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# CHAPTER 1
# Argument-Driven Inquiry

## Stages of Argument-Driven Inquiry

The argument-driven inquiry (ADI) instructional model was designed to change the focus and nature of labs so they are consistent with the three-dimensional instructional approach. ADI therefore gives students an opportunity to learn how to use disciplinary core ideas (DCIs), crosscutting concepts (CCs), and science and engineering practices (SEPs) (NGSS Lead States 2013; NRC 2012) to figure out how things work or why things happen. This instructional approach also places scientific argumentation as the central feature of all laboratory activities. ADI lab investigations, as a result, make lab activities more authentic (students have an opportunity to engage in all the practices of science) *and* educative (students receive the feedback and explicit guidance that they need to improve on each aspect of science proficiency).

In this chapter, we will explain what happens during each of the eight stages of the ADI instructional model. These eight stages are the same for every ADI laboratory experience. Students, as result, quickly learn what is expected of them during each stage of an ADI lab and can focus on learning how to use DCIs, CCs, and SEPs to develop explanations or solve problems. Figure 3 (p. 4) summarizes the eight stages of the ADI instructional model.

### *Stage 1: Identify the Task and the Guiding Question*

An ADI lab activity begins with the teacher identifying a phenomenon to investigate and offering a guiding question for the students to answer. The goal of the teacher at this stage of the model is to capture the students' interest and provide them with a reason to complete the investigation. To aid in this, teachers should provide each student with a copy of the Lab Handout. This handout includes a brief introduction that provides a description of the puzzling phenomenon or a problem to solve, the DCI and CCs that students can use during the investigation, a reason to investigate, and the task the students will need to complete. This handout also includes information about the nature of the argument they will need to produce, some helpful tips on how to get started, and criteria that will be used to judge argument quality (e.g., the sufficiency of the claim and the quality of the evidence).

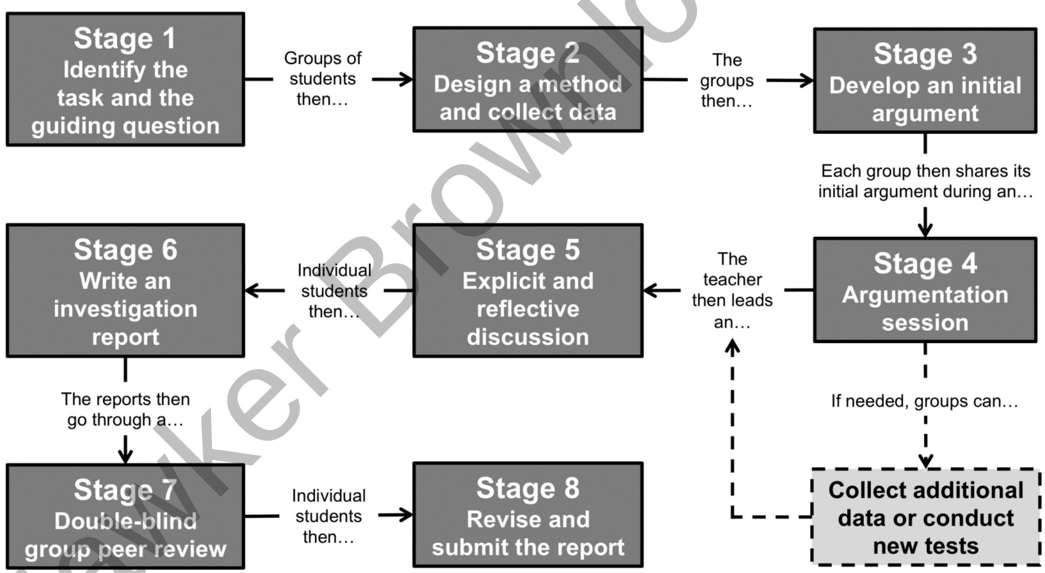
Teachers often begin an ADI investigation by selecting a different student to read each section of the Lab Handout out loud while the other students follow along. As the students read, they can annotate the text to identify important or useful ideas and information or terms that may be unfamiliar or confusing. After each section is read, the teacher can pause to clarify expectations, answer questions, and provide additional information as needed.

Teachers can also spark student interest by giving a demonstration or showing a video of the phenomenon.

It is also important for the teacher to hold a "tool talk" during this stage, taking a few minutes to explain how to use the available lab equipment, how to use a computer simulation, or even how to use software to analyze data. Teachers need to hold a tool talk because students are often unfamiliar with specialized lab equipment, simulations, or software. Even if the students are familiar with the available tools, they will often use them incorrectly or in an unsafe manner unless they are reminded about how the tools work and the proper way to use them. The teacher should therefore review specific safety protocols and precautions as part of the tool talk.

## FIGURE 3

**Stages of the argument-driven inquiry instructional model**




Including a tool talk during the first stage is useful because students often find it difficult to design a method to collect the data needed to answer the guiding question (the task of stage 2) when they do not understand how to use the available materials. We also recommend that teachers give students a few minutes to tinker with the equipment, simulation, or software they will be using to collect data as part of the tool talk. We have found that students can quickly figure out how the equipment, simulation, or software works and what they can and cannot do with it simply by tinkering with the available materials for 5–10 minutes. When students are given an opportunity to tinker with the equipment, simulation, or software as part of the tool talk, they end up designing much better investigations (the task of stage 2) because they understand what they can and cannot do with the tools they will use to collect data.

