Knowledge-Building as a future focus pedagogy in science classrooms

Abstract

Simon Taylor

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This paper will discuss how Knowledge-Building is an effective pedagogy for framing future-oriented science education in schools. It will examine how Knowledge-Building can be used to support the Nature of Science. It will conclude by discussing how particular learning capacities are needed for future-oriented programmes and how Knowledge-Building principles are closely associated with them.

Contexts, Challenges and Issues

The intention of a Knowledge-Building Community (KBC) is to produce new ideas and knowledge, which is useful to, and useable by the community (Scardamalia, 2002). There is an emerging opportunity for science teachers to develop learning programmes for students to improve knowledge, even to create knowledge, not just reproduce it. Knowledge-Building has been described as a community process where all students are empowered in knowledge creation as legitimate contributors (Lai, 2013). It is a pedagogical model described by 12 principles developed by Scardamalia and Bereiter (2010).

Occasionally there is misunderstanding about the overarching Nature of Science (NoS) strand defined in the New Zealand Curriculum (Ministry of Education, 2007), as it is sometimes confused with *inquiry*. When studying science, students are hopefully aware of the differences between observation (using the senses) and inference (why it happens), this cognitive process, specific to NoS, involves constructing understanding by making inferences from the observed data (Lederman & Lederman, 2004). How these ideas are interpreted depends much on students' beliefs and individual backgrounds, and that this knowledge is tentative as new evidence is found or reinterpreted. The 12 Knowledge-Building principles developed by Scardamalia (2002) align well with the Nature of Science, where ideas are improvable (able to be improved) and there is purpose to create knowledge useful to the community. However, there is one principle that stands out and associates closely with the process of observation and inference, that is the encouragement of students to generate explanation-driven questions (the “how” and “why” questions). *Real ideas and authentic problems* are specific to the Knowledge-Building principle concerned with learner understanding based on problems and/or observations in the real world. This also establishes the need for students to work on developing the questions, rather than just sharing information. As well as asking “what” questions, some subtle, careful remodelling can be prompted: “What makes you think so?” “How do you know that?” What science ideas does your explanation link to?” The justification of ideas using explanations to these questions gives rise to opportunities where new understandings could be espoused; hence the role of the teacher plays a vital part in supporting the students to facilitate the nature of these specific questions pertinent to NoS. To sum up the links between NoS and Knowledge-Building, Barker (2011) invites a thought-provoking question “What do students actually have to know about the NoS?” (p.34). The response lies in that they begin to perceive that the world is understandable, through the interchange of observation and inference their own understanding evolves, explanations require specialist language, and that scientific inquiry is a human and collaborative endeavour.

Future-oriented capacities

An intention of future-oriented science education is developing knowledge with learners which consider implications for a human and potentially non-human society (Kurzweil, 2005). Scientific and future technologies come packaged with a variety of moral, ethical and indeed practical decisions. Future oriented examples include: artificial intelligence, natural disaster relief, space travel, human genetic modification, synthetic life, nuclear fusion and renewable energies. Hodson (2010) urges the value of explicitly featuring socio-political contexts in science teaching programmes. If current social and environmental problems are to be solved, we need future generations of scientifically and ethically literate citizens. As science teachers we can place prominence using contexts of personal and societal issues. This takes a much more future-oriented direction to help foster both learner capacities of personal knowledge and disciplinary knowledge. Curiosity also plays an important role to fuel learner engagement in the activity, without curiosity there is little momentum to carry through with the exploration. My viewpoint, is that personal knowledge is an *active*, participatory practice, where learners construct ideas together, where they can make sense of different viewpoints, grapple with conflicting arguments and justify them. It is a learner capacity closely associated to epistemic agency, where students are active in their learning journey, where they take control of the learning, and they defend the claims. This provides an essential foundation for future-focussed education, to be able to *improve* ideas, applying evaluative processes. Improvement of ideas is at the heart of Knowledge-Building. In contrast, disciplinary scientific knowledge, which results from experts, refining and creating new ideas in a specialised research field. Gilbert (2018) highlights that knowledge, not learning, could be a possible future-oriented focus for schools. She argues Knowledge-Building is unlike that of constructivism, and there can be confusion around the meanings of constructivism. A way forward could be to ensure that there is clarity around the representations of both learning and Knowledge-Building.

If Knowledge-Building is to be established as a future focus pedagogy in science classrooms, it highlights the need for teachers to understand both the Nature of Science and the Knowledge-Building principles. It also signals that future-focussed learner capacities are interconnected with two forms of knowledge. Finally, if there is one critical role identified for future science education, it is to empower students to be able to improve knowledge in a collaborative process. In a complex world in which the future is largely enigmatic, it is critical for all students to be able to apply cognitive processes of validation and improvement.

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