Introduction to Claims/Evidence Approach
(From Tom Thompson, Science Teacher, Philomath School District)

A great deal of science involves applying basic principles, theories, or laws to new and interesting questions. The claims/evidence approach to scientific inquiry is based on this particular view of science. Students are first exposed to a claim that may be a scientific hypothesis, theory, or law. Students are exposed to the claim through a series of well-structured activities or possibly some carefully chosen reading material. Once the scientific claim is identified, students are asked to investigate a novel situation where the claim might apply. The purpose of the investigation is to collect evidence to support or refute the validity of the claim as it applies to the specific context. A biology class may be introduced to the food pyramid and trophic levels. They read about the claim that predatory species should be fewer in number and biomass than prey species. Students then develop a way to investigate this claim in the context of a local stream where they collect evidence such as the number and trophic level of different invertebrates in the stream.

On the surface this may appear to be a typical confirmation lab or activity. However, unlike most confirmation labs, students develop the approach to collect meaningful data to use as evidence. A claims/evidence approach may also result in data that could refute the original claim which can then lead to discussions about errors, limitations, and general strength of evidence. This is a much closer approximation of real science than a confirmation activity where the data collection is designed to guarantee a specific result.

Perhaps the most important aspect of a claims/evidence approach to scientific inquiry is the connection to important scientific ideas. By making the original claim explicit and linking it to an important principle, students seem to be able to make stronger connections between scientific inquiry and important scientific content.
Help! I’m Trying to Teach Content Through Inquiry!
(From Emmely Briley, Science Teacher, Molalla River School District)

An Easy-to-Use Tool for Getting the Most out of Scientific Inquiry

Recently, I became involved in the planning meetings for the Oregon Science Teacher Leaders Institute where I heard about the Claims-Evidence approach to teaching scientific inquiry. It has been very helpful to me in encouraging independent thinking regarding experimental design and scientific principles, focusing my students’ inquiry on specific content, and inspiring critical thinking when it comes to deciding what the results of an experiment mean. All three of those areas really needed improvement in my teaching. It is so simple and easy-to-use that I feel that it might be of interest to other science teachers. I’d like to share how I used it in my classroom and the pleasing results I observed.

Previous Attempts at Teaching Inquiry

At the time of this project, I was in my second year teaching, and my physics class was made up of mostly juniors with a senior and sophomore or two thrown in for good measure. I had done one or two homemade inquiry labs with them previously. They were usually canned labs that I tried to make into inquiry activities by deleting certain parts and then asking the students to come up with their own hypotheses and procedures. I left the same questions that usually come at the end of a lab and then required a formal lab write-up. These first attempts at teaching inquiry, however, did not produce the results I wanted.

One such lab was when I asked the students to design an experiment to verify that the acceleration due to gravity (g) on earth was 9.81 m/s². As I wandered around the room to approve each group’s procedure, I noticed that most of the groups had not thought much about the problem on their own. It became clear that during our class discussion, the students found out what the “smartest” kids were doing and then copied their method. I had ten groups all dropping and timing blocks. It seemed like the groupthink had converged on the “right” method, and nobody wanted to do it “wrong.”

When the lab was finished and I began reading the conclusions my students had written, I was disappointed by the weak analyses. Most of my students seemed to write something like, “Our results were very accurate. We proved our hypothesis that g is equal to 9.81 m/s². We could improve our lab next time by using better equipment.” “Ugh!” I thought, “Where is all this critical thinking that I’m supposed to be seeing.”

The last, and I think most eye-opening, discovery that I made about my inquiry teaching was that much of the content that I was hoping to get across by doing the lab had dissolved into mist along the way. I went around to each group and discussed with them what they had learned from the lab. I quizzed them on certain concepts relating to acceleration, and to my horror, I realized that a significant number of my students still thought that heavier objects fall faster than lighter ones! I felt like my budding career as a physics teacher was withering on the vine. Not only that, but I remember thinking, “I’m doing inquiry like I’m supposed to. If this is such a great way to teach science, why aren’t my students gaining any conceptual ground?” Right then, I was really tempted to give up on inquiry and get out my lecture chalk, but I knew there had to be a better way to get content across while doing inquiry if I could just discover it.
The Claims-Evidence Approach in Action - Day One: Open Planning

After hearing about the Claims-Evidence approach, I decided to try it in my physics class. We were studying conservation of momentum in Chapter 6 of Holt Physics. This time, instead of giving them a canned lab that was tweaked to make it more inquiry-like, I kept the process more open by using Figure I as the only prompt as they began planning their experiments. I used the grid to focus the content of the inquiry but still give them the leeway to pose their own question by asking the class to skim the chapter and come up with a claim from the chapter which they could test. A “claim” is a statement that can be tested.

<table>
<thead>
<tr>
<th>What is the Claim?</th>
<th>What is the Question I want to ask?</th>
<th>What evidence would I accept to support the claim?</th>
<th>What evidence did I actually get?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure I.

The class brainstormed a few claims from the chapter such as “Momentum is mass times velocity,” “A change in momentum over a longer time requires less force,” etc. I wrote the ideas up on the class claim grid on the chalk board, and then they voted on the one that they liked the best. During this time, I talked about keeping the claim simple and testable, and the use of controls and variables. I tried to give pros and cons of each claim idea attempting to steer the students toward a claim that would be manageable with a simple experiment. In the end, the students chose a claim to test that would not have been my first choice, but that they, nonetheless, could relate to.

