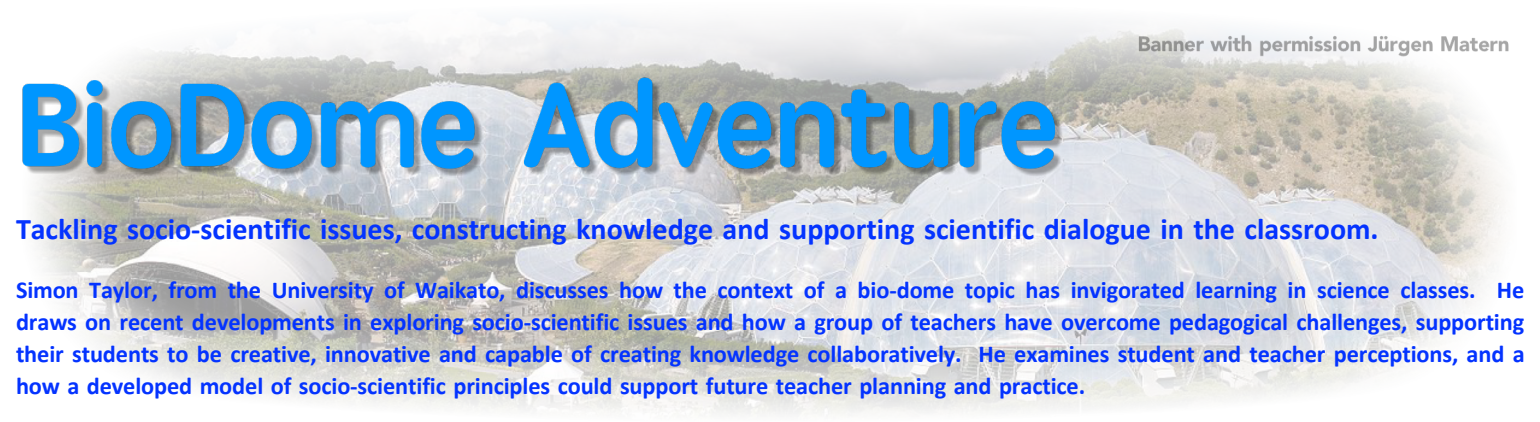

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BioDome Adventure

Tackling socio-scientific issues, constructing knowledge and supporting scientific dialogue in the classroom.

Simon Taylor, from the University of Waikato, discusses how the context of a bio-dome topic has invigorated learning in science classes. He draws on recent developments in exploring socio-scientific issues and how a group of teachers have overcome pedagogical challenges, supporting their students to be creative, innovative and capable of creating knowledge collaboratively. He examines student and teacher perceptions, and a how a developed model of socio-scientific principles could support future teacher planning and practice.

Implementing socio-scientific inquiry, young people constructing knowledge

It is argued, more than ever before, that we can foster a knowledge society (Gilbert, 2005) where young people take the opportunity to solve problems; not just through acquiring prescribed knowledge and skills, but by creating new knowledge as they learn (Bereiter, 2002).

We have, right now, an opportunity to break away from certain traditional, entrenched teacher practices of the past and to approach learning as a genuinely communal activity, where students shape knowledge using social and scientific considerations. Socio-scientific issues based inquiry involves the deliberate use of a context that requires students to engage in dialogue, debate, and, perhaps importantly, it is mechanism which gives opportunity to meet a demand of the 21st century - *where our young people are expected to construct knowledge not just acquire it.*

The purpose of the proposed learning and teaching programme was to develop an inquiry in which students would face a social and environmental challenge posed to them. It would demand both scientific and ethical thinking, and it needed to be tackled in small teams.

It was interesting when we initially asked the students to identify what the best thing they did to help their learning was; a preference for working in a group was voiced by 72 per cent of respondents in a survey. Watkins (2015) discusses that, on the surface, in most classrooms some of the features of co-operative structures are usually evident. However, the teachers in this research wanted to go beyond this by encouraging students to create something greater between them than they could accomplish separately. Hodson (2010) urges the significance of incorporating socio-political action in science education and that if current social and environmental problems are to be solved, we need a generation of scientifically and politically literate citizens.

