

Lessons learned? – Learning lessons!

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Questioned how the Covid-19 pandemic will impact the future, especially regarding science and academic culture, I find myself constantly re-aligning my thoughts along with progressing developments. The question itself appears somewhat premature, since the nature of a new equilibrium – should there be such a state at all – and pathways towards it remain quite unpredictable. To watch conditions change, globally, in just a few weeks has been interesting and worrisome. Correspondingly, I assume for the state transition from before to after Covid-19 that surprises might be encountered along the way.

The crisis has been described widely as the most disruptive global experience since decades, with severe medical, ethical, economic, political, juridical, psychological, further social and other consequences. The situation also depends sensitively on the local circumstances. A rather personal view may thus be the only valid perspective. You may have guessed from the above terminology that I am a natural scientist (indeed, a senior professor of physical chemistry); this certainly influences my view. I will present my current thoughts in five brief paragraphs.

• Scientific contributions

In the past weeks, it appeared that science, all of a sudden, was publicly recognized – not as nice-to-have cultural accessory, but as systemically relevant. Science was and remains omnipresent in reports about infections and their spread, scenarios and probabilities, health conditions, test functionalities, potential medication, and vaccine developments. With unusual depth, politics and media request scientific reports and updates, and facts and figures as well as background explanations are sometimes reported by the hour. Equally impressive is the international level of activity and collaboration regarding the disease and measures against it. I cannot remember a period in which scientific activity seemed so important. Science is needed to fight the pandemic, obviously, and to explain processes and precautions. Biomedical contributions have been more prominently in the spotlight, but other disciplines are also concerned with various aspects of the massive impact of the pandemic.

It is a situation for multidisciplinary, creative thinking, not only for inspecting immediate problems and possible reactions. How do we wish to live in the future? How to establish precautions that the present situation might not become repetitive? The crisis has illustrated many influences that might not have been regarded in context. Now accepted views and business-as-usual routines could be reflected. New concepts and bold ideas could constructively challenge established thoughts about global interactions, production and logistics, work, healthcare, social systems, mobility and other factors. Scientists could be the group that might develop perspectives and become a driving force.

• Sustainable transport and production

Transportation and production have been challenged with disruptive changes. With traffic between countries stopped, airplanes on the ground, and people working from home, air quality has improved and energy use decreased. Economy, prosperity, timely production, and delivery of goods have dominated public debates, rather than measures to plan more sustainable action for the future. A

consequence of the current crisis regarding transport specifically might be a different split between air, land, and sea transportation, a different mix between transport of passengers and goods. Foremost, however, a different balance of economic versus ecologic aspects would be desirable.

Climate and pollution crises have not gone away. Health concerns and shutdown of regular operations in many countries are causing gigantic economic burdens. Warning signs regarding climate change and environmental threats have currently sunken in priority, with media attending mainly to the Covid-19 crisis topic. Gigantic support plans for the economy could present welcome chances for innovative pathways towards more sustainable industries and transport options. Natural sciences and technical disciplines are well positioned to address such pathways, together with their colleagues in other fields.

• **Digital and material world**

Digital tools and infrastructure are keeping academia afloat in the pandemic. They might also prepare societies for a more productive and resilient handling of the crisis. While we commonly accept the importance of the "real world" for arts, crafts and trade, or for medical and consumer services, it seems that the so-called exact sciences could resort more easily to digital means. However, natural sciences and engineering explore and interact with the "real world" in terms of experiment, analysis, synthesis, production processes, or construction. It is important to establish a good balance between experiment and simulation, especially with restricted access to equipment.

Chemistry is a subject that concerns transformation of matter. Initiating, controlling and using such transformations provides numerous products. Chemical processes that happen in nature and environment must be equally well understood, regarding air quality, for example. Chemistry thus combines creative processes to provide new compounds and materials, with synthesis not unlike an art form, and characterization techniques to study the material world, with quantitative information, for example, on the potential for renewable energy storage and conversion. While digital tools help, interrogation of the material world and creative, haptic aspects should not become less important.

• **Academic teaching and learning**

Digital platforms for teaching and learning have existed before the crisis. However, there has not been such a concerted push to use them. Multiple grass-roots practices evolve to support academic teaching, foster interaction and feedback between students and teaching staff, to enable digitally conducted exams, and to provide virtual meeting rooms, to only name a few aspects. Nevertheless, it should not be forgotten that teaching and learning also profit highly from personal interaction.

Academic teaching concepts will probably not roll back to the initial state before the crisis, but online teaching-only is not the ultimate solution. Obviously, positive achievements should be built upon in future, and negative examples analyzed why they failed. Digital teaching could lead to more international activity in the classroom and could reach out to distant or less privileged learners. Digital courses could be shared between institutions. They could favorably complement hands-on lab courses and research training, leading to innovative curricula. Such experiences should be evaluated individually and jointly, regarding new formats, new curricula, and new responsibilities for teaching and learning. However, by whom and when, since there is never time for teaching? Teaching must be credited more highly for academic careers and for institutions, in its role to form the next generation and thus also shape the future of disciplines and science.

- **Trust and collaboration**

The crisis seems to re-introduce borders, both geographical and mental ones. Such borders can be detrimental for science and academic development in general. Science needs transparent exchange of data, critical debate, common agreement on suitable methods and their capabilities, exchange of researchers, and standing together of the scientific community in mutual respect and trust. This may be obvious to scientists, but is it to all?

Trust builds on personal relationships though. These components of seeing each other live and discussing together as real persons has many communicative channels and facets that cannot be digitally represented. It is an easy response to praise purely digital communication in science as the future best practice for scientific exchange, avoiding conferences and project meetings, lab visits, and scientific talks elsewhere. However, emergency solutions are temporary and can provide creative formats and bridges, but they have their shortcomings regarding a continuing forum for scientific discourse, and they will rarely offer the serendipity that sparks off new ideas.