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CREATIVITY IN SCIENCE: HISTORICAL ILLUSTRATIONS AND THE ACADEMIC PARADIGM

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ABSTRACT

Koestler identifies creativity in terms of the ability of the individual to make analogies, the ability to recognize relationships between apparently unrelated events. Joseph Lister struggled with the unknown cause of sepsis, gangrene and suppuration in surgical wounds. Ignaz Philipp Semmelweis was immersed in his work to determine the cause of puerperal fever. Of many creative giants in the history of science, Walker places Pasteur among the best for his "astonishing ability for seeing the salient factors of a problem." Boyer relates scholarship and creativity to academics who carry on research, publish, and perhaps relay to their students what they have discovered. Creativity is not easily defined nor explained, but the history of scientific discovery has provided some clues as to the nature of the creative person.

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A practitioner in science must guard against engaging in scientific jargon in place of accepted scientific language because the uncritical may interpret the jargon as creative thinking (Middleton 1976). Koestler (1967) insists that creativity in science is dependent upon the ability of the person to make analogies, to recognize interrelationships between or among events where none apparently exist. Koestler states, "Thus the real achievement in discoveries ... is seeing an analogy where no one saw one before ... The essence of discovery is the unlikely marriage ... of previously unrelated forms of references or universes of discourse, whose union will solve the previously insoluble problem."

Graubard (1953) points out that it is unfair to assume that until the coming of modern science man did not know how to ask questions or observe and interpret natural events. Also, it is unfair to assume that man was loaded with superstition and did not know how to seek answers. The contributions of creative thinking to scientific knowledge have accumulated in a fashion since the period of Babylonia, 3500 BC. Just as rockets, computers, and vaccines are the technological products of science today, so too were pyramids, plumbing, and celestial mapping the results of early scientific insights.

The contributions of earlier scientists such as Galileo, Newton, Darwin, Harvey, Lord Kelvin, and Marie Curie are well known. The work of these noble persons may be described as investigations of phenomena in which the creative persons had a passion that was not snuffed by skepticism or exception, but rather burned all the brighter. The term "research" as we know it today was not part of the vernacular of early science. Boyer (1990) indicates that the term research was probably first used in the 1870s by reformers in Cambridge and Oxford who wished to make these institutions ... "not only a place of teaching, but a place of learning ... (and that) ... scholarship in earlier times referred to a variety of creative work carried on in a variety of places, and its integrity was measured by the ability to think, communicate, and learn."

Research and creativity have been and are expected commitments in scholarly endeavor. This expectation is reflected in the development of rank in the universities. In the twelfth century, teachers began to gather in the larger cities of Europe and banded together by common interests to form guilds which eventually led to the first universities.

In the universities, the Masters of Arts were the full members of the teaching guild who were admitted to the university by their superiors. Originally, the designation of bachelor referred to an assistant of a land-owner, an apprentice; but, in teaching the title referred to the person who was striving to reach the status of Master of Arts. It is not certain when the title of doctor originated as the degree above the masters degree, but its use in teaching can be traced to the universities in Bologna, Paris, and Oxford in the Twelfth Century (Hargreaves-Mawdsley 1963, Walters 1939). The term doctor is derived from the Latin *docere*, meaning to teach.

The first doctors were teachers. In the 1400s the term Doctor of Philosophy came to mean an academic degree in a field in which a person specialized and in which scholarship was expected of the doctor, the teacher. It is interesting to note that when the first medical schools opened in the mid-1700s in the United States, an attempt was made to distinguish between the doctor-teachers and the physicians by awarding the physician the Bachelor of Medicine degree. The assumption was that the M.B. person would practice medicine for a short time, probably with an established physician, and then return to the university to do graduate study and be granted the doctor's degree, the M.D. (Budd 1980). However, few physicians did this, and in the late 1700s most schools of medicine adjusted their curriculums and began awarding the M.D. degree.

It is conceivable that the adjustments made to curriculums in the 18th and 19th centuries may have contributed, in the 20th Century, to a splintering of the science disciplines, that is, the development of departments of zoology, botany, genetics, entomology, agronomy, etc. The emphasis on specialization on the Ph.D. level narrowed fields of learning and, coupled with the splintering effect, made it more difficult for the teacher to accomplish the vital process of establishing connections across disciplines.

Despite the breadth or narrowness of the formal preparation, when scientists throughout history have been confronted with difficult and seemingly insoluble problems, they have grasped for almost any explanation. The pronouncement on bubonic plague by the medical faculty of Paris, as Hecker (1844) states, is an example of searching for answers to problems hidden from the view of man. The medical faculty during the plague of 1348–1349 was asked to deliver a judgment on its cause and on ways to keep from contracting it. The cause of the plague, they said, was attributable to rays of the sun being combatted by constellations, by corrupted waters, and by stinking rain. Citizens were admonished not to sleep in the daytime, to drink little water at breakfast, and to refrain from going out at night because dew could be harmful. Perhaps today we too are grasping at scientific straws in areas of disease and other natural phenomena which perplex us and at the moment seem insoluble.

Joseph Lister (1827–1912) five hundred years after the pronouncement of the medical faculty of Paris, struggled with the unknown cause of sepsis, gangrene and suppuration in surgical wounds. Walker (1956) states that "Lister accepted the prevalent view that the contagion was spread by the foul atmosphere, laden as it was with the odour of decomposition." The overcrowding of surgical wards and poor circulation of air were identified as being responsible for disease.

