

## Socratic Seminar with Data: A Strategy to Support Student Discourse and Understanding

JOAN GRISWOLD, LOREN SHAW,  
MAUREEN MUNN

### ABSTRACT

A Socratic seminar can be a powerful tool for increasing students' ability to analyze and interpret data. Most commonly used for text-based discussion, we found that using Socratic seminar to engage students with data contributes to student understanding by allowing them to reason through and process complex information as a group. This approach also provides teachers with insights about student misconceptions and understanding of concepts by listening to the student-driven discussion. This article reports on Socratic seminar in the context of a high school type 2 diabetes curriculum that explores gene and environment interactions. A case study illustrates how Socratic seminar is applied in a classroom and how students engage with the process. General characteristics of Socratic seminar are discussed at the end of the article.

**Key Words:** analyzing and interpreting data; student-led discussion; Socratic seminar; type 2 diabetes; gene-environment interactions.

### ○ Introduction

The three-dimensional learning proposed by the Next Generation Science Standards (NGSS) integrates science and engineering practices, crosscutting concepts, and disciplinary core ideas for fully articulated teaching and learning. This article focuses on the science and engineering practice of analyzing and interpreting data and presents Socratic seminar as an impactful strategy that can be used to support student discourse about data. During a Socratic seminar, students can talk about, reason through, and socially construct the meaning of data through collaborative dialogue. Socratic seminars are foundational to Paideia methods of instruction and are most commonly used with text, not data. In our education outreach work with teachers and students, we applied structures developed for traditional text-based Socratic seminars to the

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interpretation of graphs, tables, and diagrams. Formative assessment of this strategy reflects high teacher interest and positive student outcomes.

Student ability to analyze and interpret data is an essential component of practicing science, and the NGSS asks students to expand their capabilities in this field as they mature in order to use tools that allow them to represent, visualize, analyze, identify patterns, and tabulate data (NGSS Lead States, 2013, p. 56). Although most high school students can create a graph, many have difficulty reasoning through data and describing stories that data can tell (Garfield & Ben-Zvi, 2007). Recent research highlights the importance of giving students the opportunity to intuitively make sense of data by working with data to detect patterns or evaluating a scientific hypothesis before asking students to perform precise statistical calculations using the data (Smith et al., 2014).

Classroom teachers participating in summer professional development workshops offered by Genome Science Education Outreach (GSEO) through the University of Washington have been exposed to Socratic seminar through dissemination of the high-school curriculum *Type 2 Diabetes: A complex disease of gene and environment interactions* (<https://gsoutreach.gs.washington.edu>). This project-based, multi-week unit teaches about the role of glucose in the body and how the failure of mechanisms that maintain balance results in chronic high blood glucose levels. High school students consider genetic factors that contribute to the disease, as well as environmental factors that influence health, including social, political, and economic structures.

Throughout the unit, students are exposed to a wide range of data, from graphs from the research literature detailing glucose, insulin, and glycogen homeostasis, to tables showing results of a long-term research study involving thousands of people. Formative

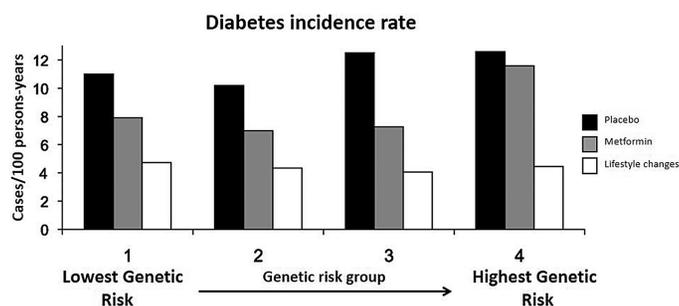
evaluation of using Socratic seminar to interpret data during teacher professional development workshops reveals an increased understanding of the data and its nuances through the power of collective meaning-making for teachers, and a high interest by teachers in using this method in their classrooms. Teachers who have used Socratic seminar with data in their classrooms report that the method contributes to student understanding by allowing them to process complex information as a group. This approach also provides teachers with insights about student misconceptions and understanding of concepts by listening to the student-driven discussion.

This article provides a quick review of this strategy by detailing one example of a teacher using Socratic seminar with data in the science classroom. Characteristics of a seminar are touched on after the case study description, and specific instructions for conducting a seminar and information on the pedagogical underpinnings of this method can be found in the background resources.

