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Editorial

Why Chemists Need Philosophy, History, and Ethics

Since many years national and international science organizations have recommended the inclusion of philosophy, history, and ethics courses in science curricula at universities. Chemists may rightly ask: What is that good for? Don't primary and secondary school provide enough general education such that universities can focus on chemistry alone? Is that only a conservative call back to an antiquated form of higher education? Or do they want us to learn some "soft skills" that can at best improve our eloquence at the dinner table but is entirely useless in our chemical work?

The answers depend on what you understand by chemistry, philosophy, history, and ethics. Let's begin with chemistry.

If the prototypical chemist were somebody who secludes himself in his laboratory, ponders on some self-imposed questions, and once in a while comes up with an idea to impress his colleagues, there would perhaps be little need. However, modern chemical research is a highly connected activity, conducted in teamwork that is typically interdisciplinary. It is project-based, that is, it seeks a solution to a problem that the scientific community or society at large, or both, consider important, and which mostly aims at the improvement of material conditions of life. The results are likely to have an impact on future research and the technological world we live in.

Similarly, if chemical research consisted in following simple routines, in doing some minor modification here and there to produce easily predictable results, there would be little need either. However, scientific research results are expected to be novel in the proper sense, i.e. they cannot be predicted, derived, automatically produced, or bought with grant money, contrary to the expectations of many science policy makers and managers, and unlike the usual rhetoric of grant proposals. Such creative, and even more so groundbreaking, work requires questioning the received wisdom, what is taken for granted in science at the moment. Thus, if you want to be a successful chemist, you cannot just apply what you have learned in your chemistry class. On the contrary, you must be able to challenge exactly what has been taught to you to be the edifice of science, and take it only as a provisional state in the course of the ongoing research process of which your work is meant to become a part.

Next let's see what kind of philosophy, history, and ethics is needed for chemical research, and what not.

If philosophy of science were the marveling at theories from physics, as the popularization of physics has long articulated it, it would be of little use for chemistry. Indeed, most chemists have a much better understanding of the benefits and limits of quantum mechanics in their own field. However, philosophy is a way of asking questions about what is taken for granted but badly understood, and it usually aims at a better understanding. Such as science (which historically emerged out of philosophy) asks question about nature that don't bother ordinary people, so does philosophy of science asks question about science that scientists once stopped asking. What are the goals of science? How do scientists develop and establish knowledge? How is their knowledge organized, on which presuppositions does it depend? Which fundamental concepts do they use and how can those be defined? And so on. While the professional philosopher has learned to take any intellectual edifice apart within minutes, a little training in philosophy helps scientists to raise the right questions at their research frontiers where the received taking-for-granted view is just deadlocked.

Moreover, many chemists are inclined to say that everything is chemistry, as do many physicists, biologist, engineers, mathematicians, etc., each for their own discipline, claiming a privileged access to the world. However all such disciplinary chauvinism is not only built on ignorance of the diversity of modern science, it is also poisonous to any interdisciplinary teamwork. Only if you take your own chemical (or physical, biological, engineering, etc.) way of asking questions and solving problems no longer for granted but understand its disciplinary peculiarities that might essentially differ from that of other, equally acceptable, disciplines, you will be prepared for interdisciplinary teamwork. Abstract as it

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is, the philosophical understanding of different disciplinary approaches helps break the interdisciplinary barriers of conceptual misunderstandings and lack of mutual appreciation, which is more needed than ever. As a side-effect, you will understand your own field, chemistry, much better if you are able to look upon it from the outside, such as you understand your own culture much better once you have spent some time abroad.

If history consisted in setting up a fact sheet of who-did-first-what-and-when, that would not help either, other than to commemorate the ancestors and give them due credit. However, professional historians of science try to understand the scientists of the past from their own perspective, how they saw the world, what goals, beliefs, and methods they had, and in which social and cultural context they worked. Because all that frequently differs considerably from our present perspective, history trains our capacities of thinking science differently, exactly what the creative mind needs as a starter. Furthermore, history turns the static textbook view of the scientific edifice into a processual view of scientific evolvement, with all its entwined paths, dead ends, and prematurely given-up alternatives. History thus teaches you to understand science as a complex process, which you need in order to make creative and convincing contributions to it in the presence. Moreover, only by looking at chemistry in its social and cultural context and their interactions over time, you understand what chemistry means in a broader sense, what role it plays in society, what societal expectations, hopes, and fears it raises.

If ethics were a form of moral indoctrination, of making people comply with fixed rules, we would better do without. However, ethics, one of the oldest philosophical disciplines, is a technique of abstract reasoning about norms and values, of balancing different values, and of building moral arguments that try to justify why this is better than that. Chemists who are engaged in research projects that aim to improve the material conditions of life, must be able to understand all ethically relevant aspects of their work and to develop moral justifications for what they do – if they really aim at improvement in the full sense. They must so in three different senses. First, they are morally obliged to do so because they will be held accountable for all possible adverse effects of their research work. Second, because all technological innovations transcend traditional life forms, their moral assessment cannot simply follow traditional norms tailored to ordinary life contexts. Instead for each possible innovation we have to develop moral deliberations anew, which of course requires being acquainted with the tools of moral reasoning. Finally, if the goal of chemical research is material improvement according to general values, chemists can only be successful if they know all these values and are able to connect them in a balanced way to their research projects. Chemical success thus depends as much on ethical competence as on chemical knowledge.

In sum, education in philosophy, history, and ethics, each rightly understood, helps improve chemistry by making it more creative, more open to teamwork, and more aware of the social and ethical contexts that partly define it. It is therefore no additional luxury but in the self-interest of chemistry as a science to open itself to these fields. That has already been done in many countries, albeit mostly upon the request of accreditation agencies or governments, because society needs a stronger chemistry for the solution of many of its current problems. For the same reason, a journal like *Substantia* that aims to broaden the chemical horizon is particularly important and welcome.

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