Socio-scientific issues based instruction is similar in its teaching approach to problem based teaching in that both frame science content within a story. However, a socio-scientific based approach is different in that the students are challenged to explore the controversy on the issue, informed by science, integrating the social aspects (ethical, cultural, spiritual, economic) and developing a position based on their investigations. Wilmes and Howarth (2009) explore the distinction between this teaching approach and traditional teaching approaches. Students spend their time not only acquiring and sharing knowledge, but also evaluating scientific evidence, applying reasoning, examining positions and weighing

TABLE 1. Distinctions between traditional practices and socio-scientific issues based learning

Less prominence on….	**More prominence on….**
Discussing science concepts in isolation	Discussing science concepts in the context of personal and societal issues
Working individually	Collaborating with a group that simulates the work of a scientific community or represents authentic groups found in society
Acquiring scientific information and skills	Developing conceptual understanding, constructing knowledge and applying this in making and evaluating personal, societal and global decisions

Making sense of pedagogical challenges

Following discussions with the teachers and the students, three key points emerged with regard to the challenges of teaching and learning using socio-scientific issues:

- The first was the nature of student collaboration and the specific grouping of students into teams. Teachers spoke candidly about the make-up of the groups and that the success of the inquiry depended on teams that had members with a mix of academic strengths in them. Students talked openly about the need for negotiation, they believed their voice was important in the initial talk about group make-up. A handful of students signalled that they were anxious that some of their classmates did not pull their weight and rode on the merits of others. In terms of student motivation and engagement, the teachers tended to discuss the importance of the general well being of the class as a whole, and specific team personal issues would usually be sorted out with one-to-one chats between the teachers and the students.

- The second challenge was to ensure conceptual ideas were aired. What do the students know about the science concepts? This was a question a teacher posed in preparation for the socio-scientific inquiry. She believed it was important to investigate those concepts and identify them. For example: What did her students know about photosynthesis? Did they know how viruses spread? Did they know how food is made? Did they understand the concept of life? Student planning and brainstorming time was incorporated into the early lessons and this was seen as a valuable process to focus on prior knowledge, both at a student individual level and also at the teacher level. What conceptual knowledge would teachers require teaching this topic? This was a question that came up in teacher meetings. They considered their own scientific conceptual knowledge could be overlooked and that it was easy to get carried away with the controversy or issue of the inquiry. They said that they had to keep a check on identifying key scientific ideas throughout the inquiry.

- The third challenge was the importance of designing a context that was meaningful for the students. Teachers believed there was a pedagogical tension between adopting the socio context and how the scientific concepts would be tackled. One teacher commented on this challenge: "Getting the right context is tricky, so that students run with it and the science ideas can naturally arise". The teachers discussed their angst over ensuring an authentic context was incorporated into the inquiry. They described that it would take time in planning and setting up the issue on the topic. However, once this was accomplished their own confidence in the proposed inquiry was raised and that operational matters fell in place.

The Bio-dome context used in the socio-scientific inquiry

The context and scenario are given here to illustrate an example of the socio-scientific inquiry. This example is an excerpt from a Year 9 science class. (*See next page*)

Bio-dome Challenge

The World Health Organisation (WHO) has recently become concerned about the number of frequent virus outbreaks including Ebola and the Zika Virus. While these outbreaks have been contained so far, the WHO is concerned that a new virus may emerge that we have no knowledge of, which could be highly contagious and deadly.

As a result of these concerns, the WHO has decided to create emergency 'Bio-domes' in a number of countries, so that in the event of a new outbreak a safe refuge will be available for a set number of people.

It has been decided that one of these Bio-domes will be built in your hometown. How long people will have to stay within the Bio-dome to ensure that the outbreak is contained is currently uncertain.

The WHO have issued guidelines that plans should be made to stay within the Bio-dome for two years at a minimum. As the nature of any outbreak is as yet unknown, other guidelines they have set include excluding anything from entering the Bio-dome other than sunlight.

Question: Investigate what and who will be given a place in the bio-dome to sustain life for a period of at least two years, and why.

- *Your job, as a team, is to investigate and consider evidence for all your decisions.*
- *You will be expected to build a model of the Bio-dome and present your ideas.*

To encourage students to research key ideas in the inquiry and keep them on track, eight concepts were identified: Food, water, energy, sustainability, air, waste, community and life. These ideas were further discussed in detail, and in some classes, there were teams specialising, for example in: Respiration, photosynthesis and food chains. Particular teams became specialists or experts in these areas and they fed back progress to the class.

