Science Notebooks

Writing About Inquiry

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Discussions with Two Scientists

Scientists develop explanations using observations (evidence) and what they already know about the world (scientific knowledge). Good explanations are based on evidence from investigations. Scientists make the results of their investigations public; they describe the investigations in ways that enable others to repeat the investigation. Scientists review and ask questions about the results of other scientists' work. (National Research Council 1996, 123)

How Scientists Use Their Notebooks

In order to consider authentic implementation of science notebooks in the classroom, it is important to understand how scientists use notebooks in their line of work. Two scientists, Kay Rohde and Alan Gallaspy, were interviewed separately and shared ways that they have used notebooks. Kay provided insight as a national park specialist on observational fieldwork. Alan, a forensic scientist, offered information from the perspective of a controlled lab setting. We also asked the scientists to consider what is important for teachers and students to take into account when utilizing notebooks.

Please describe your job.

Kay: I am chief of interpretation for Lake Mead National Recreation Area [in Nevada and Arizona], which means that I manage all of the information and educational services in the park.

My current position does not require me to use a notebook, so I will focus on my experiences when I worked in a cave. I worked as a cave specialist for a number of years.

Alan: I am employed as a forensic scientist at one of the regional crime labs in town and usually work in the toxicology section. Toxicology is the study of the disposition and effects of poisons; most of my work is centered on drunken driving and various

crimes where drugs of abuse might be involved. I also occasionally find myself testing specimens from people that have been accused in murder cases so I can better understand their thought processes at the time of the crime.

What type of notebook do you use in your work?

Kay: The science notebook we used had a slightly different purpose; it was actually a survey book with waterproof pages, because caves can get dripping wet. We had a staff logbook in which everyone would record cave conditions. Many of our entries would have a sketch with the actual readings: forward, backward, azimuth, the whole nine yards. We would also inventory resources. For each survey station, we would list everything around us and sketch the room. We also kept personal notebooks while leading cave tours, keeping watch of things in the cave, noting differences. Eventually, we used the information in the notebook to help us develop a picture of what a year in the cave looked like. We were able to document changes and use it as the basis of research later.

Alan: We are running the entire spectrum of notebooks these days. We may maintain a small spiral notebook as a record of small off-the-cuff calculations. Or, we may make some kind of notation that there is a leak in the roof that was dripping on one of the instruments to remind us to have it fixed.

We also maintain extensive logs. For example, if we have a piece of instrumentation or some kind of analytical device, we may keep a logbook on it detailing maintenance issues, what kind of calibrations have been performed on it over time, what kind of repairs may have been made on it, when it was placed in service, and when it was taken out of service.

We have logbooks and computer systems to help us keep track of each piece of evidence that comes in and goes out of the laboratory. We are just surrounded by paper all over the place and it can get kind of crazy at times.

What type of information do you record in your notebook and how do you organize it?

Kay: The survey book was not just my book; it was a community book. We actually taught note taking as one of the skills for working in the cave in order to maintain consistency in this community survey book. When you went in on a survey crew, you learned what and how to record. We had a tape person who measured and a note taker who could write legibly and take it

all in. There was a real skill to note taking, not just getting the numbers down as the tape person called them out, but being able to sketch and record all the details.

For every surveying point we had to do a physical sketch of the room, both in cross-section as well as in plain view. The survey book became a document of everything in the cave, an inventory of it. We would go into the cave and sketch rooms including pools of water, stalactites, stalagmites, and anything else we noticed. Most of the time, it was just normal stuff and we used shorthand, indicating a feature and the size of it. But if there was something unusual, we wrote it all down and described it in detail. Unusual items might be wet spots, fossils, and things like that.

I would also go into the cave with one of the entomologists when I worked at Carlsbad [Caverns National Park in New Mexico]. He would take his own notebook into the cave and note what he found and sketch the "critters" himself. We would bait traps, he would describe their location in his notebook, and then we would go back at a later time and check the traps. He had to describe what the trap consisted of because those things could become variables in his work. When we captured insects, he would note all of the details: where the insect was found; what it looked like; conditions of the area; temperature; substrate, sometimes taking a sample of it; behavior; and time, although this might be considered irrelevant in a cave.

Alan: We spend a lot of time organizing and documenting the experiments that we are going to perform. For example, if we want to test several bloods for their alcohol level, there are a lot of things that we will do for that particular experiment. We will make a list of the samples that we will run for that particular experiment. For each of those samples, the unknowns, there will be demographical information. For example, each blood sample would have a name and maybe a case number associated with it. We might even have multiple samples from the same person drawn at different times, and we might have a number of different people all involved in one case. So we have to have some type of system to keep all of those things organized and not confuse one with the other.

In addition, if we are doing quantitative analysis, we want to have different information on where we obtained the quantitative calibrators: the manufacturer, lot number, and date of manufacture. We might have additional information on the lot numbers of different reagents used in a particular experiment. Those are just some of the elements of an experiment that we have to keep track of one way or another.

I was not by any means the first employee for that particular laboratory and there were various systems in place already. I was given a certain amount of latitude to do things my own way, but nonetheless, I was expected to comply and conform to whatever systems were currently in place. There is no sense in allowing one person to reinvent the wheel. If there is something that is known to work, to fulfill the needs of that particular institution, it makes sense to go ahead and educate others about that system.

How did you use the information in your notebooks?

Kay: A lot of the cave was sitting right under parking lots and we began to notice some trends in our notes. With the notes, we knew where all the wet places were, where there was dripping or water formations. Those notes provided us with data and became the beginnings of hydrological studies. In those studies we used dye tracing to help us make sense of the trends we were seeing. We ended up finding petrochemicals in some of the water samples, and we could directly tie the information to the parking lots, and it was the notes in our survey book that began to show us the trends.

