on its own with suspicion." - This is a theme that shows up in diagrams as well.

4. In a related Barenboim masterclass, https://www.youtube.com/watch?v=14dwegqniNg, at 5:10, Lang Lang reflects on the masterclass process: "We all look at the same score - which is what Beethoven wrote, right? - but everybody has a different thinking. And obviously different doesn't mean 'good' - it doesn't mean you're different in a 'good' way. … he [Barenboim] can really bring the knowledge, the structure, who to bring the elements into one big shape." —This is important, particularly in our course, because students can feel that the emphasis on students' ideas means that "anything goes," and "everyone's entitled to their own opinion." Instead - as with interpretations of Beethoven - not all interpretations are equally good. And the role of an instructor is to help clarify for students how the interpretations they are making (that is, the models they are constructing) can be improved.

Finally, we have used two ways to select a student to present their work for the masterclass. As this is done several weeks into a semester or unit, you should have an idea of students' work by this point.

1. On the day before the masterclass, share videos (see "Introduction to the Masterclass," below) and ask if anyone is interested in volunteering to be the student in the science masterclass. This gives you somewhat less control in selecting a student whose work you think will benefit from a public discussion, but it does mean that the student will be comfortable in front of the class and willing to do this.
2. Select a student whose work you think would be interesting to critique; this is not someone chosen because they have a "good" or "bad" diagram, but instead one that shows attention to details (or articulates a clear idea but does not represent that idea in a diagram well) — someone to whom you can ask pointed questions about those details and their interpretation of the data that led to this diagram. Contact them prior to class and say something like, "*tomorrow I want to work closely with one student up at the board, and I was wondering if you would be interested in that? Your work has been so interesting and I think other students would really benefit from watching us work on it further*."

While the approach we outline below is employed for diagrams, it can be equally well used for a range of topics: crafting a definition, creating an abstract, structuring a paper, etc. In those cases, working on a computer that is projected on a screen works well. (We have also had each group at a laptop, watching as we work on a shared Google Doc, which works for small groups.)

Introduction to the Masterclass:
Since this activity - a student working at the board as the teacher questions, critiques and offers suggestions to a student - is a dramatic departure from other, more student-centered, activities that we do, it's important to frame it for the students. This is not an instructor telling a student what they did wrong, and what they should have done, but an opportunity for one student to hone her work with specific feedback, and other students to extrapolate from that some general ways of approaching and refining a diagram.

The specifics of how you introduce this will depend on your setting: what have you noticed about their work so far? why are you choosing to use this approach now? For us, particularly in our work with elementary education majors, who tend to be loathe to critique, we might say something like this:

> *One thing I want to impress upon you is that critiquing someone's work is a sign of respect; it shows that you are taking their ideas and the development of those ideas very*

seriously. One of the worst things you could do as a reviewer is to say "Oh that's really nice" without ever really engaging with the work. A second pitfall is when a reviewer doesn't engage with their ideas, and instead says "You should have done this…" or "I did it this way instead…". Your job as a reviewer is to help the author articulate <u>her</u> ideas, challenge those ideas when appropriate, and ensure that those ideas are being represented clearly in her work. You should really push one another - as a sign that you're taking one another seriously.

So today we're going to do something a little different — I'm going to work with _____ to show you how you might go about giving and receiving feedback. And I'm modeling that on something that musicians do, called a Masterclass.

In a Masterclass, the "master" is usually a renown musician - he may be traveling through town to play with the symphony, and everyone would like to have a private lesson with him, but that's not possible. So he will essentially give a private lesson in front of an audience. And people will compete to be the person who gets to be the student in this lesson — everyone wants this critique and feedback from the master. And people come watch to see what kind of advice and tips the master has for the student. By watching a masterclass, students learn how to give feedback and how to receive feedback, in addition to the details about the particular piece. And I want to start off by showing you a few excerpts from masterclasses…

Share with students two to three videos of different masterclasses that you have selected. After each one, you might ask them what stands out to them, or simply articulate for them the things you notice.