## ○ Classroom Context: A Case Study

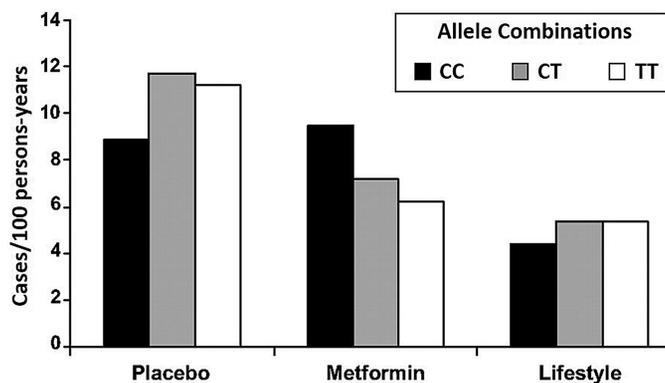
The increase in type 2 diabetes nationally and globally provides context throughout the GSEO type 2 diabetes unit for student learning about the genetic and environmental contributions to this challenging disease. Figures 1 and 2 are examples of complex data that students can collaboratively work to understand through a Socratic seminar. These data are from the Diabetes Prevention Program (DPP; Knowler et al., 2002), a long-term research study involving over 3000 people in the United States. (See the Appendix for more information about the DPP.)

Loren Shaw, a science teacher from rural Oregon who has participated in GSEO teacher professional development, has conducted Socratic seminars with his 8th grade life science students using Figures 1 and 2. In one exemplary seminar, student responses to the opening *literal question*, “What do the data show?,” revealed that many students misinterpreted the y-axis by assuming that higher numbers are always better. During the discussion, students pondered why the *placebo* group did so well and the *lifestyle changes* group did so poorly, which was contrary to the both the data and student predictions. Confused and in a state of cognitive disequilibrium, students were receptive to a classmate’s observation: “Wait,



**Figure 1.** Diabetes incidence rate among different genetic risk groups on three interventions. Copyright © 2011 American Diabetes Association. From *Diabetes* 2011, April; 60(4):1340–1348. Reprinted with permission from *The American Diabetes Association*.

**Diabetes incidence rate**



**Figure 2.** The effect of allele combinations on outcomes of interventions. Copyright © 2011 American Diabetes Association. From *Diabetes* 2011, April; 60(4):1340–1348. Reprinted with permission from *The American Diabetes Association*.

low numbers [on the y-axis] are better because less people are getting diabetes.” This clarification created a class-wide “aha” moment and furthered the discussion.

Once students understood the structure of the graph, the *interpretive question*, “What do the data mean?,” moved the class to a deeper discussion about the implications of the data. This led to an understanding of the role of lifestyle changes, a discussion of study design, and student interest in reading more about the DPP study itself. A common refrain from students when asked about a takeaway from the seminar was how diet and exercise “work” (i.e., decrease the incidence of diabetes) for all genetic risks groups.

Lastly, the *evaluative question*, “How might this apply to you?,” allowed students to share personal connections to diabetes, and many students made statements about their own need to start exercising to avoid diabetes in the future. In the end, students in the class rated the 30-minute seminar highly, evidence for its appeal shown by repeated requests for the “horseshoe graph activity.”

The biggest challenge during the seminar was the domination of the discussion by a few students. The teacher addressed this in subsequent seminars by spending time before the activity to revisit the discussion norms, as well as coaching students on how to read body language cues and how to disagree with someone’s position respectfully. Tools to increase participation can also be helpful, such as student-constructed “discussion grams,” which chart who has spoken and how many times, as well as the use of discussion partner evaluation forms (see Background Resources, below). After this seminar, the teacher provided another chance for participation by asking every student to share one concept he or she took away from the graph and/or discussion.

## ○ Characteristics of a Seminar

When students are working together to achieve a deeper understanding of a text or data, there are a few features that define a Socratic seminar.

*Discussion norms* are important, and may differ from classroom norms that have been developed for other contexts. Similar to a

respectful discussion around a dinner table with comments building on prior remarks, students should not raise their hands to speak, but talk to (and look at) each other rather than the teacher. They should monitor their speaking time, and everyone (especially the teacher) should be prepared to weather long silences that may feel uncomfortable.