At nearly the same time, Ignaz Philipp Semmelweis (1818–1865) in Vienna was immersed in his work to determine the cause of puerperal fever (childbed fever), which was taking a high toll of expectant mothers. Both Semmelweis and Lister tested assumptions which might lead to cause and effect relationships, Lister with carbolic acid spray to cleanse the operating room atmosphere, and Semmelweis with chlorinated water in which physicians were to wash their hands between the examinations of expectant mothers.

It is ironic that these two great men never met or did they exchange information on their research, which undoubtedly would have enhanced the work of each. The resolution of each of these seemingly insoluble problems was ultimately accomplished through the creative genius of Pasteur. Of Pasteur's work in bacteriology, Walker (1956) states "It is quite true that Pasteur was not a surgeon, nor even a medical man, but he had such an astonishing faculty for seeing the salient features of a problem that he would have been able to point out to Lister mistakes in the strategy of his surgical campaign against sepsis." So would Pasteur's work have helped Semmelweis. Lister knew of Pasteur's work, but he waited much too long before he began to correspond with him.

In a lecture to the Academy of Medicine in Paris Louis Pasteur (1822–1895) demonstrated his ability to analyze a surgical problem and at the same time set the stage for research which would lead not to the enhancement of the antiseptic surgery of Lister but to the aseptic surgery of today. Walker (1956) quotes Pasteur's speech thus:

> This water, this sponge, this lint with which you wash or cover a wound, deposit germs which would have the power of multiplying rapidly within the tissues and which would invariably cause the death of the patient in a very short time, if the vital processes of the body did not counteract them. But alas, the vital resistance is too often impotent; too often the constitution of the wounded, his weakness, his morale, and the inadequate dressing of the wound oppose an insufficient barrier to the invasion of these infinitely small organisms that, unwittingly, you have introduced into the injured part. If I had the honor of being a surgeon, impressed as I am with the dangers to which the patient is exposed by the

microbes present on the surface of all objects, particularly in hospitals, not only would I use none but perfectly clean instruments, but after having cleansed my hands with the greatest of care, and subjected them to a rapid flaming, which would expose them to no more inconvenience than that felt by a smoker who passes a glowing coal from one hand to another, I would use only lint bandages and sponges previously exposed to a temperature of 130° to 150° C.

Creativity and research in science have been and persist in being analogous to scholarship. Boyer (1990) expands the definition of scholarship to include four functions: the scholarship of discovery which contributes to new knowledge; the scholarship of integration which emphasizes connections across disciplines and the utilization of facts; the scholarship of application, an element of research in which research findings are parlayed into solutions for societal problems; and the scholarship of teaching in which Boyer contends the work of the scholar, the teacher, can be meaningful only if discoveries promote understanding of natural phenomena and encourages students to become scholars themselves. Hence, the good teacher is routinely the creative person. Good teaching and active scholarship are not mutually exclusive; they are in fact highly compatible.

A categorical definition of creativity is elusive. Perhaps, it is best explained by Leon Eisenburg of the Harvard Medical School. Eisenburg states of creativity that the principal problem:

> ... is that the scientist who attempts to explain in retrospect how he developed a creative idea is only rationalizing a series of events that he thinks might have happened. The events, in fact, probably did not happen in quite the way he recalls them. Innovation is, for a majority of people, essentially a preverbal process and the necessity of translating that thought process into words almost certainly alters the perception of the process. (Maugh 1974)

The scientist and the academic in science are educated in the products of scientific creativity—theories, the laws, and the practical applications of discoveries. In addition to product, the dimension of process in scientific endeavor must be emphasized. Studying how a discovery was achieved, for example—Paul Ehrlich's compound 606; Gregor Mendel's laws of heredity; Edward Jenner's work with smallpox; and Robert Hooke's theory of elasticity—will certainly enhance the education of the science-oriented person.

The academic especially, in contrast to the scientist whose thrust is basic research, has an obligation to be a practitioner and a student of the processes of scientific creativity. It is the responsibility of the teacher to develop the connectedness which is so essential to the learning of science.

LITERATURE CITED

Boyer, E. L. 1990. *Scholarship reconsidered: priorities of the professoriate*. (The Carnegie Foundation for the Advancement of Teaching). Princeton, New Jersey, The Princeton University Press: 147 pp.

Budd, W. C. 1980. Is there a doctor in the house? *Phi Delta Kappan* 61(8): 557.

Graubard, M. 1953. *Astrology and alchemy, two fossil sciences*. New York, Philosophical Library: 360 pp.

Hargreaves-Mawdsley, W. N. 1963. *A history of academical dress in Europe until the end of the Eighteenth Century*. Oxford, The Clarendon Press: 235 pp.

Hecker, J. F. C. 1844. *The epidemics of the Middle Ages*. (B. G. Babington, trans.). London, G. Woodfall and Son: 380 pp.

Koestler, A. 1967. *The act of creation*. New York, The Macmillan Co: 751 pp.

Maugh, T. H., II. 1974. Creativity: can it be dissected? can it be taught? *Science* 184(4143): 1273.

Middleton, T. H. 1976. Light refractions. *Scientific Research*. April 17. (McGraw-Hill's News Magazine of Science).

Walker, K. 1956. *Joseph Lister*. London, Hutchinson and Co. (Publishers), Ltd.: 195 pp.

Walters, H. 1939. *The story of caps and gowns*. Chicago, E. R. Moore Company: 14 pp.