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EDITORIAL

Learn the Map, or How to Use It?

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Science education research is advancing by combining insights from research and scholarship in developmental psychology, social sciences, history and philosophy of science and perhaps other fields. However, it seems that some fundamental problems remain unresolved in classrooms. Science educators around the world—appropriately and timely—argue that attention should be paid and time should be devoted to developing efficient teacher preparation programs and useful curriculum materials (textbooks, hands-on activities, etc.). I assume that most people would agree that a well-trained teacher who has the necessary teaching materials would most likely be quite successful in teaching effectively compared to one who does not have the required training and materials.

Nevertheless, even in those cases that teachers have all the prerequisites, teaching may still be ineffective and students may not learn what is intended. One reason for this is that practical issues, such as summative assessments and grading, tend to attract most of the attention and quite often force teachers to "teach towards the test". This imposes on them certain priorities as covering a certain amount of content knowledge in a certain amount of time and find ways to assess whether students have managed to learn this content knowledge. This leaves less time for topics that are often overlooked but that may be essential for science education. One of these is the use of models in science.

Many of the topics taught in contemporary science education are about, or are related to, models. In biology, for instance, we teach about the double helix structure of the DNA molecule. However, rarely do we explain to students the properties of this model. We often implicitly convey the message that such models are true, whereas we should explain that they are not true, that they only exhibit similarities with the actual molecule of DNA and that they do not portray how the molecule of DNA actually is. In short, although we teach about several scientific models, we do not clearly explain to students that these are a means of representation with particular strengths and limitations.

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A nice example that can be used in order to clearly show to students the properties of a scientific model is a map, as suggested by philosopher Ronald Giere in his book *Scientific Perspectivism*. Maps, like models, are representational tools with specific features: they exhibit similarities with aspects of real systems; they do not represent whole systems, neither are they true of them; they are neither entirely precise, nor entirely accurate; and they are used by scientists for a particular purpose in a specific context. In my view, every science course at every grade of secondary school should start with a discussion of the nature of scientific theories and models, and I think that maps would be an excellent example to use for this purpose, even if they are not a good example for all kinds of scientific models. The goal would be to explicitly and clearly teach students what models are and why and how they are used in science.

Students will probably forget the details of the models of the atom, of the solar system or of the DNA molecule after finishing school. However, if they could end up understanding the general features of a scientific model, this would enable them to become scientifically literate citizens who would understand later in life why, e.g., weather forecasts are not always confirmed. Understanding what to expect and what not to expect from a scientific model, details notwithstanding, would be an important aspect of science literacy. It would be even better if students could understand the use of these models in science for predictions or explanations, and therefore why models have a central place in scientific theories.

So, let us consider this important question: do we want our students to learn the contents of a map, or learn how to use it? If you agree with me that the latter is more useful than the former, what can we do to bring about this change in schools?

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