They chose the claim, “Kinetic energy is conserved in an elastic collision.” They all wrote the same claim in the first column of the grid and then were left to fill in the last three columns themselves. In the second column, most students simply rewrote the claim in the form of a question. Column three was space for students to start thinking about the evidence they would need to support the claim. At this point, students were allowed to work in groups of two or three. The grid was their planning space, but they were to write the details of their procedures and results in their lab notebooks.
Since this was the first time our class used this format, we also brainstormed some ideas for column three together as a class. Although the question is “What evidence would I accept to support the claim?” it was clear that students were not used to making a connection between the data they gathered during a lab and the actual question they were attempting to answer. At first, students just started throwing out variables. As I filled in our classroom column three up on the board, students shouted out things like, “speed,” “time,” “distance,” “mass,” etc. I was unpleasantly surprised to hear nothing about the definition of kinetic energy or collisions or relationships they should be looking for. I tried to probe the class by asking questions. “What is kinetic energy?” I asked. A student or two gave the mathematical formula after looking it up. I hoped that this lab would give them understanding of kinetic energy beyond its formula. Next, we talked about what it meant to be conserved. I probed them more. I asked them, “How will you know if kinetic energy is conserved or not?” Eventually, a student or two said that kinetic energy should be the same before and after a collision. I gave them the assignment to think about how they might design an experiment to test this prediction and come back the next day with a rough sketch of a hypothesis and a procedure.

**The Claims-Evidence Approach in Action - Day Two: Independent Experimental Design**

The next day, I read each group’s procedure before allowing them to begin the lab. Some of the groups had a good start, meaning they could eventually calculate kinetic energies with the data they were collecting and their experiments were feasible. I knew that some of these groups would run into practical problems with losses due to friction and inelastic collisions, but I let them begin anyway because I wanted them to have experience working out the difficulties on their own.

Other groups, however, needed more guidance. They described their experimental set-up, but had no idea what data they should collect. Others were collecting the right variables but made no mention of the data’s connection to kinetic energy. Still others had creative but overly complex experimental set-ups. I asked these groups a few probing questions using the claim form. I asked them to think about the original claim, “Kinetic energy is conserved in elastic collisions.” Then, I asked them to write down how the data they were going to collect would support the claim and then revise their procedures as necessary. This prodding helped most of the groups focus a little better, and their rewritten procedures were more applicable if not stellar. The really pleasing thing I noticed about the students’ experimental designs was that they were all different. During this activity, they did not seem interested in copying what the “smart kids” were doing. I believe that because they were thinking so hard on their own, they all felt smart.

**Lively Discussion of Scientific Principles**

As I wandered around the room while students were performing the experiments they had created, what struck me most were the differences in their conversations from those during a regular, more guided lab. Students often talk about what step to do first, second, or third without reference to why they are collecting a certain datum. During the claims lab, I heard students discussing and debating the scientific principles involved. They disagreed and gave reasoned arguments for why colliding two marbles was better than colliding one with the wall, for example. Most of the groups revised their procedures as they ran into practical problems. I was thrilled that my students were actually thinking about science and experimental procedures.
Tighter Focus on Core Content

I had some students that struggled with lab work. Even during cookbook labs, they usually became overwhelmed by all the steps they needed to perform, let alone how their data related to the scientific content we were investigating. The openness of the claims-evidence inquiry lab felt even more overwhelming at first. They were unsure of how to get started, of what they were “supposed” to do.

By using the grid worksheet, however, I could help the students to focus on the overall purpose of their experiment by asking a simple question, “What is the claim you are trying to test?” Usually, this question was all the students needed to get going in the right direction. I think the non-intimidating language of the worksheet helps students to think about scientific problems in their own terms.

The grid also helped to keep the main idea of the lab before the students’ eyes at all times. Maybe it was the simple fact that there was a big box around the claim, “Kinetic energy is conserved in elastic collisions,” that helped my students be able to articulate the core concept we were working with. When the time came for them to write about what their data meant, they had already been thinking about it for a long time. The content did not get lost in the inquiry.

Critical Thinking When Analyzing Data

A nice result that I observed from using the claims-evidence approach was the improvement in what students at all ability levels had to say in their conclusions. They went into more detail than usual about what happened during the lab, what their results meant, what accounted for the losses they observed, and how the experiment could be improved in the future. I had one student who was thinking about the physics of kinetic energy conservation so much that he went out and did extra research on his own to try to understand it.

Summary

Using the open claims-evidence approach as a planning tool for students and as a means to keep the focus of inquiry on the scientific content at hand, I saw improvements in student learning from an inquiry activity. There was more creative experimental design, minds-on discussions of the meaning of what they did in lab while they did it, better focus on the concepts I wanted to get across, and more detailed written conclusions. Some challenges I experienced using this approach were that students chose a claim that was not the one I would have chosen. Also, many students initially lacked a meaningful connection between variables and the concept of kinetic energy, and some students felt overwhelmed by planning their own experiment from scratch. I think these issues will improve as I continue to use this approach, and my students and I gain more competence doing open inquiry. Many versions of the grid can be made and adapted as needed. Next time, I want to use a column heading that asks, “How can I make my evidence as strong as I can?” I found the claims-evidence approach a helpful tool for my classroom, and if you think it might be helpful to you too, I hope you’ll try it!
Sources


Acknowledgements

I would like to thank Tom Thompson, Dave Hamilton, and Edith Gummer who first introduced the Claim-Evidence approach to me at the Oregon Science Teacher Leaders Institute planning meetings.

The writing of this paper was supported by WRITE ON! a writing retreat facilitated by the Oregon Collaborative for Excellence in the Preparation of Teachers (OCEPT) funded by National Science Foundation grants DUE-9996453 and 0222552.