Engaging students in conducting Socratic dialogues: Suggestions for science teachers

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While students are often involved in classroom discussions, it is more often in the role of responder rather than questioner. Socratic dialogues – which are designed to enhance academic discourse – often take place with students providing responses to a teacher's questions only. One of the goals science teachers should have for Socratic dialogues is to develop within students a disposition for and skill in questioning. Indeed, students should learn to question all information provided them. What better way to get students to adopt a skeptical attitude than to have them become actively involved as questioners in the process of discussion? The authors offer suggestions for engaging students in the questioning process.

Many of the 42 Modeling Method physics teachers involved in the *Chicago ITQ Science Project – Modeling Method of Instruction* over the past two academic years have indicated to the Project's director (CW) that it is difficult to engage students as leaders in the process of Socratic dialoguing. Students are willing responders to questions posed by teachers, but reticent to take the lead by posing their own questions to peers. This problem persists even when teachers follow traditional guidelines for Socratic dialoguing (Wenning, 2005). Why might this be so?

Perhaps it has to do with the fact that students so often have been treated by teachers not as active inquirers but as passive recipients of information. They do not question because they have not been expected to question. They do not question because they have not been taught to question. They do not question because they lack the skill to question. These problems are closely associated with a didactic form of instruction where a teacher is seen as the fount of all knowledge and students as empty vessels to be filled. In the Modeling Method, and other forms of inquiry-oriented instruction, students are seen as anything but passive recipients of information. Rather, they are expected to become actively involved in the construction of knowledge based on careful observation, data collection and analysis, logical reasoning, and questioning.

Because students are not often encouraged to or informed how to question in a classroom where teaching by telling is taking place, they frequently are reticent to do so in novel inquiry-oriented classroom settings. Many students respond to hundreds of questions each year, but they often fail to pick up the art of posing meaningful questions as a result of these experiences. Unfortunately, students don't learn the skill or habit of questioning by "osmosis." Teaching effective questioning skills is rarely seen as part of a traditional course. As it is true of teachers who are attempting to use Socratic questioning for the first time, so it is will be with students who are expected to question others. If they are to become engaged in Socratic dialogues as active inquirers, they would benefit from direct instruction in this area.

Many students are at a loss when it comes to developing the wide variety of probing questions commonly asked by teachers during Socratic dialogues. Teachers have an advantage. They know the difference between divergent and convergent questioning. They know the subject matter and the misconceptions that students often bring into the classroom. They know the processes and assumptions, principles and values of science. Whether they are aware of it or not, many teachers turn to Bloom's taxonomy of educational objectives (Bloom, 1956) as a guide to formulating questions.

As almost any first-year teacher can explain, there are categories of question types associated with each of the six cognitive domains in Bloom's taxonomy: knowledge, comprehension, application, analysis, synthesis, and evaluation. While Bloom's taxonomy is a rudimentary guide to developing questions, its cognitive domains do not depict the much wider range of question types that might be posed during a Socratic dialogue – especially one associated with scientific processes. Rhodes' typology of questions (Rhodes, 1995) is a more powerful guide to formulating questions in this situation, and science teachers should be as familiar with it as they are with Bloom's taxonomy.

The Rhodes' Typology

The Rhodes' typology of questions is a comprehensive treatment of content-directed question types, and is extremely well suited for use in Socratic dialogues based upon observation and/or experiment. All content-based questions in this typology are classified into one of eight categories: informational, interpretive, explanatory, procedural, relational, verificational, heuristic, and evaluational. Each category has subcategories, but these will not be dealt with here for the sake of simplicity. A sampling of questions from each category and sub-category will be provided, however, to show the great variety of questions that can be posed when involved in Socratic dialogues.

Informational questions – the questioner seeks knowledge concerning a particular fact, circumstance, or conclusion derived through observation or experimentation:

- What is it?
- How does it work?
- What does it do?
- What happened?

Interpretive questions – the questioner seeks to understand the meaning of an observation or a conclusion:

- What does that mean?
- What do you mean by that?

Explanatory questions – the questioner seeks clarification; asks for things to be made understandable:

- Why does it work that way?
- What is the reason for that?
- Why did you do that?

Procedural questions – the questioner seeks clarification of methods or processes:

- What was done?
- How is that done?
- Is it done this way?

Relational questions – the questioner seeks clarification of the connections between various elements:

- Which is the most important?
- Which is largest?
- Which came first?
- How do these compare or contrast?

Verificational questions – the questioner attempts to confirm the validity of an observation or procedure:

- What are the facts to support it?
- Where are the data?
- Where is the proof?
- What is the reasoning?
- How do you know that?

Heuristic questions – the questioner attempts to stimulate interest as a means of furthering investigation:

- What would happen if?
- What could we find out?
- How could we find out?

Evaluational questions – the questioner attempts to determine the worth of an observation or conclusion:

- Is it any good?
- How good is it?
- What difference does it make?
- So what?

Fully Engaging Students in Socratic Dialogues

One of the student complaints that *Chicago ITQ Science Project* Modeling teachers frequently report is that, "The teacher doesn't tell us anything." This often stems from the fact that students fail to see the importance of their own questions in getting the answers they seek. Because students have yet to learn to question and then, in turn, trust the findings of their own work and that of their peers, they often feel they are being left without guidance. They retain a strong tendency to rely upon the word of their teachers who are seen as absolute authorities of the subject matter. Students, if they are to be at all confident of

the credibility of their own conclusions and those of other students, first must learn to skeptically question these observations, processes, and conclusions. Only then can they take confidence in their own work and that of their peers, and see nature itself as the final arbiter. In so doing, they come to understand one of the critical elements of the nature of science (Wenning, 2006).