Masterclass:
Leading the masterclass can be challenging. As Robert Irwin, an artist and professor, notes:

> "It's very difficult to avoid, the student being lost in the beginning and the school set up to emphasize short-term performance. So they tend to imitate what you *do* as a way of associating with what you *say*. But what you're trying to do is develop their sensitivities and not your own… That's the crux and the challenge and the responsibility of having the opportunity to deal with young people at such a crucial time in their formation. One of the hardest things to do is not to give them clues—'Here, do it this way, it's a lot easier'—and instead to keep them on the edge of the question."
>
> from *Seeing is Forgetting the Name of the Thing That One Sees* by L. Weschler

Below we offer a detailed description from a masterclass we led - it is sometimes easier to see what it looks like than to describe it more generally. In addition, we offer the following tips:

1. Ask the students in the class to take notes - on your comments, on the student's work, etc. You might specifically ask for some students to take notes on the questions and comments you make, and others to take notes on the scientific ideas and changes to the diagram.
2. Begin by simply asking the student to draw their diagram.
3. Feel free to interrupt early and often.
4. Questions should be neutral: why this? what are you trying to show? is that consistent with an observation your group made? Clarify as needed.

5. Narrate for the students what you're seeing: here's how I am interpreting you — I think you're saying here _____. Is that correct?
6. Offer suggestions that are consistent with the student's ideas. For example "so you're trying to show _____; your diagram doesn't convey that to me because ______." "I think this might be another way to get at that idea might be _____."
7. Once the student completes a diagram that you both feel happy with, ask the class if they have suggestions or questions for the author, or if anyone wants to summarize the diagram in their own words.
8. Review the series of steps — why particular representational choices were made — and reiterate that students may make other choices, depending on their observations, ideas and goals.

As an instructor, you may be asked by the class: "so is that right?" or "Is that what I should have drawn?" Remind the students that you are developing this one student's ideas and, so far, this diagram is consistent with the one student's observations and interpretations of those observations. If other groups had different observations or interpretations, their diagrams will look different.

Small groups:
Ask students in small groups to summarize several things on their whiteboards — both the particular ideas about this diagram, generic ideas about constructing diagrams, and then what they noticed about the feedback you offered. You may want to divide this among the different lab groups:

- ask one group(s) to discuss and prepare some summary comments on a whiteboard related to the diagram that the student developed.
- ask another group(s) to summarize some general ideas that came out related to diagrams — what more generic advice might they have now for someone else's diagram?
- and then ask a third group(s) to summarize the feedback that you offered - what kinds of questions did you ask?

As they work, circulate among the groups, talking to them about particular things they noticed. After 5 - 10 minutes, have the groups present to the class.

Debrief:
The goal of the debrief is for students to step back from the masterclass and generate more general ideas about: (1) this specific problem, (2) diagrams in general, and (3) feedback. As each group presents their board, pull out themes you see emerging that are related to those general ideas.

Resources:
This material draws from our work published in Atkins Elliott, Leslie, Jaxon, Kim & Salter, Irene. *Composing Science: A Faciliator's Guide to Writing in the Science Classroom*. Teachers College Press & the National Writing Project, 2016.

Example Masterclass

In the masterclass described below, students were asked to imagine how the world would look if your eye simply had a pupil, but no lens. Specifically, we asked them to describe what you would see when looking at a traffic light. (For those not familiar with optics, a pinhole for a pupil would have a clear, small, upside down image of the traffic light. But with a more realistic, wide pupil, the image becomes increasingly blurry in very predictable ways - every point on the image becomes a circle of color, overlapping with other circles of color, as Daniel, below, ultimately describes.)

Most student diagrams were not incredibly precise: they showed a few rays from the light entering the eye, and, perhaps, *described* the image as blurry, but did not clearly explain how their diagram led to that inference. Nor could they make stronger claims: would you know you were looking at a traffic light? how blurry is it? would such an eye be useful at all? what colors would you see?

