

Book Review

Review of Rudolph, J.L. (2023) *Why we Teach Science (and Why we Should)*.

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Why do we teach science in schools? There are many usual responses to this question. Because scientific knowledge is useful for everyday life; because the developed reasoning skills are also useful in everyday life; because future citizens will need to be able to make decisions about important socio-scientific issues, and thus require both knowledge and reasoning skills from science, and so on. However, as John Rudolph brilliantly shows in his book *Why we Teach Science (and Why we Should)*, the science education typically taught in US schools (and I would add almost everywhere else in the Western world) falls short from achieving these goals. Despite the declarations of policy makers on the importance of science for society and of curriculum developers on scientific literacy playing a major role in school education, public polls more often than not show that people lack both a solid understanding of science, and the trust in scientists, as became apparent during the COVID-19 pandemic. Why is this the case?

There are many reasons for this. Populism and disinformation are main reasons for science distrust. But Rudolph points to a more perennial problem: the kind of science we teach in schools. Despite arguments about science education being useful for developing various kinds of skills, Rudolph shows that at least in the USA, science education has always been content-focused. Regardless of the desired learning goals, the teaching in classrooms has focused on the transmission of content knowledge. The reason for this has been the – untested and wrong – assumption that if students learn and do science in school, they will come to understand and be able to use it. However, research in science education has long shown that this is far from true. Retention of science knowledge after school is low, as students soon end up forgetting the details of whatever they were taught. Furthermore, they often do not exhibit the rationality and the reasoning skills that they were expected to exhibit. Rudolph thus argues that we have reached a dead-end in school science education and that something has to change. I wholeheartedly agree.

But isn't science content knowledge at least useful for those students who will become scientists? And don't we need more of them? Rudolph provides evidence that not only are more scientists not needed, but also that those students who will become scientists (meaning both study science and work in science-related jobs) correspond to a very small portion of each cohort of school students (roughly 7% in the USA). He therefore suggests that we had better leave specialized training in science for tertiary education, and reconsider how we teach science in schools in order to benefit the vast majority of students (93%). But what do these students need, if not exclusively science content knowledge?

Rudolph suggests that we must reconsider why we teach science in schools, and abandon the practice we have followed so far, which as every teacher and parent knows, often makes students wonder “why do we have to learn this stuff?”. The assumption that a solid understanding of science depends on a solid knowledge base is a long-standing belief, Rudolph argues, which as we now know is wishful thinking. Instead, we must entirely switch the focus of school science teaching, focusing on two learning goals: The first is help students understand the way scientists arrive at knowledge about the world. We can simply describe this as a shift from “what we know” to “how we came to know what we know”. Rudolph argues, and I completely agree, that by presenting the reasoning and practices of scientists that have led them to the invention of concepts and theories, students will not only learn those concepts and theories, but will also better understand them. Furthermore, this will help rebuild trust in science, as students will come to understand the real potential of science, as well as its limitations. The second goal is learning about the role of science in society. Instead of the lonely (white, male) genius stories often found in textbooks, we must help students understand science as a social process that is in constant and mutual interaction with society. Students will thus be guided to understand that science is not something alien or external to society, but rather something co-constructed within it. Science and society influence each other in a variety of ways, and understanding why and how this happens is essential for people whom we wish to develop scientific literacy.

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The book concludes with the most important question: how can we reach these goals? Rudolph admits that this is far from simple and easy, and states clearly that his book aims to start a discussion rather than provide all answers. However, he proposes what he describes as (and again I could not agree more) three essential changes in our thinking. The first is to revitalize the civic mission of school science education for rebuilding public trust in science for all students. The second, and most crucial in my view, is to change the way science teachers are prepared so that they are able to teach with regards to the two goals mentioned above. Science content is relatively easy to teach and assess, whereas teaching about how we know what we know in science, as well its place in society, requires an understanding beyond a science degree. This will be a difficult task, but it is worth trying. The third change is to build a science education based on evidence: look at the available research about what works and does not work, and act accordingly.

Whereas I agree with Rudolph, I am pessimistic that we will see these changes any time soon. The reason is that mentalities and habits do not change easily. Most importantly, if the teaching in the science departments from which science teachers get their degrees do not change, there is little hope that teachers will ever learn to teach in a way that is radically different from the way they themselves were taught. Having said this, something must be done and a modest first step is to make science educators and science teachers aware of the dead-end which we now face. This is why *Why we Teach Science (and Why we Should)* should be read by every science educator and teacher. The more we come to realize that change is needed, the more likely it is for this change to happen. John Rudolph is to be commended for writing a book that is a call for change, which also points to how this change might be brought about.