Students gather evidence to build scientific trust and construct knowledge

To help us understand how a socio-scientific issue would be incorporated in a science programme, we developed and used a triangle (see Figure 1) to depict the key socio-scientific planning and practice principles.

At the apex of the triangle is *prior knowledge*, which is the initial and on-going teacher quest of finding out what students know about the science concepts. Members of the group/community have a responsibility in *working together* to inquire, collect evidence and build scientific trust collaboratively, using a range of sources of data. To achieve the goal of constructing knowledge, the socio-scientific inference requires having *meaningful and authentic contexts*; these contexts expose the learners to situations where they are motivated to make personal decisions.

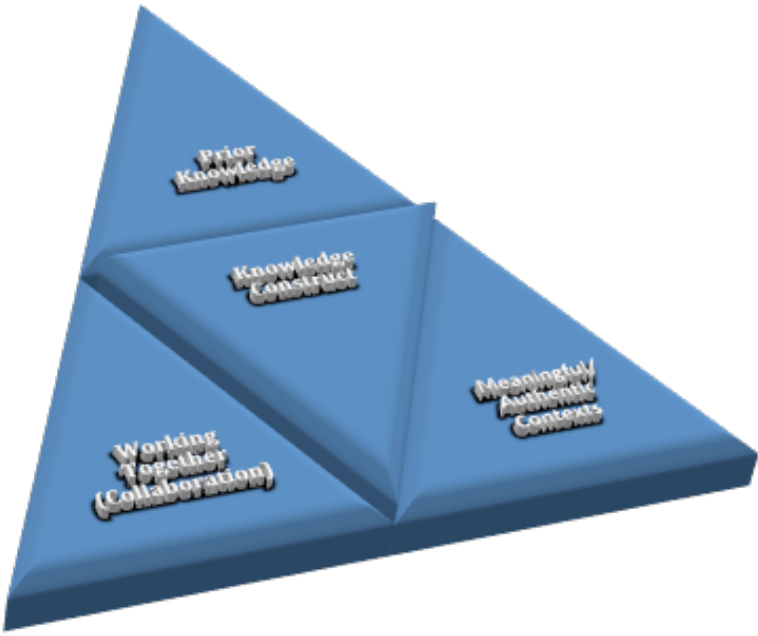

FIGURE 1. The socio-scientific practice and planning triangle

Encouraging both scientific and learning dialogue through progress checks

Hanks (1991) advocates that learning is a process that take place as participatory in a social interaction, not in an individual mind. Discussion of dialogic practice (Lyle, 2008), as a vehicle for increasing student engagement at a deep level and raising the quality of classroom interaction, offers an approach that has transformative potential in science classrooms. One way of encouraging dialogue in a socio-scientific context is to create opportunities where students take charge of their learning progress, talk about what they have achieved so far and where they are going in their inquiry. These kinds of formalised progress ' Pit-stops' through the inquiry have focussed the nature of the student conversations on the socio-implications, not just the science conceptual knowledge. As suggested by one teacher:

"I said to the students, because I'm going to be supporting your thinking, I believe it would be good to have a time each week where each team presents their progress, identifies what they have been learning about and their next steps. I want them to talk and think critically about the role of science in the dome. There are big decisions to be made about the design of the dome and I believe it's important that as a class we hear all the possibilities."

Another teacher agreed:

"I need to tune into the students, where they are at, it's easy to get into the trap of seeing the science through my eyes rather than the students eyes"

Encouraging students to reshape, reflect and evaluate their work was seen as important, where students considered that it was okay to change tack in the inquiry, that they could take the opportunity to look at alternative views from their peers, talk about their own personal learning, the group's learning and have the confidence to make changes using the scientific evidence. Teachers suggested that it was beneficial to listen to all aspects of the leaning progress conversations, so that they would know how to respond to students when they checked in with them, providing next steps in their learning.

Conclusion

Socio-scientific issues based inquiry offers the opportunity for students to be both creative and collaborative.

As discussed, it is not a practice that has minimal pedagogical challenges in the classroom, the teachers said it was not an easy practice to do, however it can be transforming and poses an exciting future for science education.

In this article I have discussed the differences between traditional practices, going beyond these, to tackling socially implicative issues that could be accommodated into current science programmes. Incorporating societal issues into the science classroom can support students to think critically about the role science plays in society. Consequently, using this method we have an opportunity to further raise scientific literacy with our young people.

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