At this point in the semester, student ideas regarding light were relatively well developed: we knew how light travels (in straight lines, moving out in all directions from a source) and how images were constructed when there is a pinhole. We knew that light rays pass through other light rays without affecting either ray. An eye dissection at the start of this unit had led to this representation of the eye.

We projected the homework onto the whiteboard, and Daniel used whiteboard markers to construct a diagram.

One thing to keep in mind: there are multiple canonically correct ways to describe what is happening here, and different students explain the blurriness of the image in different ways.

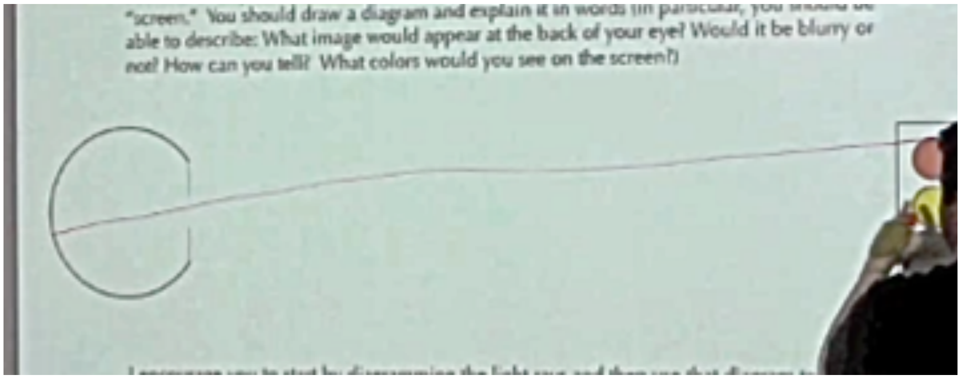
- each point of light on the object (traffic light) creates a circle of light on the retina; those overlapping circles create a blurry image. (This is what Daniel describes.)
- each point on the retina receives a ray of light from multiple places on the object. These overlapping rays mean that the image is blurry.
- a crisp, clear, upside down image is projected through each spot on the pupil and onto the retina. These overlapping images (because the pupil is large, with may such points) mean the resulting image is blurry.

The instructor did not have a preconceived notion that Daniel would describe blurriness in any particular way. The conversation took a turn early on, with Daniel noting that one spot “this point would like be reflected in multiple spots over there,” that led down this path.

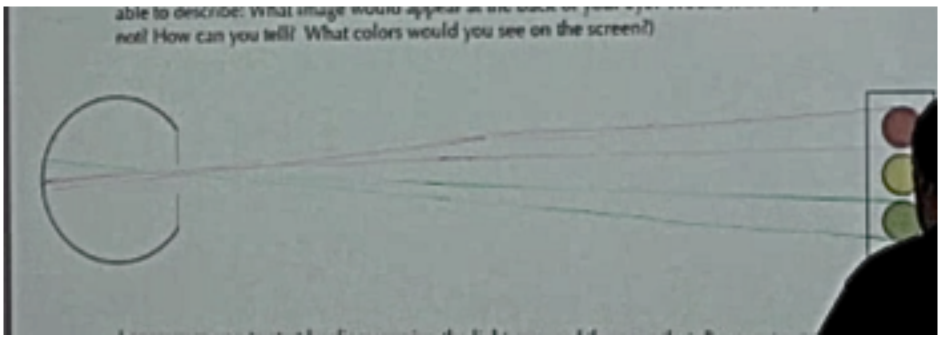
Steps in the process are described below:

1. Daniel begins by drawing straight lines from the object, through the pinhole, to the screen.

Leslie:	As- as you're drawing tell us why you’re drawing what you're drawing.
Daniel:	(sketches a line, shown above) Um - sorry, that's supposed to be straight.
Leslie:	Is - is there no, is there no ruler up there?
Daniel:	Oh, well - yeah… These should be straight because light travels straight.