*Classroom arrangement* is an important consideration. It is helpful for students to sit in a horseshoe or circle and be able to call each other by name. Students should each have a copy of the data, and the data can be projected on a white board to allow students to come forward to draw or make notes on the graph or chart as the seminar unfolds. For larger classes, we recommend the *Fishbowl* method, in which students sit in two concentric circles. Students in the inner circle participate in the discussion while being assessed by their silent partners in the outer circle. With this method, some teachers reserve a “hot seat” in the inner circle for students in the outer circle who really want to make a contribution to the discussion, and then leave. Teachers should provide two sets of similar data (see Figures 1 and 2) so that students in the inner and outer circles can switch places and begin a second seminar with new data to discuss.

*Questioning* lies at the heart of Socratic seminar, and discussion questions posed by the teacher will ideally lead students to the core ideas represented by the data. We recommend three tiers of questions, in this order:

1. *Literal questions*, such as “What do the data show?,” ensure that students understand the structure of the graph or chart, and can be answered by looking in the item. Corollary questions could be: How are the x-axis and y-axis labeled? How do they relate to each other? Does the title of this graph fit the data?
2. *Interpretive questions*, such as “What do the data mean?,” elicit students’ understanding of the implications of the data, and should be the core of the seminar. Another question could be “Do these data have any consequences?” If the data speak to any societal issues, questions could be: What are the social implications of these data? Could these data be used to support a cause or claim? In what way?
3. *Evaluative questions*, such as “How might this apply to you?” or “Do you have any experience with this topic?,” should be saved for the end of the seminar. This allows for students’ subjective answers and lets them share their own experience or opinion, if applicable. To answer these questions, students do not need to refer to the data.

*Debrief* the seminar after it is over by asking participants if they have a better understanding of the data. Allow students to share their experiences, and feel free to share your experiences as a facilitator. It can be helpful to point out both highlights and challenges.

## ○ Background Resources for Conducting a Socratic Seminar

Teachers can find extensive materials on how to teach a Socratic seminar at Paideia.org. The Northwest Association for Biomedical

Research (NWABR) has promoted Socratic seminars in science classrooms specifically as a relatively new tool (Chowning, 2009). NWABR provides resources on background, key elements, and student support materials, including a discussion partner evaluation form in *An Ethics Primer* and lesson two of *The Social Nature of Scientific Research*, both available at [nwabr.org](http://nwabr.org).

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JOAN GRISWOLD is Science Education Specialist at Genome Sciences Education Outreach (GSEO) at the University of Washington, Box 355065, Seattle, WA 98195; email: [jcgriz@uw.edu](mailto:jcgriz@uw.edu). LOREN SHAW is science faculty at Glide High School, 18990 N. Umpqua Hwy, Glide, OR 97443; email: [loren.shaw@glide.k12.or.us](mailto:loren.shaw@glide.k12.or.us). MAUREEN MUNN is the Director of GSEO; email: [mmunn@uw.edu](mailto:mmunn@uw.edu).

## APPENDIX

### About the Diabetes Prevention Program (DPP)

At the beginning of the DPP study, all participants were pre-diabetic (having blood glucose levels above normal but below the diabetic range) and overweight. DPP participants were randomly divided into different treatment groups. The lifestyle intervention group received intensive counseling on diet, physical activity, and behavior modification, with the goal of losing 7 percent of their initial body weight and maintaining the loss. The second group took 850 mg of Metformin, a drug that controls blood glucose levels, twice a day. The third group received placebo pills instead of metformin. The metformin and placebo groups also received information about diet and exercise but no intensive counseling.

Genetic studies have identified over 60 different gene variants associated with type 2 diabetes. In one study, DPP participants were genotyped for 34 significant risk alleles. Each allele was weighted according to its effect on the development of type 2 diabetes, and the weighted scores were summed to give a Genetic Risk Score (GRS) for each participant.

In Figure 1 (redrawn from Hivert et al., 2011), GRSes were used to divide DPP participants into four genetic risk groups. The diabetes incidence rates for the three treatment groups were graphed separately for each genetic risk group. Figure 2 shows the effect of risk allele at a single gene locus on incidence of diabetes for the three treatment groups (redrawn from Jablonski et al., 2010).