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In his paper, Slock (1977) commented upon a different view of what science is and how it operates. It has been my experience that prospective secondary science teachers are extremely deficient in this area. Perhaps, it is not a different view that is needed as much as a definite viewpoint that is needed. For the past four years, I have taught a biology methods course for teacher education students. Invariably, at the beginning of the course the students have been asked to write a definition of science and to explain the operations of science. They are all able to reproduce an acceptable textbook definition of science. Their extrapolations from what science is to how it operates always left much to be desired. In a manner of speaking, they have memorized a standard definition and are able to regurgitate it on request but are simply unable to explain this in terms of operation. It would appear that we have done an adequate job of designing curricula which provide for the proper accumulation of subject matter for teacher education students in science. However, it is my contention that we have greatly neglected the philosophical aspects of science.

One might argue that as the subject matter of science is studied, one is also bound to learn how the field operates. How can one learn *what it is* and yet not know *how it operates?* It may be that we are able to prepare future teachers in terms of the vocabulary and other basics without actually cultivating an appreciation for the *how* of the field. I would strongly suggest that we don't really adequately prepare the future teacher in *what* science is or he/she would be able to explain how it operates, also. Please don't misunderstand; I am not calling for the "structuring" of another "module" in education to fill the need. Harry Fuller's paper (1956) as well as his ideas have never been far from my thoughts on this subject.

There are many definitions of science. It is not so important which one is used by a teacher so long as he/she is able to translate the definition into how science operates. Campbell's (1952) "Study of those judgments concerning which universal agreement can be obtained" is one that is quite usable for secondary students. To be able to present this definition to secondary students is not difficult and to have them memorize it is not difficult. The critical point is to translate this definition into the workings of the subject. It has been my experience that future science teachers have not been prepared for this.

Let us continue with the Campbellian approach to science. An important characteristic of science is that it is self-testing and self-correcting. The testing and correcting are done by means of observations that can be repeated with essentially the same results by normal persons operating by the same methods and with the same approach. That is the sense in which "universal agreement can be obtained."

One such judgment has been stated as "substances move from areas of great concentration to areas of less concentration." For this judgment we can obtain universal agreement. One can readily test this by opening a bottle of wintergreen oil. This "judgment" is quite evident when one detects the odor of wintergreen oil. This particular one has been termed the law of diffusion. The law of diffusion is used in making predictions. The very essence of a science is predictability. Laws and their explanations, the theories, are used in predicting the outcome of experiments. The explanation of the law of diffusion is the kinetic theory of matter. The theory states that all molecules, ions, and other sorts of particles, because of their heat energy, are in constant motion and may move with equal probability in any direction. Since more paths lead away from a previous location than back toward it, the sum of successive movements results in a particle moving farther and farther from its original position. The law tells us *what* will happen and the theory explains the *how* of it.

The law of diffusion and kinetic theory of matter is extremely important in making predictions in chemistry, physics and biology. The common basis existing in science may be illustrated by this law and theory.

Slock stated that, "With a better understanding of what laws and theories are, we can now find out more about science and how it operates." It has been my experience that future teachers and most now teaching in secondary schools have an understanding, although somewhat vague, of what laws and theories are, but would be up the proverbial creek if they were ever called upon to name three scientific laws, the theories which explain them and to demonstrate how they are operational in science.

This network of law-theory occurs throughout science. There are laws that are applicable to a great portion of science and there are those which apply to very specific sciences. For example, in biology and more specifically in botany, there is a law of plant ecological succession. This might be stated as "There are orderly processes of community change with a sequence of communities which replace one another in a given area." In situations where the process is well-known, the seral state or transitory community present at any given time can be recognized and future changes predicted. The explanation of this law, e.g., the theory of plant ecological succession might be stated thusly: "As the environment changes due to physical, climatic, and biotic factors, plants better adapted to these changes will move into an area or although it is generally true that habitat characteristics play the basic role in determining the kind of community, the latter certainly determines many of the characteristics of its habitat."

Again in biology, but specific to zoology, there is a law of blood coagulation which may be stated as "coagulation of normal blood takes place rapidly when blood escapes from a vessel." The law can be demonstrated easily and we can predict quite well with it. We can observe the phenomenon — we can predict *what* will happen when a blood vessel is cut and blood escapes. The *how* of the coagulation is another matter. Here again we rely on a theory. One such theory has been termed "Howell's theory of blood coagulation." This "explanation" relies upon seven different substances and is concerned with a chain of events. The triggering substance is thromboplastin which is found in blood platelets and some tissue cells. Thromboplastin reacts with anti-prothrombin leaving prothrombin free (normally prothrombin and antiprothrombin are neutralized by each other.) Prothrombin reacts with calcium salts (normally present in the bloodstream) to form thrombin. Thrombin reacts with fibrinogen (normally present in the blood produced by the liver) to form fibrin. Fibrin is the solid part of a clot and when seen in its pure state is a whitish-yellow, firm elastic network.

Here, we have presented three scientific laws and theories as they are used in the sense of Campbell. It is my contention that when science is made more meaningful from a definition standpoint with the definition translated into the operations of science as can be done through the Campbellian philosophy we will begin to impart the appreciation for science that is so often lacking. The future teachers are weak in this aspect of science. However, they do not make out the curricula for teacher education programs in science. It is high time that emphasis be placed on the understanding of science and on a meaningful science.

We should strive to give future teachers a thorough understanding of some philosophy of science. Campbell's concepts can be taught easily but should be taught with examples such as have been presented here. A philosophical approach in which an abstract definition is presented may be impressive for teachers to memorize and to pass on to students, but is of rather questionable value in providing meaning to science. Science has a beautiful pattern which, when students understand it, can be as rewarding as any "appreciation" of the arts.

Literature Cited

Campbell, N. 1952. *What is Science?* Dover Publications, Inc., 186 pp., New York (first publ. 1921).

Fuller, H.J. 1956. The Bureaucracy of Education. *The American Biology Teacher* 18(3):119-123.

Slock, J. 1977. A Philosophical Approach to the Meaning of Science. *Iowa Science Teachers Journal* 14(3):2-3.