2. Daniel erases the lines and grabs a meter stick. With another student holding it in place for him, he draws 6 rays, two from each bulb:



Leslie:	So so tell us more - why, why those?
Daniel:	I chose the bottom and the top of each light so I can show light crossing… I drew it all intersecting at one point [in the pupil] even though this hole is not very big - I mean this hole's not very small - because I kind of wanted to explain that. Um - [reconsiders his diagram] there's no way that it could be perfectly small enough to be intersecting there… but that's all I've got so far.
Leslie:	So so -- the first line up at the top. There's a point on that red traffic light, and light leaves - does it leave in one direction or does it leave everywhere from there?
Daniel:	From there? It leaves in every direction. Should I show that?
Leslie:	Okay - ah no no - why did you choose the one that you chose?
Daniel:	That direction? Because that's the one that goes into the eye.
Leslie:	Is it the only one that left that point on the lightbulb and made it into the eye?
Daniel:	Ah, no. Not if the hole's gonna be that big.
Leslie:	Yeah, the hole's gonna be that big. That was the homework.
Daniel:	Then no - then like there - this point would like be reflected in multiple spots over there (gestures to retina).
Leslie:	Okay so erase erase erase. We're starting over.

3. Daniel begins again, now using a rule and diagraming three rays from the topmost point on the topmost bulb: one that goes through the top of the pupil, one that goes through the middle

of the pupil, and one that goes through the bottom of the pupil. Leslie summarizes what this conveys to her, inviting Daniel to fill in details as she questions him on those:

Leslie: Okay. So - so I feel like this is helping me say, like, what happens with one spot on the on the traffic light. If it was a pinhole I would have had just one ray from that spot hitting it. Right?
Daniel: Maybe one or two.
Leslie: But since we made the pinhole big - ?
Daniel: A bunch.
Leslie: We've now got a spot of light - what does that spot look like? If you were inside the eyeball looking at the back of the eyeball -
Daniel: Like a big, blurry, red splosh.
Leslie: Why blurry.
Daniel: Ah - because it's all spread out. And you're also gonna have like - I know we're not talking about these colors yet - but you're also gonna have some of those colors [the yellow and green lights] on that spot, too.
Leslie: Before those colors are turned on, is that spot blurry or not -
Daniel: Ahh- no. It's gonna be red. Solid red color.
Leslie: Is it red and fuzzy - or is it red and crisp?
Daniel: Red and fuzzy.
Leslie: Why.
Daniel: Because.
Leslie: Are you guessing?
Daniel: Yeah.
Leslie: So where is our pasta thing? (We have an aperture, designed to measure spaghetti servings but quite similar to a camera aperture, that Daniel had brought to class.)

4. Simply asking the question ("where is our pasta thing?") causes Daniel to answer the question more definitively.

Daniel: One spot.
Leslie: Not blurry?
Daniel: (weakly) Not blurry.
Leslie: (mimicking a violin masterclass we had just watched) Stand up! Bow out!
Daniel: (Loudly and confidently, pointing to his diagram.) Those things are not blurry!

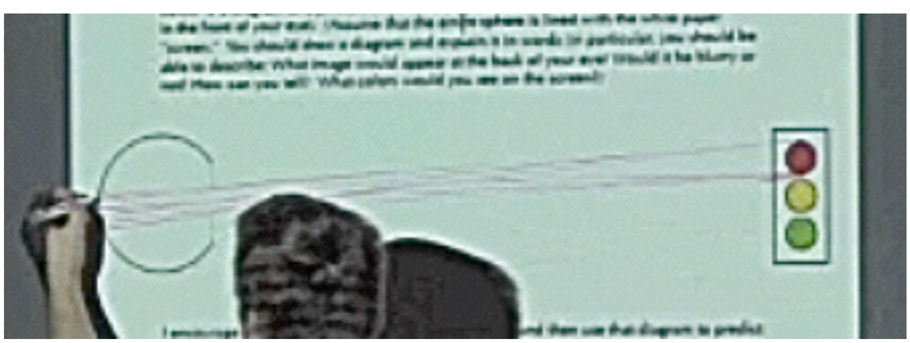
Leslie:	Why not!
Daniel:	Well, actually, I think the disk *is* blurry. I think it's blurry because like, if you're getting spots from all of this red light? the middle of this should be more concentrated red- it should be more red lights. And towards the outside it's only going to be like a few rays on each side.

