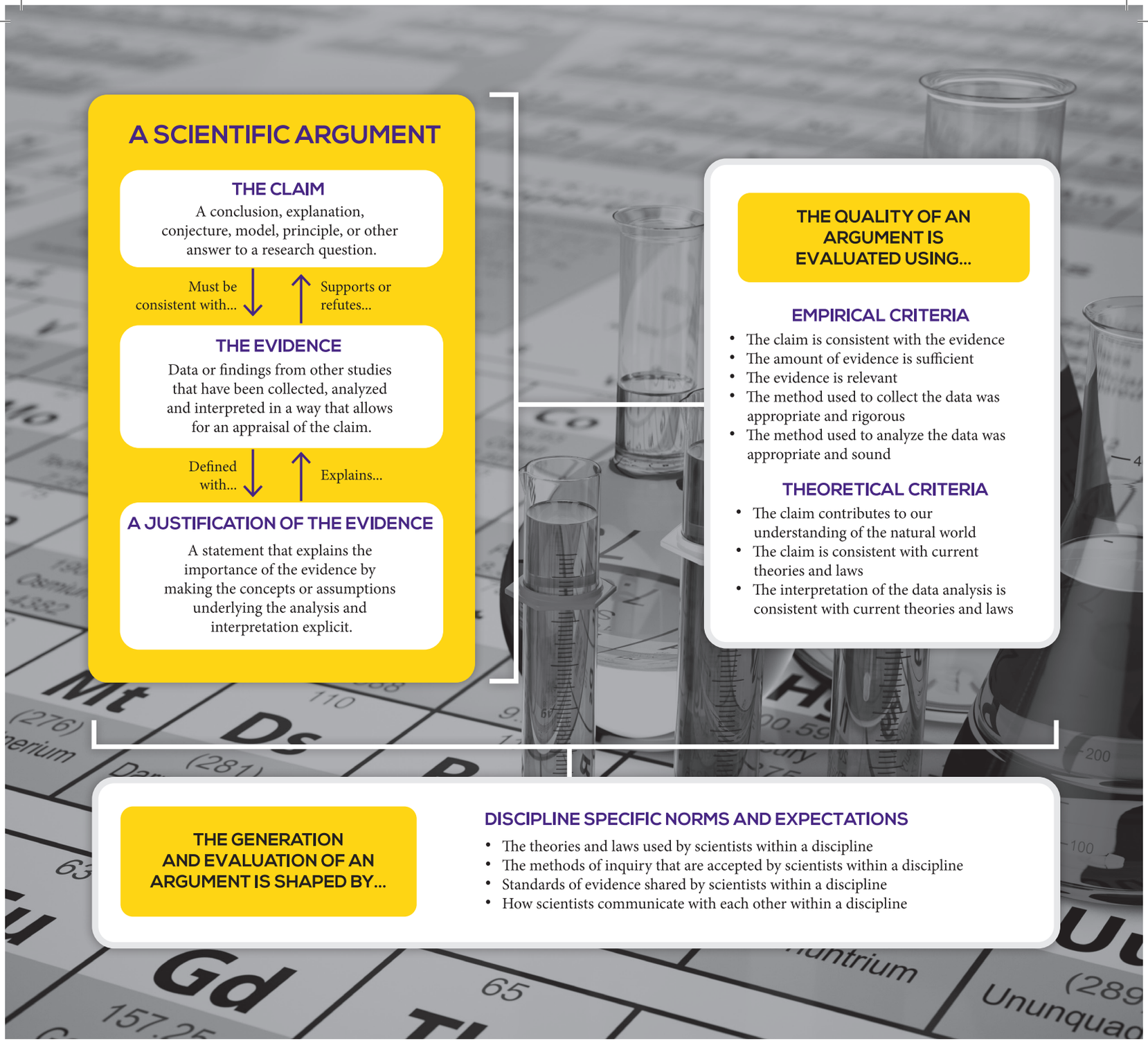
A SCIENTIFIC ARGUMENT
THE CLAIM
A conclusion, explanation, conjecture, model, principle, or other answer to a research question.
Must be consistent with...
Supports or refutes...
THE EVIDENCE
Data or findings from other studies that have been collected, analyzed and interpreted in a way that allows for an appraisal of the claim.
Defined with...
Explains...
A JUSTIFICATION OF THE EVIDENCE
A statement that explains the importance of the evidence by making the concepts or assumptions underlying the analysis and interpretation explicit.
THE QUALITY OF AN ARGUMENT IS EVALUATED USING...
EMPIRICAL CRITERIA
• The claim is consistent with the evidence
• The amount of evidence is sufficient
• The evidence is relevant
• The method used to collect the data was appropriate and rigorous
• The method used to analyze the data was appropriate and sound
THEORETICAL CRITERIA
• The claim contributes to our understanding of the natural world
• The claim is consistent with current theories and laws
• The interpretation of the data analysis is consistent with current theories and laws
THE GENERATION AND EVALUATION OF AN ARGUMENT IS SHAPED BY...
DISCIPLINE SPECIFIC NORMS AND EXPECTATIONS
• The theories and laws used by scientists within a discipline
• The methods of inquiry that are accepted by scientists within a discipline
• Standards of evidence shared by scientists within a discipline
• How scientists communicate with each other within a discipline

