TEACHING THE NATURE OF SCIENCE THROUGH PHILOSOPHICAL DIALOGUE

Jelle De Schrijver[1], Lynda Dunlop[2]
[1]Odisee University College, Brussels, Belgium
[2]University of York, York, United Kingdom

Addressing the philosophical questions characteristic of the nature of science can be a challenge for science teachers less used to dealing with uncertainties and multiple perspectives. We argue that science teachers can be strengthened to teach the nature of science by incorporating an approach consistent with teaching and learning in philosophy. Philosophical dialogue can enhance reflection about and understanding of the nature of science as it stimulates reflection and allows dealing with non-consensus situations. We explore the potential of philosophical dialogue for teaching the nature of science by drawing on research literature relating to dialogic teaching in philosophy and the use of philosophical dialogue in science.

Keywords: nature of science, philosophical dialogue

THE CHALLENGES OF TEACHING ABOUT THE NATURE OF SCIENCE

Teaching about the Nature of Science (NoS) involves addressing the epistemological and ontological underpinnings of science such as its levels of uncertainty, its realm and limits, its biases and the reasons for its reliability (Lederman, 2006). NoS forms a key component of the science curriculum as it is necessary to contribute to the scientific literacy of students and positively impacts naïve conceptions about science (Miller, 1998). Yet, there lingers a conflict in the science curriculum between the aim to teach about 'objective' scientific knowledge and the aim to teach about NoS by contextualizing and questioning the objectivity of scientific knowledge. It is therefore not surprising that tackling the philosophical underpinnings of NoS and its underlying multiperspectivity can be challenging for science teachers.

Observations of classroom practice in relation to teaching about uncertainty reveal that this is a particular challenge for science teachers, and that there may be useful lessons to be learnt from humanities teaching. Levinson (2001) observes that compared to science teachers, humanities teachers have greater confidence and skill in teaching controversial issues in science with multiple possible answers. Ratcliffe (2007) found that even experienced teachers feel the need to provide students with neatly tied up answers at the end of the lesson. Donnelly (1999) found that science teachers placed stronger emphasis on content knowledge, with uncertainty perceived as threatening, in contrast to history teachers who placed children's interpretations and judgements at the centre of teaching. Accordingly, addressing NoS, calls for an approach more consistent with humanities teaching, and the teaching of philosophy in particular shows promise in this regard.

To overcome this challenge, we will address why it is relevant that philosophical multiperspectivity should be addressed while teaching NoS in high school. Then, we will explore how philosophical dialogue can help students reflect about NoS and can help teachers to deal with uncertainties. We will do so by drawing on the literature relating to philosophy for children more broadly, and specifically in a scientific context.

THE MULTIPERSPECTIVE NATURE OF THE NATURE OF SCIENCE

While some of the characteristics of NoS are uncontroversial, most aspects of the NoS are contextual and have complex exceptions (Clough, 2006). For instance, although scientific knowledge is always tentative, some scientific findings or theories are more probable and more reliable than others, implying that the tentativeness of science differs according to the domain that is under scrutiny. Furthermore, as philosophers of science often fundamentally disagree about science, it would be unwelcome to reduce this complexity to simplified tenets. Therefore, teaching the NoS implies conveying a plurality of views – multiperspectivity - so that science teachers and students come to understand the importance of the issues and complexities regarding NoS (Clough, 2006). Accordingly, explicit and reflexive teaching of NoS is considered central to enable understandings of the NoS (Lederman, 2006). It follows that teaching NoS does not entail only lecturing, or imposing particular perspectives, but rather implies designing lessons to address NoS issues

where students construct their own perspectives and make connections between what they experience and the issues at hand (Khishfe & Abd-El-Khalick 2002). Philosophical questions about science can be starting points to sparkle discussion and active involvement of the students and uncover the multiple perspectives about science harbouring in the students' minds.

THE MERITS OF PHILOSOPHICAL DIALOGUE FOR NATURE OF SCIENCE EDUCATION

According to the philosopher Matthew Lipman (2003), one of the key distinctions between science and humanities education is the way in which knowledge is presented, with science textbooks presenting scientific knowledge as though settled in contrast to the more intrinsically problematic way in which it is treated in the humanities. In the humanities, students are encouraged to look for new problems of interpretation or conceptualisation rather than apply standard methods of problem solving in new contexts (Donnelly, 2004). The humanities, including philosophy, offer approaches for teaching NoS, which has different characteristics to curriculum content focused on scientific ideas. One such approach is the philosophical dialogue.

In a philosophical dialogue participants search for answers to challenging questions under the supervision of a teacher (facilitator) structuring the dialogue and stimulating logical investigation. There has been growing interest in the practice of philosophical inquiry in a scientific context (see Sprod, 2011; Dunlop, 2012) and in the production of materials to support such practice. This approach not only positively impacts cognitive ability, attainment at the end of primary school or self-esteem (Gorard et al., 2016), it can further help students create meaning by encouraging them to clarify concepts and to link scientific ideas with other ideas (Sprod, 2011). In doing so, students engage in argumentation and search for a balance between multiple possible answers. Thus, philosophical dialogue may exactly allow science teachers to embrace uncertainty, put children's ideas at the centre, and to problematize (scientific) knowledge and methods. After all, while facilitating a philosophical inquiry, it is important for the teacher to encourage students to identify, develop and critique arguments rather than providing answers for them. A philosophical dialogue entails three main relevant strategies: creating philosophical questions, facilitating philosophical dialogue and sustaining philosophical dialogue.

