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Teaching Science as a Hermeneutic Event

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Abstract

In this article, the author explores the need for science education to be taught as a hermeneutic event, as opposed to a book of facts to be memorized. The fragmented, passive transmission of facts does not allow students to have a clear understanding of science, its' traditions and how science lives in the world. Reconnecting biology back into the world, and recognizing its creativity and uncertainty, will help students understand how science impacts their lives and the world. The author explores how, through hermeneutics, students can experience the living discipline of science, as opposed to learning *about* science.

Keywords

curriculum studies, hermeneutics, high school biology, learning, philosophy of education, science education

Upon returning from their immersion week, the first year pre-service teachers in my secondary science curriculum course were excited to talk about their teaching experience, what went well, as well as some of the surprises and learning opportunities that arose for them. After 15 minutes of discussion, Megan (pseudonym) spoke up and said "I asked my partner teacher whether I could talk to the biology students about the recent earthquake and Tsunami in Japan (that happened only days earlier). The teacher responded, 'No, that is not biologically relevant; it is not in the curriculum.'" The class of pre-service teachers gasped and then a stunned silence settled onto the classroom. There was something in this incident that we knew did not feel right; the living discipline of biology that has been entrusted to us as teachers was not being honored (Jardine, 2006). If we simply look at a few of the pictures displayed by the news stations from the Japan disaster, we can easily see that

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events such as this that address us are the reason why we teach biology, so that we can understand and be part of the world in which we live. An investigation of the Alberta Program of Studies demonstrated direct links to the skills, attitudes, and content found within the mandated curriculum. Instead, Megan gave her notes on the respiration system and then a set of questions from the textbook, while the opportunity to root what we know about biology in the world was left behind.

Yet, at the same time as an experienced biology teacher, I could understand the response of that teacher. In a highly pressured world of heavy curricula, student/parent expectations, and the ever-present standardized test, this response was familiar to me. This moment made me wonder what makes it so that a teacher would feel necessary to respond this way. What is this saying to us about how science is seen in the school? "Hermeneutics suggests that these striking incidents make a claim on us and open up and reveal something to us about our lives together and what it is that is going on, often unvoiced, in the ever-so commonplace and day-to-day act of being and being a teacher." (Jardine, 2006, p. 280).

In this paper, I explore how science is commonly presented in schools and the impact this has on students in terms of their immediate understanding of science as a subject and, even more importantly, how this way of teaching ignores the urgent need to recognize that school science is perpetuating the conditions that contribute to the current ecological crisis. Pretending that there is no ecological crisis is ignoring the inevitable where Earth as a system will no longer be able to sustain life. Orr (2004) argued that we are educating students as if there is no planetary emergency, or as if environmental problems will be solved by technology. Taking science up as a hermeneutic experience can offer the opportunity to explore the complexity and interconnectedness of science with the world and allow student questions to be an opening to new understanding. Hermeneutics recognizes that all understanding, including scientific, is "historical, linguistic and dialectical" (Palmer, 1969, p. 212). Through participation in the experience of science being a hermeneutic event, students may begin to be able to take up science as something more than "deadly dull information that [they] must consume" (Jardine, 2003, p. xiv) and begin to understand science connected in its ancestry, traditions, interdependence, conflicts, ethics, and belonging in the world (Jardine, 2003).

Common Image of School Science

According to a study completed by Aikenhead (2003), one of the key concerns regarding traditional science teaching is the "dishonest and mythical images about science and scientists it conveys" (p. 12). Scientists are often presented as being objective and science and its methods provide absolute proof (McComas, 1998). What is often lost with this vision is the tentativeness and creativity which are both key components of the process of science. One of the main culprits of this vision is the way laboratories and the scientific method is presented in science classes. In most science textbooks, a linear, lock-step, approach to the scientific method is provided that implies that all scientists follow a common series of steps to do research (McComas, 1998). Many students, in fact, are disappointed when they learn that scientists do not have a framed copy of the scientific method posted above their workbench (McComas, 1998). The scientific method is presented in classrooms as predetermined, tidy, linear activities students must follow, and then write up to hand in for assessment. There is no imagination, creativity, or opportunities for discovering new ways of

understanding a concept. Instead, students go away with an image of science that does not bear any relation to the lived world of science (Blades, 2001).