ARGUMENT-DRIVEN INQUIRY DESCRIBED

This lab course is taught using an innovative instructional model called Argument Driven Inquiry (ADI). This model is designed to give students a more authentic science laboratory experience and to promote and support student learning inside the classroom. Rather than simply verifying known scientific values or concepts, students must design their own investigations in order to answer a thought-provoking research question. All the labs require collaborative work not only with students at the same table, but with other students in the class as well. This is how science is done, not in isolation but as part of a team. In the scientific community, results from research are shared and evaluated by fellow researchers. In this way results are validated through comparison and differences are resolved through discussion with others. A version of this system is part of the ADI laboratory program as well. Finally, when a scientist submits written results to a journal for publication the paper goes through extensive review and revision before it is finally published. To simulate this process, peer review and revision of lab reports are also part of the ADI instructional model.

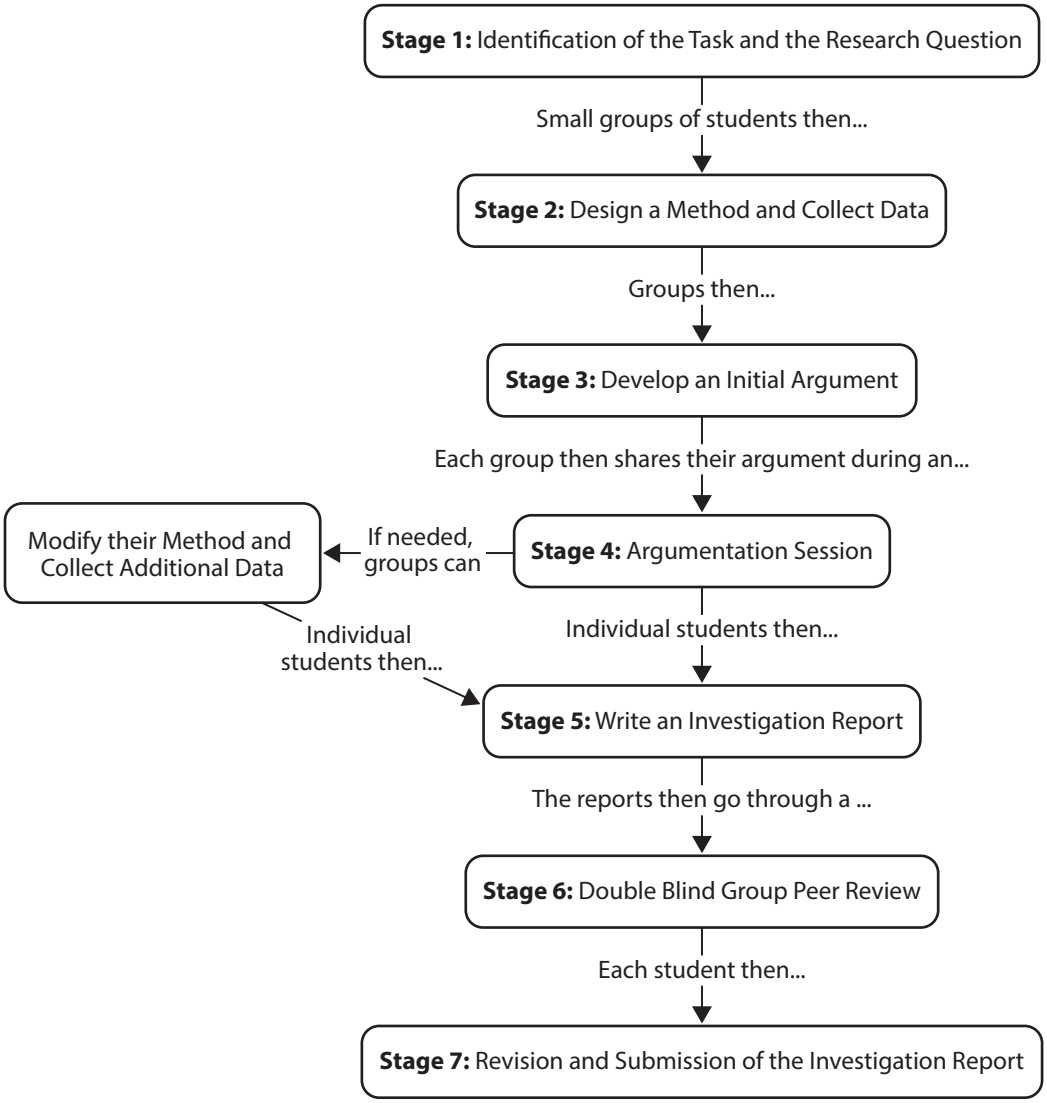

Figure 0.1. 7-steps of ADI.