Our notes also helped us develop a picture of the cave. We would take the numbers we recorded while underground and connect them to numbers on the top. This allowed us to actually construct a map of the cave in relationship to the surface under which it lay. With surveying, we were able to check how accurate we were with our data. When we surveyed around and the walls of the cave did not meet, we knew we had some errors in our data. Knowing this allowed us to revisit data and develop an accurate picture of the cave.

Alan: We might conduct various experiments to draw a conclusion. For example, for a drunken driver, we will analyze the quantitative level of alcohol in the person's blood and we will have the supporting data we generated for that particular sample. Based on that quantitative level, we can say whether or not someone was perhaps under the influence of alcohol while he was driving. We're fully prepared to present those findings, as more of an adversarial courtroom presentation, at that point.

Recommendations for the Classroom

Science notebooks are an essential component in the scientific community. Therefore, it is important to understand the scientists' perspective on why notebooks should be used in elementary science. This became a

main component of the interview, focusing on the scientists' ideas regarding the role of notebooks in elementary science.

Why should children use science notebooks?

Kay: The main thing is to get the observations and information down; reflection will come later. If reflection is pushed too much, it will get in the way of the real purpose, which is to record the data so you can do something with it later. There needs to be a point where students think about why they did something; however, reflection should come later. The critical thing is to get the data down so it can be replicated or examined later. In a science notebook, students should be gathering information and taking notes so they can do something with the information later, such as build a map, construct an experiment, look up something, or identify a little bird.

I think that using the notebook will help kids be able to verbalize and describe. Recording in the notebook will help in vocabulary development and describing; being able to write descriptively is better in the long run no matter what they do.

Alan: You can never depend on your memory. I can't even remember what I had for breakfast this morning. If that was important, I should have recorded it in my notebook. But nonetheless, it would be foolhardy to rely on your memory for a particular experiment, no matter how simple it might be.

What are the elements that you feel are essential for student notebooks?

Kay: I think that the notebook is something that builds. Background data is essential—who, what, when, where, why, and how, particularly who, when, and what because all of that influences the investigation. With young kids, it is starting small, with very simple data, such as the temperature. As students get older they are going to figure out what else might go in there. I would probably want students to record who they are working with because that becomes important if there are questions. Then I would consider items that are specific to whatever is being investigated. Having that information helps build a picture of conditions for whatever is being done. The other thing I would want to see kids include is some questions because those are the kinds of things they go back to and say, "Hmm, let's look into that."

Alan: It is good to try to keep as much detailed and organized information as possible if you don't really know what is going to be important down the road. Completeness would account for

something. You can go back from your complete notes and ascertain what was irrelevant and what was important.

What advice do you have about recording data and organizing it?

Kay: I hope teachers don't make kids write in complete sentences; they just need to get the ideas down. Everybody learns differently. Sometimes for me, just a word helps me remember; for others, they need more words or more descriptions. Let kids come up with the criteria that they need to record. It may be a collective class effort, but constantly do that so they learn what to record and they don't just rely on journaling. Journaling is fine, there is a place for it, but it will get in the way of the data collection, which is why scientists use notebooks—to record data. If scientists don't record the data, they can't replicate their work; they can't build a picture; they can't use the data if it is not complete.

Alan: The main take-home point is that it is good to anticipate, if you possibly can, what you want to record and then try to organize it in some sort of systematic way, be it a table, graph, or something along those lines. A little preparation goes a long way. There are, of course, different ways to record things; both in my work and in every scientific endeavor that I have been a part of in my life, there has been more than one way to record something.

For example, if students were making a series of observations of a seed sprouting, they would have to have some sort of organized, systematic way of recording those observations. They might have notebook entries ranging from the initial day—day one, day two—for as long as they care to run the experiment and make provisions for whatever observations they care to record in that particular space. But the key to these entries is to have an organized, systematic recording of the experiment.

Hopefully, students will be able to take a look at the data they generate with a known situation and apply that same experiment to an unknown situation and draw a conclusion from it. If they organize their notebooks properly, students should be able to do that.

What other thoughts would you like to share?

Kay: I don't ever remember using a notebook in school. I wish that someone had taught me. I think it is important to think about how students use them so it is not considered a chore but becomes natural. Maybe start with just data or just observation as a first step rather than trying to do it all. To me, having to do it all would be overwhelming as a kid.

Also, I think that it has to be real; it can't be contrived. So when doing a science project, just keep notes, time, and date—these things are automatic, kind of like putting your name, class, and period on the top right corner of the paper. I think that it is a gradual thing. Sometimes there is the expectation that a third grader will automatically have the same kind of science notebook that a premed student or biologist would have. That is one of the things that teachers need to be careful of. I think that a well-developed notebook is a gradual thing.

Alan: Careful note taking is what separates science from casual observation. For instance, I have noticed for years and years that the sun comes up over the mountain. But if I wanted to quantify that a little bit better, I would have to take very systematic notes, such as exactly which part of the mountain it comes over and if I am standing in the same spot in the valley when I make this observation.

Overall, the notebook is something that develops with time. It is like any other endeavor: you have to expose not just kids, but anyone, to a certain thing any number of times before they will get the knack of it and master it.

One of the purposes for maintaining science notebooks, in addition to exploring scientific content and literacy, is to replicate the work that scientists do. Kay and Alan have provided their perspectives on authentic use of science notebooks in two different fields of scientific study. By examining the way scientists utilize notebooks and the recommendations they have shared, teachers can develop a sense of purpose for implementing science notebooks in the classroom.

Thinking point: Based upon the scientists' perspectives, how will you make science notebooks authentic for students?