

WHY RESEARCH EXPERIENCE?

“...on fait la science avec des faits comme une maison avec des pierres; mais une accumulation de faits n’est pas plus une science qu’un tas de pierres n’est une maison.”

“...one builds science with facts, as (one builds) a house with stones. But a collection of facts is no more a science than a heap of stones is a house.”

— Jules Henri Poincaré (Science and Hypothesis, 1908)

Any science student learns a lot of facts. But the enterprise of science, as Poincaré stresses earlier in the essay that I quote above, is fundamentally one of doing experiments and making observations, and, equally critical, developing a theory that comprehends the past observations and makes predictions for the outcome of future experiments. That is the enterprise of research. Research is the essence of science. The facts, (by which Poincaré means the things learned by past observations and experiment), and the theories that comprehend these facts are a product of research. Without some knowledge of the process by which these facts and theories were obtained a student cannot know what science is all about, nor distinguish scientific information from myth or speculation.

None of us has the time, nor the resources, to reproduce all the experiments and redevelop all of the theories. In learning science one mostly learns just the results, the facts and theories, without learning very much about

how these results were obtained. Even laboratory classes only scratch the surface of the problem. All too often the experiments have been reduced to rote following of procedure. The iterative process of interaction between experiment and theory, the uncertainty, the missteps and wrong guesses, are rarely met.

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A research experience allows a student to see the process of science firsthand, to struggle, as researchers must, with the confusion of not knowing what is going on, with the uncertainty and the excitement of a new idea. The student can experience the detective-like hunt for a clue, for a way to make an experiment work, or for an interpretation of an unexpected outcome. This experience brings the student face to face with issues that do not appear when learning means finding out about what others already know.

Research is so different from learning science in the classroom that anyone considering a career in science should seek out every opportunity to experience it. In studying science, a student may experience the fascination of the big ideas and be excited when reading of a new theory in the paper. While that excitement indicates the student may like being a scientist, it is only the first step. The real test comes with some actual experience of having a problem to solve that is not just an exercise. It must be a problem to which no one quite knows the answer yet. Beyond that, the student needs to experience what it means to be part of a research team, with others who rely on your results to push forward the joint endeavor, as you rely on them for their insights and advice on your part of the problem, as well as for their results.

Some students may perhaps feel that, despite strong interest, they are not quite cut out for a career in science because others in their classes read and understand faster, or do better on the exams. However, once in the research lab, some of these students find that other skills that they possess are more important than those that make it easy to get good grades. Skills in making equipment function, skills in envisaging a change in the setup that will overcome a problem you are experiencing with it, skills in working as part of a team and combining your ideas with those of others; all these are critical in research but seldom tapped in the classroom. The research experience lets a student learn about these skills and demonstrate them too — and a letter of recommendation from a research mentor can be the key to admission to a first rate graduate school.

On the other hand, a student may find that living with uncertainty and confusion appeals not at all. If so, this too is invaluable knowledge. A career in research is probably not the best choice for such a person. Their interest and skills in learning about science can lead to other options: teaching, science writing, working as a hospital radiation physicist, to name but a few. The sooner the student knows this the better educational choices can be tuned towards the careers that will be most rewarding.

Whether the research experience steers the student away from or toward research as a career direction, it will be invaluable. The experience teaches the student things about herself, or himself, and about science, that no classroom can teach. Experience of the process by which scientific results are obtained is valuable for anyone. At some level it needs to be part of basic science education.

The opportunity to experience research in the real world of advanced scientific laboratories, such as those supported by the Department of Energy, is particularly precious. The students who have had this experience, whose research abstracts and papers are published in this journal, will never again take a scientific result for granted. Some will go on to be the leaders of their fields of science in future careers. All will be well-informed citizens when considering issues of science in society and in their lives. We wish them well, and hope many more like them will apply to the program next year.



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