Argument-Driven Inquiry Steps

There are seven steps to Argument Driven Inquiry. These steps have been intentionally designed to provide students with a richer and more genuine science laboratory experience.

Step 1: The question. Each lab investigation will focus on answering a specific research question.

Step 2: Investigation and Data collection. For each investigation students will have a list of materials and some general suggestions for how to start collecting data, but there are no detailed instructions to follow. It is up to each group of students to decide what to do and to coordinate their efforts so that everyone is involved.

Step 3: Creation of Posters. Each group will produce a poster presenting their explanation or answer to the research question along with their evidence and reasoning. This is not a detailed presentation of data, but a presentation of an argument, which is a conclusion, supported with evidence and a rationale that explains why the evidence supports the conclusion.

Step 4: Argumentation session. Each group will leave one member at the table to present their argument and the remaining group members will move around the room to other groups. At each table the presenter will begin a discussion of the results with the visiting group. The students should compare results and question each other's findings and method.

Step 5: Creation of an investigation report. The investigation report consists of three sections identified by the following questions.

Section 1: What were you trying to explain (or figure out) and why?

Section 2: How did you go about your work and why did you conduct your investigation in this way?

Section 3: What is your argument?

A scoring rubric is used to assign points for each section of the lab report. Students should refer to this rubric as they write their report.

Step 6: Double Blind Peer Review. Each student will bring four copies of a draft lab report to lab. The draft will be labeled with an ID number, NOT the student's name. There are four copies for each member of the reviewing team. The reviewing team will read the draft report and collaborate in completing a peer review sheet. Reviewers should identify deficiencies in the lab report and make suggestions for improvement on the peer review sheet. Before each peer review session, the instructor will highlight key concepts that should be addressed in each of the three sections of the report.

Step 7: Revision and submission of the final report. If a student's draft is accepted by the reviewing team they may submit it "as is" to the instructor. Most students choose to revise their draft based on the peer review suggestions and insight gained by reading other lab reports. The instructor will collect the final lab report, the peer review sheet and the marked-up copy of the draft lab report the following week. The instructor will then score the lab report using the scoring rubric. The instructor will also check the peer review to see if the reviewers were sincere in their effort to score the report.

The complete ADI cycle requires a minimum of three weeks to complete. This requires students to engage with a concept for an extended period of time, which tends to deepen understanding. The overall process is designed to provide an apprenticeship for students in the scientific community. Research conducted has demonstrated improved ability to use evidence and reasoning as well as improved attitudes towards science.

Initial Argument

Once your group has finished collecting and analyzing your data, you will need to develop an initial argument. Your argument must include a *claim,* which is your answer to the guiding question. Your argument must also include *evidence* in support of your claim. The evidence is your analysis of the data and your interpretation of what the analysis means. Finally, you must include a *justification* of the evidence in your argument. You will therefore need to use a scientific concept or principle to explain why the evidence that you decided to use is relevant and important. You will create your initial argument on a whiteboard. Your whiteboard must include all the information shown in ***Figure 0.2***.

The Guiding Question:	Group Members:
Claim:	
Evidence:	Justification of the Evidence:

Figure 0.2. Whiteboard Layout.

Argumentation Session

The argumentation session allows all of the groups to share their arguments. One member of each group stays at the lab station to share that group's argument, while the other members of the group go to the other lab stations one at a time to listen to and critique the arguments developed by their classmates. The goal of the argumentation session is not to convince others that your argument is the best one; rather, the goal is to identify errors or instances of faulty reasoning in the initial arguments so these mistakes can be fixed. You will therefore need to evaluate the content of the claim, the quality of the evidence used to support the claim, and the strength of the justification of the evidence included each argument that you see. To critique an argument, you might need more information than what is included on the whiteboard. You might, therefore, need to ask the presenter one or more follow-up questions, such as:

- What did your group do to make sure the data you collected are reliable? What did you do to decrease measurement error?
- What did your group do to analyze the data, and why did you decide to do it that way? Did you check your calculations?
- Is that the only way to interpret the results of your group's analysis? How do you know that your interpretation of the analysis is appropriate?
- Why did your group decide to present your evidence in that manner?
- What other claims did your group discuss before deciding on that one? Why did you abandon those alternative ideas?
- How confident are you that your group's claim is valid? What could you do to increase your confidence?

Once the argumentation session is complete, you will have a chance to meet with your group and revise your original argument. Your group might need to gather more data or to design a way to test one or more alternative claims as part of this process. Remember, your goal at this stage of the investigation is to develop the most valid or acceptable answer to the research question!