Creating philosophical questions

Philosophical dialogue begins with a question. Philosophical questions can be described as those that are "open to informed, rational and honest disagreement…possibly constrained by empirical and logico-mathematical resources, but requiring noetic resources to be answered" (Floridi, 2013), i.e. to be open and to lend themselves to authentic exploration through reasoning. These can be questions such as: 'What is the difference between a scientist and a magician?' or 'Can one perceive reality as it is?'. Using philosophical questions as the focus for inquiry allows students to explore, discuss and develop their own ideas about NoS. The questions can originate from the children or from the teacher, and may occur in response to reflections on different stimuli and in distinct contexts. For example, in historical, contemporary, personal and non-school settings, scientific stories and experiences can act as prompts for students or teachers to create philosophical questions ensuring the link between the individual, science, and the philosophical dimensions.

Facilitating philosophical dialogue

In philosophical dialogue, the teacher takes on a different role to that more common in science classrooms: as a facilitator of the dialogue. The facilitator's role is to create the environment for the inquiry (Palsson et al, 1999), to model skilful thinking (Sprod, 2001), to focus discussion, and to encourage deep consideration of the topic through the use of procedural questions (Gardner, 1996). Typically, the teacher asks questions that seek meaning and reasons and which require students to find ways to explain and justify their views.

This Socratic approach demands that the teacher does not contribute substantially to the dialogue but rather enables the children to do so by asking procedural questions that encourage children to evaluate claims. Worley (2016) argues that an important dimension to philosophical dialogue is the dialectic: the systematic investigation, examination and evaluation of claims and options using questioning. Questions that encourage this include: 'do you agree?', (encourages engagement and evaluation of another's argument), 'Why do you

think this? (seeking evidence and argument), 'What might people who disagreed with you say?' (identifying counterarguments), or 'What alternatives are there?' (suggesting possibilities). These questions make students' thinking explicit, and encourage them to think deeper about the special nature of scientific knowledge, the tools and products of science and the human elements of science.

Sustaining philosophical dialogue

Both participating in and facilitating a philosophical dialogue requires sustained practice, over an extended period (Lipman, 2003). There is often an initial discomfort as students become familiar with identifying and experiencing uncertainty, developing an argument, and thinking about the reasons and evidence that they believe as they do. It can take students time to adapt to thinking philosophically about science, and the teacher needs to create the space for open, philosophical dialogue that is challenging yet supportive.

DISCUSSION AND CONCLUSION

Though philosophical dialogue can be of help to induce reflection about NoS, teaching NoS cannot be reduced to only facilitating dialogues as students by themselves are not able to build a complex understanding of science by mere dialogue. Students cannot discover in hours what scientists and philosophers have been working on for generations. The dialogue acts like a reflection instrument, allowing students to reflect and ponder upon the issues arising in the classroom. Therefore, the use of good stimuli, contexts or examples necessary to start the discussion remains a crucial aspect of NoS education. This makes philosophical dialogue a complementary approach to existing approaches to teaching NoS.

Thus far, there are few quantitative studies focusing on the impact of using philosophical dialogue to address NoS. An important next step is to map existing approaches to philosophical dialogue in science and to identify common grounds upon which they might be evaluated. This may help science teachers to deal more effectively with uncertainty in science classes, and contribute to students' understandings of NoS.

REFERENCES

Clough M.P. (2006). Learners' responses to the demands of conceptual change: considerations for effective nature of science instruction. *Science & Education,* 15,463–494.

Donnelly, J. (2004). Humanizing science education. *Science Education*, 88, 762-784.

Dunlop, L., Humes, G., Clarke, L., & Martin, V. M. (2011). Developing communities of inquiry: dealing with social and ethical issues in science at key stage 3.(Report). *School Science Review*, 93, 113-120.

Gardner, S. (1996). Inquiry is no mere conversation Critical & Creative Thinking 16(2), 41-49….

Gorard, S., Siddiqui, N., & Huat See, B. (2015). Philosophy for Children: Evaluation report and executive summary. London: Education Endowment Foundation.

Khishfe, R., & Abd- El- Khalick, F. (2002). Influence of explicit and reflective versus implicit inquiry-oriented instruction on sixth graders' views of nature of science. *Journal of Research in Science Teaching*, 39 551-578.

Lederman, N.. (2006). Research on Nature of Science: Reflections on the Past, Anticipations of the Future. *Asia-Pacific Forum on Science Learning and Teaching*. 7(1): 1–11.

Levinson, R. (2001). *Valuable lessons: engaging with the social context of science in schools: recommendations and summary of research findings*. London: The Wellcome Trust.

Lipman, M. (2003). Thinking in education [electronic resource] (2nd ed. ed.). New York: Cambridge University Press.

Miller, Jon. 1998. The Measurement of Civic Scientific Literacy. *Public Understanding of Science* 7: 203–23.

Palsson, H., Sigurdardottir, B., & Nelson, Y. (1999). Participation in a "Community of Inquiry" nourishes Participants Perspective – *Talking Capacity: A Report of a Two Year Empirical Study*. Akureyri: University of Akureyri.

Ratcliffe, M. (2007). *Values in the science classroom*. In: Corrigan, D. Dillon, J. (eds.). *The Re-Emergence of Values in Science Education*. Rotterdam: Sense Publishers.

Sprod, T. (2011). *Discussions in science*. Victoria: Acer.

Worley, P. (2016). Ariadne's Clew Absence and presence in the facilitation of philosophical conversations. *Journal of Philosophy in Schools 3*, 51-70.