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The Value of Science Experiments in Primary and Secondary Schools

One education topic of interest to both American and Chinese educators is the use of experiments, laboratories, and other hands-on activities in science classes. I myself am particularly interested in this topic as a science major who will be completing a senior thesis on science education in the United States. As part of this project, I will be required to teach part of a high school biology course for about 4 hours a week for over 20 weeks my senior year. In preparation for this thesis, I have enrolled in a pedagogy course this semester, studying the state of science education in America. The use of science experiments, in particular, fascinates me because such activities have a lot of potential to intrigue and captivate students, but often these activities fall short of their goals. I actually did not really like many of my science courses before college, but after coming to Georgetown, I found both science classwork and labwork enjoyable. My proposed project for the ACC Field Studies program would incorporate an overview of science education in America, and examples of how science experiments are used in classroom settings, as outlined below.

American society has historically placed a high value on technological creativity and innovation. From landing on the moon to establishing the beginnings of the internet, from inventing the polio vaccine to leading the Human Genome Project, the United States has been at the forefront of scientific research for over a century. Correspondingly, the U.S. government and private citizens have appreciated implementing in all grade levels a robust education in science and especially student-driven experimentation.

Unfortunately, this appreciation for science has not translated into convincing results. Although science education in earlier grade levels meets most international standards, the quality of high school science education in the United States has declined over the past few decades. In most international assessments, American high school students have average or even below average science scores, behind many developed European and Asian countries. Education researchers have explained this progressive decline in science achievement as a symptom of problems ranging from administrative flaws to the disconnect that students feel between their life experiences and their science curriculum. Among the most important solutions that education policy experts have advanced to solve America's science education problem is to increase the emphasis on student participation in science experiments and laboratories.

From the earliest grades, American science classes have practical components that highlight, compliment, or even go beyond material that the teacher has lectured upon. In elementary and middle school, students may, for example, collect leaf samples or measure rust build-up on metals. Older students perform increasingly complex experiments which may involve dissecting animals or studying plant photosynthetic rates. However, because most public schools only require students to take a limited number of science classes in high school, high school students receive limited exposure to more complicated and potentially more interesting experiments. Private and public charter schools often have more stringent science education requirements and may require students to complete a more complicated science project before graduation.

These science experiments serve many pedagogical purposes. Besides stressing and further explaining material that the teacher deems important, science experiments

introduce students to the possibility of a science career and also give students valuable skills that make them more productive members of society and can help them succeed at careers even unrelated to science and technology.

Educators usually consider the primary function of science experiments to be a method of further emphasizing material taught during the lecture. For example, in the earliest grades, after studying colors, students could mix together different paints to reinforce color combinations previously taught. After studying gravity, mass, and weight, middle school students could drop similar sized balls made of metals of different mass and measure the rate of descent. High school students studying acid-base chemistry can perform titrations of weak acids and bases. By repeating lecture material with hands-on laboratories, students are more likely to retain information from class.

Science experiments also have obvious value in instilling within students an interest in a possible science career. Graduate schools in the sciences require students to have completed substantial research as undergraduate students, and this undergraduate science research and class work is based on mathematical and science foundations from primary and secondary school. In earlier grades many students participate in science fair projects, which involve investigating some observable phenomenon. Many high schools with more rigorous curricula encourage students to complete a more complicated independent science project before graduation. These projects can involve collaboration with laboratories in community colleges, universities, or pharmaceutical companies. Most science experiments that American students perform, however, are more textbook based and involve fewer independent opportunities. Either way, the experimental methods that

students practice before college, and especially in high school, are the same that are used throughout the career of a scientist.

Even if students do not plan to become career scientists, science classes and associated experiments give students the tools to be more dynamic citizens. The first experiments that students carry out often require extensive group work. Learning to work with others and be a part of a productive team is an important overarching goal of the American education system. Laboratories also have components completed independently, requiring the student to develop their creativity and problem solving skills. Science experiments at higher grade levels also typically require the student to design certain procedural steps, interpret end results, and write up a paper summarizing the materials used, procedure followed, results, and conclusion. These analysis and writing skills are beneficial to students aspiring for any job.

My presentation would focus on the information outlined above. If possible I could within a PowerPoint presentation include short video clips of various experiments in the context of K-12 science education. As the United States tries to strengthen its science curriculum, and as China considers moving away from lecture-based standards, highlighting the need for such science experiments will become more and more important.