If teachers are to effectively engage students in Socratic dialogues as questioners as well as responders, student must be made aware of the nature of the question-generating process. Teachers can share what they know about the question formulation process with students in an effort to enhance the quality of classroom discourse by developing students as questioners. Even a small amount of instruction can be helpful in this area. For instance, it might be very helpful if the teacher were to speak explicitly about questioning procedures. While it is doubtful that most students would care at all about a formal typology of questions, they probably would be inclined to learn about how to ask appropriate questions.

For instance, one of the authors of this article who is an expert in the Modeling Method of Instruction (JS) defines two groups of questions students might want to ask during whiteboard discussions. Sample questions (see Table 1) are posted in front of the classroom on a whiteboard for all students to see. These question forms then become part of the traditional "toolbox" that teachers often refer to in the Modeling process.

I. Clarification Questions

a. How do you know…?
b. Where did you get…?
c. Why did you do…?
d. What does…tell you?
e. What does…mean?
f. Where on your (graph, motion map, diagram)…?

II. Extension Questions

a. What if we changed…?
b. How is this problem different from…?
c. How is this problem similar to…?
d. Is there another way to do this?
e. What is key to solving this problem?
f. How does…compare to…?

Table 1. *Providing two types of questions to get students started with the questioning process.*

Not only must teachers educate the intellect if students are to become actively engaged in the questioning process, they must also help students understand that they are expected to question, and that developing critical questioning skills is a valuable part of the educational process.

Additional Suggestions

Before students will become fully engaged in Socratic dialogues as active questioners, they need to be comfortable with the process. In an earlier article the lead author (CW) summarized a list of guidelines for conducting Socratic dialogues (Wenning, 2005). As an adjunct to that article, the current authors provide procedures to be followed in order to enhance student comfort with Socratic dialogues – especially when the basis of that discussion is a whiteboard presentation:

- **Allow students to present without interruption.** Let presenters do the bulk of the talking at the outset. When students are making a presentation, it is time for the teacher and all others to be good listeners. Listen intently and patiently to what the presenters are saying; try to understand things from the speakers' viewpoint as novice scientists. Avoid interrupting the presentation. Wait until after they have completed their overview before allowing comments or questions. To interrupt before students are finished making their initial presentation is suggestive of presenter error or audience impatience. The listening approach might well reveal the cause of student error if any is revealed. This might include important preconceptions that students are prone to bring into the classroom.

- **Promote peer questioning.** After students have learned about formulating and posing questions, the teacher should encourage students to ask questions. Teachers should use wait time effectively to get students to start asking questions. Indeed, it is be best to allow audience members to begin the questioning process because they can then ask the easier and more obvious questions. If students fail to note an error or oversight, this is where the teacher can contribute the most to the questioning process.

- **Show respect for student conclusions.** Many times students will be absolutely correct in their findings and assertions. When this is the case, it is best to have the class acknowledge that this so. On the other hand, student errors should be addressed by asking questions rather than by providing a direct critique. A central tenet of the Socratic approach is to avoid telling presenters directly that they are mistaken. Questioners should work to make visible students' intellectual processes and, thereby, lay bare the source of student misunderstanding. If presenters are found making a mistake, it is best to allow them to redeem themselves by identifying that mistake and drawing the proper conclusion through the Socratic questioning process. This will allow them to save face, and make them more amenable to the presentation format. If other students have made this same mistake in the past, the teacher should draw attention to this fact in a general fashion.

- **Get students to agree.** Another of the central tenets of the Socratic approach is to achieve a consensus using evidence and logic. Student errors should not be ignored. Agree only on that which is correct and proper. When misunderstandings and preconceptions are identified, they must be confronted and resolved through questioning so that they might be overcome. When something is seen that is need of correction, point out first those things upon which everyone agrees. Keep the discussion moving forward with an open, accepting attitude. Avoid criticizing student errors; this potentially could humiliate presenters and place them on the defensive. If resolution cannot be achieved through the process of the Socratic dialogue, throw down the challenge of conducting another observation or experiment. Avoid resolving any scientific problem by fiat or by voting. These are not acceptable forms of conflict resolution in the scientific community.

- **Maintain a positive atmosphere.** Teachers should make a point of stopping any discussions where "sniping" is going on or threatened. Nothing will shut down productive discourse quicker than negative comments – making "fun" of a presenter or attempts at retaliation for a real or perceived attack. Taking the time to explicitly express the "we're-in-this-together" attitude, and to openly discuss why negative comments cannot be tolerated is critical to setting a positive atmosphere. Students are very perceptive, and are usually able to articulate why a positive climate is crucial for the class's success. Once they have expressed the need for a positive tone in the classroom, *they* take ownership of it. The enlightened despot known as the teacher hasn't dictated it.

- **Let students feel that a new idea is theirs.** Students will have greater knowledge and understanding of concepts that they develop on the basis of experience and insight rather than in ideas provided to them by teachers on the basis of authority. It is far better to ask questions and make suggestions and let students think things through for themselves. A great way to end a dialogue is to have students summarize their finding. This allows them to develop and have a sense of ownership.

- **Make the students feel that they have contributed.** When students have done a good job, be certain to acknowledge that fact honestly and sincerely. Conclude a Socratic dialogue by praising even the slightest improvement in understanding, and do so with sincerity. Make any fault seem easy to correct. It is most appropriate to have a round of congratulatory applause following student presentations.

Only after students become comfortable participating as responders in Socratic dialogues will there be any hope of them becoming actively involved as questioners. It is critical that the teacher model appropriate questioning strategies, explain the process of question formulation, and then fade from the scene so that students will become actively engaged as questioners in the process of Socratic dialogues.

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