Scientific discovery and innovation can depend on engaging more students in the arts.

Robert Root-Bernstein and Michele Root-Bernstein

Suppose you have a talented child with a profound interest in science. This child has a choice of going to an academically elite high school or to a high school where the curriculum focuses on training mechanics, carpenters, and designers. Where do you send her? It’s no brainer, right? To the academically elite high school.

Except that Walter Alvarez, a doctor and physiologist of some renown, decided to send his scientifically talented son, Luis, to an arts and crafts school where Luis took industrial drawing and woodworking instead of calculus. Big mistake? Not exactly. Luis Alvarez won the Nobel Prize in physics in 1969. He attributed his success to an uncanny ability to visualize and build almost any kind of experimental apparatus he could imagine (Alvarez, 1987).

Suppose you have a baby Einstein. The question is, would you know it? After all, Einstein was certainly not a standout in his mathematics and physics classes. Yet he also ended up with a Nobel Prize.

So what were his special talents? One was clearly an ability to visualize concepts in his mind, a talent that was fostered by Aargau Cantonal School in Switzerland, where he completed his secondary education. Based on Johann Pestalozzi’s philosophy of education, the school encouraged individual differences, sense perception, visualization, and modeling, all developed through a student’s self-directed activity. One outcome of this training was Einstein’s habit of imagining himself riding a light beam or falling in an elevator at the speed of light, the basis of thought experiments that yielded his revolutionary insights. Another outcome was his facility with devices, which he developed further as a patent examiner and through several inventions of his own.

Einstein also melded a talent for music with his thinking. Although he is well known for his improvisational ability on both the violin and the piano, few people are aware that he attributed many of his greatest scientific insights to “musical thinking” (Root-Bernstein & Root-Bernstein, 2010). As he put it, “The theory of relativity occurred to me by intuition, and music is the driving force behind this intuition. My parents had me study the violin from the time I was 6. My new discovery is the result of musical perception” (Swerdfegger, 1969, p. 90).

And what about the Swedish biochemist Hans von Euler-Chelpin? He was a direct descendant of the Swiss mathematician and physicist Leonhard Euler; Hans’s science-centered family may not have been too happy when he focused on fine arts in college. What they couldn’t foresee was that his painting classes would introduce him to experiments in color theory carried out by physicists Ogden Rood and chemist Wilhelm Ostwald. Amateur painters themselves, both Rood and Ostwald had discovered through their artistic avocations that many phenomena concerning the optical and chemical properties of colored materials were complete mysteries. Fascinated by the scientific questions involved, von Euler-Chelpin began taking chemistry and physics classes. Twenty years later, in 1929, he won the Nobel Prize in chemistry.
The more arts and crafts that scientists, engineers, and entrepreneurs engage in across their lifetimes, the greater their likelihood of achieving important results in the workplace.

Albert Einstein

The simple procedures that introductory laboratory exercises demand, and the highly specialized and intricate experimentation that professional science requires is simply beyond their imaginations.

This sad state of affairs is the result of a lack of appreciation of these skills—not among scientists, but among education “experts” who have lost contact with actual scientific practice. Long before Alvarez did so, many other Nobel laureates, notably William and Lawrence Bragg (1928) and P. M. S. Blackett (1933), rued the loss of craftsmanship and with it, the ability to perform—and here the artistic and musical connotations of that term are all too appropriate—experiential procedures. We teachers need to remember that implementing knowledge, even in the information age, must still be accomplished through inventions first constructed by hand.

Backed by Research

There are real and measurable consequences to integrating arts and crafts education with science and mathematics education. Perhaps the most obvious and most startling has to do with the SATs. Our own informal analysis of the SAT results from 2006 reveals that four years of high school arts or music classes confer a 100-point advantage over the average SAT score, whereas four years of science confer only a 69-point advantage. James Catterall (2000) has demonstrated that this positive arts effect is not limited to schools in socioeconomically advantaged neighborhoods but is actually strengthened in the poorest neighborhoods. Arts, in short, have the greatest impact of any subject on standardized tests scores, even when those tests have nothing to do with arts-related material. These studies demonstrate loud and clear how important arts-related skills are for learning in general and mathematics in particular. Moreover, these arts benefits persist beyond high school. In Quantitative, as well as qualitative fashion, we have observed the effects of adult participation in arts and crafts, as well as continuous participation from childhood into adulthood, on various measures of success among individuals at work in the fields of science, technology, engineering, and mathematics (STEM). Our data show that the more arts and crafts sciences, engineers, and entrepreneurs engage in across their lifetimes, the greater their likelihood of achieving important results in the workplace. Not only do the most successful STEM professionals engage in arts and crafts at rates significantly higher than the general population, but those who perform, most successful members of these groups engage in arts hobbies at rates higher than their peers (Root-Bernstein, Allen, et al., 2008).

The idea that arts and crafts training enhances scientific ability, first advanced by J. H. van't Hoff (1867), the first Nobel laureate in chemistry, has been substantiated by numerous subsequent studies of eminent individuals in other fields (see Cox, 1926; Crandall, 1966; Goertz, Goertz, & Goertz, 1978; Milgram, Horg, Shavit, & Peled, 1997; White, 1931).

Our own study of Nobel Prize winners indicates that these eminent scientists are 15 to 25 times more likely than the average scientist to engage as an adult in fine arts, such as painting, sculpting, and print making; in crafts, such as wood and metalworking, in performance arts, such as acting and dancing; and in creative writing and poetry (Root-Bernstein, Allen, et al., 2008).

In concert with a team of researchers at Michigan State University (MSU), we have also recently studied several populations of engineers, STEM honors graduates, and STEM entrepreneurs and found that less than o.5% of those well-schooled in technical subjects have engaged in arts and crafts participation characterizes top performers (LaMore et al., 2011, Root-Bernstein et al., in press). For instance, MSU Honors College STEM graduates are 3 to 10 times more likely to be engaged in arts and crafts than the average American.

Engineers and inventors are also more likely to participate in various
capital to be involved in a sustained manner with one or more crafts or arts. This is especially true for vocations in photography, woodwork, mechanics, electronics, and dance. It appears that inventors in the STEM fields enjoy working with mind, body, and hands. We found that measures of family wealth did not correlate with either the presence of childhood arts and crafts hobbies or mature production of creative capital. Rather, arts and crafts participation started in childhood and sustained in maturity looks to be a leveler among individuals from diverse socioeconomic backgrounds. Childhood privilege in and of itself does not give a leg-up on entrepreneurship and intelle-
vation. Arts and crafts apparently do.

STEM professionals understand and value the connections between these vocations and their work. Many report that the beneficial exercise of observing, visualizing, manipulating, and dealing with material and aesthetic and craft hobbies builds creative capacity at work. Eighty-
two percent of surveyed scientists and

tagor should possess something of this happy combination of attributes: an artistic temperament which impedes him to search for, and have the patience, imagination, beauty and harmony of things" (1951, pp. 170–171).

It’s time we listened both to what our most creative scientists have to say and to what our most creative artists have to say. The arts add value to the pursuit of science.

Arts and crafts, in short, are not luxuries that we can dispense—or dispense with—as the mood strikes us.

References


neman) National Science Foundation. (2000). Foun-


Ramirez y Cajal, S. (1935). Precepts and counsels on scientific investigation: Stimu-


tive-thinking-music-and-the-serene-


Robert Root-Bernstein (rootbernstein@msu.edu) is an adjunct faculty professor in the Department of Physiology and Michele Root-Bernstein (root@msu.edu) is an adjunct faculty professor in the Department of Theater, both at Michigan State University, East Lansing, Michigan.