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Double Dipping for Research

An Introduction to the Scientific Method

Terry Favero

Students learn science best by doing science. Therein lies the value of the laboratory experience. Yet, rather than employ cookbook type exercises and predescribed protocols for laboratory work, students come away with a much better experience of what science is when they conduct student-designed research projects. Engaging students in research can teach critical thinking, problem solving and analytical skills to all students.

Introducing the concept of research/problem solving to students can be a difficult endeavor. They often believe research and the scientific method are lofty goals for only the brightest students rather than tools to be used in solving everyday problems. Therefore, I start with a fun in-class activity designed to get students thinking about problem-solving utilizing research as a process and have them apply it to a problem to which most can relate. This activity can be completed in as few as 30 minutes or span several weeks coupled with a variety of written exercises. This activity is called "Double Dipping with Seinfeld." Double dipping is the process whereby an individual takes a chip, dips into a dip, bites off a section, and dips a second time with the same chip that has contacted the mouth, possibly returning germs to the dip to which others can be exposed. Most people consider this very offensive behavior, if not an unhealthy practice. Aside from its social considerations, is this really a poor health practice? I challenge the students to come up with a scenario to solve this problem in the following handout (Figure 1). Note that very few instructions accompany the handout.

I actually conduct this exercise twice, both times as paper exercises (i.e., no experiments are actually carried out). The first time, I let students develop any research design they desire. A number of students have some general understanding of microbiology and propose (on paper) to solve the problem by culturing the affected area (area that was double dipped) on the dip and analyze it for bacteria. Other groups suggest (once again on paper) that they will test the outcome of the germ spreading by having one person with a cold/flu double dip and then have several subjects dip, then wait a week and see if they exhibit signs or symptoms of the cold/flu. All in all, these two scenarios provide many possibilities to step back and discuss many important topics that relate to research (see list below). From my own experience, I am amazed that students who assume the role of researcher believe that in the name of good science they are allowed to expose people to harmful organisms. This usually prompts a discussion about human subjects, scientific ethics, etc. All are important problems that young scientists need to understand. At this point, several discussion/writing points may be addressed that include, but are not necessarily limited to, hypothesis generation, human subject issues, informed consent, scientific ethics, etc.

Following the above experience, I challenge the students to again consider the problem at hand, but I add the proviso that they may not use any biological or hazardous materials to conduct their study. This presents a problem for most students since they assume the only way to test whether or not germs/saliva are returned to the dip is by using saliva as the transfer medium. I provide them with several examples of parallel research design. That is, research design strategies that can measure one variable indirectly by measuring a second variable that correlates with or can represent the variable in question. For example, in most cases using human subjects, it is very difficult to **directly** measure most physiological parameters, either because of hazardous materials concerns or because of technical limitations. Students need to understand that **indirect** measurements which adequately represent the event or variable in question can be just as reliable as measuring the real thing. For instance, to evaluate the beating frequency of the heart, we measure the number of pulsations in a distal artery over a

George Costanza (from "Seinfeld") has been repeatedly accused of "double dipping" his chips (taking one chip, dipping, biting the dipped portion, and redipping the chip). Society frowns on this activity because it may propagate the spread of germs. Design a research experiment that would test whether germs would be or could be spread by this habit. (Of course, you may not use biological materials.)

Hypothesis (Students fill this section in.)

Methods (Students fill this section in.)

Figure 1. Double dipping handout. (This is all that is written on their form at the beginning of the exercise.)

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period of time. Since a perfect correlation exists between the beating of the heart and the change in blood pressure as detected by placing a finger on an artery, we can in fact indirectly measure the beating frequency of the heart. One could also use a stethoscope to listen to the heart beating. Getting students to think of creative ways to measure different parameters that represent or correlate with the variable of interest lets them explore and design solutions to problems in a very unstructured and open-ended manner. With a little coaxing, they find that there are many ways to accomplish certain tasks and sometimes realize that some methods can be more accurate than others.

Some, but not all, students conclude that one effective way to examine the problem of double dipping is to use a dye to represent the saliva and a white (usually sour cream) substance to represent a dip. At this juncture, writing the methodology poses additional questions. What about confounding variables or other related variables that may impact the outcome? Will the same result be obtained using a potato chip vs. a tortilla chip, oval vs. triangular, flat vs. ridged, salted vs. unsalted? This extends to the dip as well. Would the results be different with warm vs. cold dips, cheese-type dips vs. salsa? The variations the students generate are endless.

This provides for a wonderful opportunity to discuss methodological concerns. Although we conduct this experiment as a paper exercise only, several methods may be tested safely (such as the one listed above where no saliva is involved). Actually writing and defining the methods section means that the students will have to develop an experimental protocol that is adequate, repeatable and accurate. What is the appropriate dipping technique? Should students scoop the dip or drag the chip across the surface of the dip? Once again, many possible permutations exist. In addition, writing a defined methodology forces students to detail in writing what would seem to be a very simplistic process. Actually describing in detailed language a repeatable method for subjects to dip the chip is quite a challenging task. While providing instructions that simply specify "after dunking the dip in dye, dip the chip in the dip" may suffice, many different interpretations of that stated process will result. Some chip fanatics are dunkers, while others scoop the edible substances up onto the surface of the chip. Also, what is the appropriate number of trials to make a reasonable conclusion, 1, 10, 50? Thus, several other writing/discussion topics may be covered at this time, including variable representation, control for confounding variables, type of dip and chip, technique considerations, methodological writing, appropriate number of trials, etc.

In conclusion, science can be learned in an effective manner by engaging young students in the process of research. Creative thinking, problem solving, methodological planning and fun can all be part of the research experience. This exercise incorporates all of those elements and can be implemented as a simple discussion or used over the course of many weeks with several written assignments. While I have only used this exercise as a discussion tool, I find myself always relating several aspects of the research process back to this initial example. It is simple in scope, yet more complicated to carry out, and at the same time is very enjoyable for young scientists. At the end of the day, students should come away with a better understanding of research process and design and have fun doing it.

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Society for Neuroscience Workshop for Pre-College Science Teachers in Los Angeles

The Society for Neuroscience is offering a unique opportunity for pre-college science teachers to attend the Annual Meeting of the Society (November 7-12, 1998 in Los Angeles) and participate in special workshop activities for teachers. Special lecture/discussion sessions for teachers and hands-on demonstrations with laboratory activities appropriate for pre-college science are planned for Saturday, November 7. A Web-based neuroscience demonstration is planned for Sunday, November 8. Teachers will attend normal scientific sessions of the Annual Meeting on Sunday, November 8 and throughout the week if they wish. As part of the workshop activities, teachers will interact with scientists who will serve as mentors to guide them to interesting symposia and presentations on current research areas in neuroscience (for example: brain development, effects of drugs on the nervous system, learning and memory, Alzheimer's Disease, etc.) For addition information and application forms, contact: Libby Edwards at the Society for Neuroscience, 11 Dupont Circle, N.W., Suite 500, Washington, D.C. 20036 (202)462-6688.

Application deadline: Friday, October 1 or until the workshop is filled.