Once all the students understand the goal of the activity and how to use the available materials, the teacher should divide the students into small groups (we recommend three or four students per group) and move on to the second stage of the instructional model.

### *Stage 2: Design a Method and Collect Data*

In stage 2, small groups of students develop a method to gather the data they need to answer the guiding question and carry out that method. How students complete this stage depends on the nature of the investigation. Some investigations call for groups to answer the guiding question by designing a controlled experiment, whereas others require students to analyze an existing data set (e.g., a database or information sheets). If students need assistance in designing their method, teachers can have students complete an investigation proposal. These proposals guide students through the process of developing a method by encouraging them to think about what type of data they will need to collect, how to collect it, and how to analyze it. We have included six different investigation proposals in Appendix 4 (p. 533) of this book that students can use to design their investigations. Investigation Proposal A (long or short version) can be used when students need to collect systematic observations for a descriptive investigation. Investigation Proposal B (long or short version) or Investigation Proposal C (long or short version) can be used when students need to design a comparative or experimental study to test potential explanations or relationships as part of their investigation. Investigation Proposal B requires students to design a test of two alternative hypotheses, and Investigation Proposal C requires students to design a test of three alternative hypotheses.

The overall intent of this stage is to provide students with an opportunity to interact directly with the natural world (or in some cases with data drawn from the natural world) using appropriate tools and data collection techniques and to learn how to deal with the uncertainties of empirical work. This stage of the model also gives students a chance to learn why some approaches to data collection or analysis work better than others and how the method used during a scientific investigation is based on the nature of the question and the phenomenon under investigation. At the end of this stage, students should have collected all the data they need to answer the guiding question.

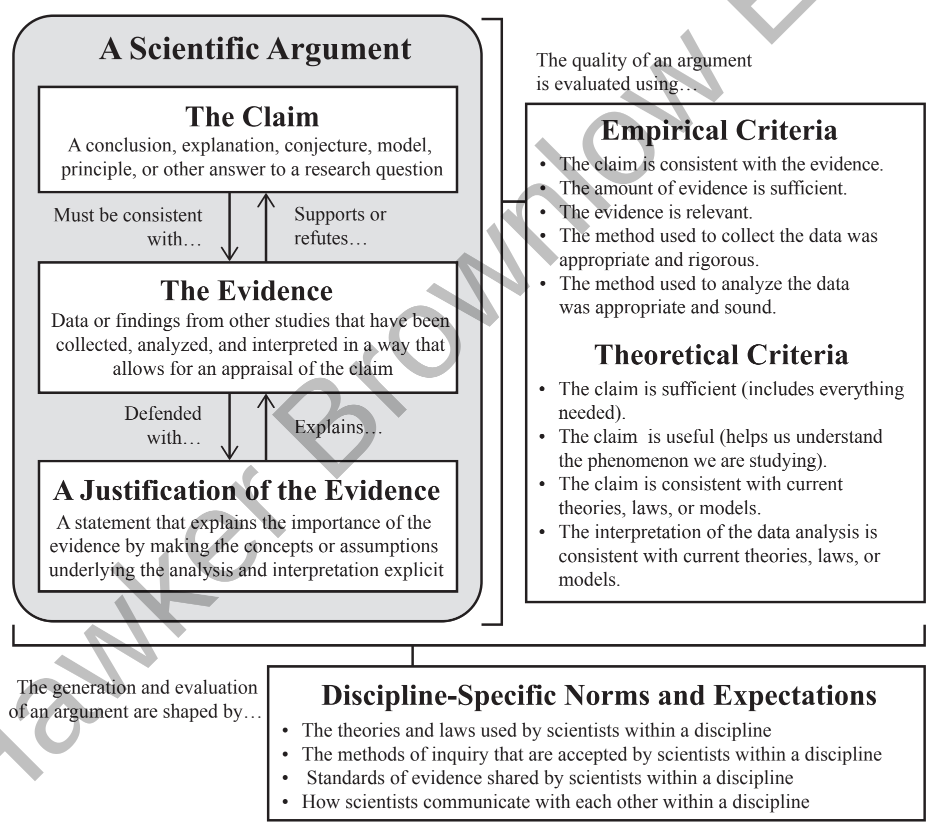
### *Stage 3: Develop an Initial Argument*

The next stage of the instructional model calls for students to develop an initial argument in response to the guiding question. To do this, each group needs to be encouraged to first analyze the measurements (e.g., temperature and mass) and/or observations (e.g., appearance and location) they collected during stage 2 of the model. Once the groups have analyzed and interpreted the results of their analysis, they can create an initial argument.

The argument consists of a claim, the evidence they are using to support their claim, and a justification of their evidence. The *claim* is their answer to the guiding question. The *evidence* consists of an analysis of the data they collected and an interpretation of the analysis. The *justification of the evidence* is a statement that defends their choice of evidence by explaining why it is important and relevant, making the concepts or assumptions underlying the analysis and interpretation explicit. The components of a scientific argument are illustrated in Figure 4.

## FIGURE 4

**The components of a scientific argument and criteria for evaluating its quality**




To illustrate each of the three structural components of a scientific argument, consider the following example. This argument was made in response to the guiding question, "What variables affect the period of a pendulum?"

> *Claim:* The only variable that affects the period of the pendulum is the length of the pendulum. The mass of the bob and the angle of release do not affect the period of the pendulum.