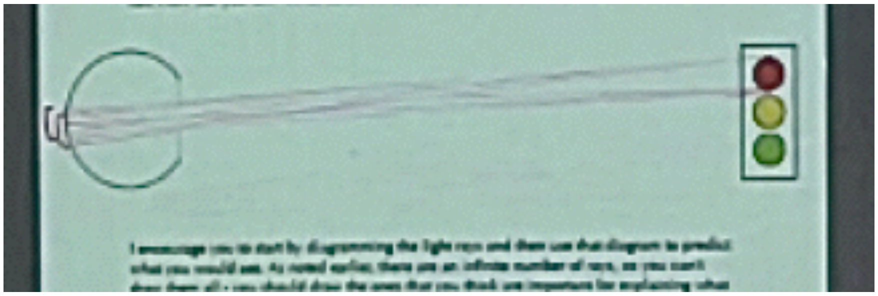
5. Draw a good sampling of the rays that make it into the pinhole. Examine; decide what that would look like - the rays leaving one point on the stoplight, according to Daniel, would make one round dot on the back of the pinhole theater. Would it be blurry? No - crisp edges...

6. Check and see - using a maglite (which is like one tiny point of light sending rays out in all directions) and a large hole (the spaghetti measuring device):

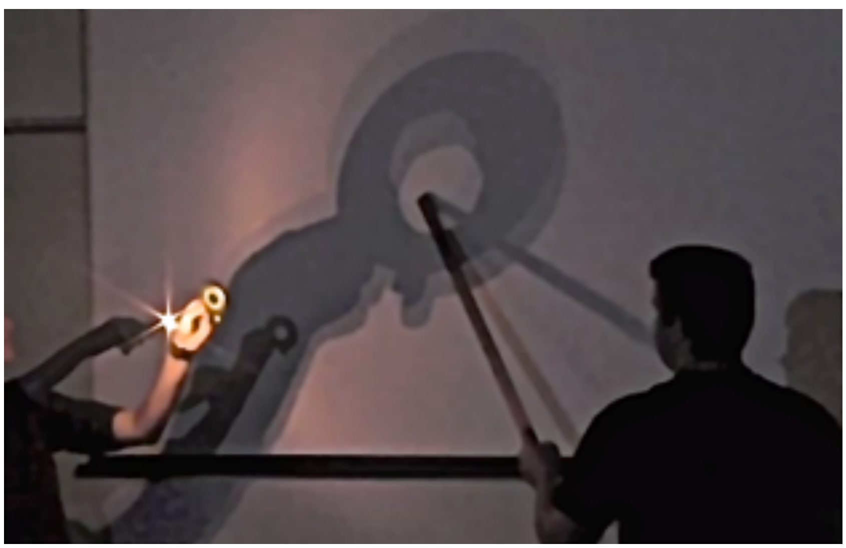
Yes. One point of light through one large hole makes one spot of light on the screen.

7. Continue on to look at another spot of light from the traffic light, again using straight lines and drawing all the rays that entered the hole:





8. Daniel argued that there were now two overlapping spots of light, like a Venn diagram, and again we use simple materials to check his model. By this point, other students have begun to enter the conversation to clarify Daniel's points and ask questions. A particularly intriguing question is brought up by Kaitlin, who at first clarifies (incorrectly) that the large spot indicates that the hole let through a "larger" ray. Daniel explains that, instead, the rays "don't actually get larger they just get separated." These two models are discussed and compared, and Kaitlin agrees with Daniel.



9. We then continue to discuss what the final image on the retina might look like, as Daniel explains how the overlapping points of light create an extremely blurry image of the traffic light.