

Department of Biochemistry, Microbiology and Immunology

BMI Teaching Trends Newsletter – August 2023

Teaching Matters By Dr. Matthew Jackson

This is the fourth installment of the *Teaching Trends* newsletter describing the new *Critical Thinking in Science Course* that Kevin Theis and I developed and delivered last fall. We will begin the second year of the course this month. The following paragraphs briefly describe the contributions of three philosophers of science, Aristotle, Karl Popper and Thomas Kuhn. Every graduate student beginning a career in a field of natural science should be introduced to the role that philosophy can have in their development. Our realization led Kevin and I to invite Dr. Susan Vineberg from the WSU Department of Philosophy to co-teach the *Critical Thinking in Science* course this year.

The works of several 20th century educators and philosophers provided a foundation for discussion in our course. In *How We Think* (1), John Dewey directed educators to focus on their students' aversion to doubt and to encourage empirical discovery as a pathway to learning. He used the term "reflective thinking" to describe "acquiring the attitude of suspended conclusion and nurturing a state of doubt that allows one to carry on systematic and protracted inquiry." Dewey emphasized several principles that are fundamental to science such as the relationship between induction and deduction, the value of comparison (which can be used to illustrate experimental controls), and the importance of paying attention to anomalies. This latter point can be emphasized using examples from microbiology: the fortuitous discovery of penicillin and the role of *Helicobacter pylori* in the etiology of peptic ulcers (2,3).

Development of the scientific method is attributed to Aristotle (384–322 BCE) who applied logic, both inductive reasoning as a process of inferring truth from empirical observations and deductive reasoning which takes the next step from general to specialized laws (4). A bit more recently, Karl Popper explored the philosophy of science in his 1935 publication *The Logic of Scientific Discovery* (5). Later, a comparison of Popper's principles of empirical falsifiability as a distinction for good science have been contrasted with Thomas Kuhn's somewhat more pragmatic approach that recognized the subjective influences that can affect scientific discoveries (6). Kuhn introduced the concepts of normal science, which is responsible for the majority of advances, and the paradigm shift, which characterizes those disruptive episodes when a foundational theory must be reconsidered (7,8). Understanding the nature of scientific thinking has been a central area of study for philosophyr and psychologists because it reveals an understating of what it is to be human (9). Philosophy lies at the root of scientific inquiry and at one point, philosophy and science

were the same disciplines (10). University students of the sciences are rarely introduced to the philosophical principles of the scientific discovery process and how they can apply broadly to life decisions because this type of learning yields its time in the curriculum to content mastery.

As they embark on a career that requires critical appraisal of the literature in their field, graduate students need to maintain a level of skepticism that is professed by Popper (6). His work provides a practical approach to the role of the inductive to deductive reasoning switch that occurs during the evolution of a hypothesis and following the switch, the value of modus tollens (denying the consequent) from classical deductive logic to science. Notable contributors to the physical sciences have made disparaging remarks about philosophy not necessarily as condemnation of philosophers but as an appeal for their return (7). These physicists' statements reflect Karl Popper's opinions that were stated in *Conjectures and Refutations: The Growth of Scientific Knowledge* (11): "The degeneration of philosophical schools in its turn is the consequence of the mistaken belief that one can philosophize without having been compelled to philosophize by problems outside philosophy. Genuine philosophical problems are always rooted outside philosophy and they die if these roots decay." Unfortunately, the involvement of philosophers in the education of scientists, as well as the converse, are limited despite the fact that they share a common purpose. In relatively uncommon instances scientists develop an interest and become the philosophers of their field (12,14).

References

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