Through a comparative analysis of three research projects conducted in England, Sweden, and Australia, Lyons (2006) found that science students held three common views of science education. The first view is that science pedagogy is simply passive transmission of facts from teachers or textbooks to students. The second vision is that the content is irrelevant and boring. Dewey described this in his article, *Child and the Curriculum,* in 1902. When science is presented as facts without any connection to students lives,

> it condemns the fact to be a hieroglyph… the most scientific matter loses this quality when presented in external ready-made fashion - those things that are most significant to the scientific man, logic of actual inquiry… drop out. (p. 202)

The third vision of science education that students commonly hold is that science is a difficult subject. This is not because the students found science intellectually stimulating, instead they described how science is full of terminology and, more importantly, that difficulties arise from the passive learning, memorization of facts, and the irrelevance of the content. Lyons (2006) saw these common views as the primary reasons why students are disengaged in science, which has led to a dramatic decrease in enrolment into scientific fields throughout the western world.

School science does not engage students in the living field of science as long as the curriculum remains content-driven and pedagogy is driven by standardized testing. Blades (2001) described how, as a result of heavy amounts of content-laden curricula and a focus on testing, students' questions are not allowed to be part of the process of learning science, that the only questions are the ones that are already provided by the teacher. Capra (1996) argued that as long as we see information as something that is "lying out there to be picked up by the brain," that we will miss the "whole network of relationships, a context, in which it is embedded and which gives it meaning" (p. 272). Capra's argument requires a break from the traditions of science education in which science classes are deeply entrenched. Hermeneutics offers ways to connect science back to its field of knowledge by allowing students to become part of the conversations, traditions, and complexities of science as an event in understanding the world.

> [Hermeneutics] provides a way to rethink what we experience in our day to day lives as teachers, what we understand teaching to be, … what we understand knowledge and tradition and language and conversation and … the methods of the sciences to be. (Jardine, 2006, p. 269)

A Shift to Hermeneutics

By focusing on the ontology of teaching science, hermeneutics asks: How does science live in the world as an ongoing emerging discourse, and what traditions are a part of science education? Furthermore, hermeneutics asks what does this conversation demand of me in regards to how I take up teaching science? "*Understanding is to be thought of less as a subjective act than as a participating in an event of tradition*, a process of transmission in which past and present are constantly mediated" (Gadamer, 2004, p. 291, original italics). Understanding is both the goal and the path, so while sci-

ence education often wishes to come up with a final, complete understanding, hermeneutics allows recognition that the process of understanding is never complete. The question then becomes: How do I proceed pedagogically when I understand that science education is not a thing with a final and definitive definition, but always in the process of becoming (Smith, 1991)?

In many current biology classes, information is given to students, and a predetermined set of questions are asked with predictable, predetermined answers expected. Science is often mischaracterized as the application of techniques or calculation methods disconnected from the traditions from which they have come (Crease, 1997). Finding ways to bring these concepts back into the world, which includes their ancestry, memories that they evoke, and what truths they say about the world is essential to begin to understand the complexity behind why students seem disengaged in science. How can students connect with ideas that are unconnected to the world in which they belong? This is where hermeneutics can speak profoundly to science, by helping to find ways to root these scientific concepts back to the habitat from which they are part of, into what Heidegger would call "being in the world" (as cited in Kozoll & Osborne, 2004, p. 158).

Being immersed in science as a living field means problems are to be understood more deeply, allowing a spontaneous and yet informed response to a question so that the knowledge can be used to respond to a question in a new and unanticipated way. By exploring in depth the many questions that emerged from the tragedy in Japan, biology as a living discipline would open up possibilities and students would be able to see why this information is important and how it lives in the world. Hermeneutics frames the possibility of teaching science as a dialectical perspective, where science is treated more as breaking open of questions (Gadamer, 2004), as opposed to closing down the conversations by presenting science as a "celebration of closure... and of the end of interpretation" (Donnelly, 2002, p. 147). The term Bildung has a variety of meanings which imply formation, cultivation, and education (Davey, 2006). Bildung stresses that hermeneutic understanding does not find the end to a topic, but allows for a deepening of the experience which opens up the possibility for more questions and more demanding experiences. It is within this process where the rigour of the facts and information are required and are able to show how they belong in the world (Davey, 2006).

Hermeneutics can replant the teaching of science back into the world in which the students and science as a field of knowledge are a part. It can help students explore how science presents a particular truth about the world and how they can explore the "perils and challenges of a materialistic account of the world" (Donnelly, 2002, p. 149). Accordingly, students can recognize how science lives as part of the world, and that it is not simply "storage of knowledge as is accomplished in a dictionary, a catalogue, etc." (Gadamer, 1992, p. 44). The historical, political and sociological aspects are all rooted within science itself, not as something separate to the body of knowledge that is considered science. With this, there is an opening and uncovering of "the ruling preconceptions of the moment [that] uncover new avenues of inquiry and thus indirectly be of service to the work of methodology" (Gadamer, 1988, p. 289). Hermeneutics also provides an opportunity to recognize "the inner interwoveness of one field of research with another" (Gadamer, 1992, p. 45), which allows students to see how science as a field of knowledge is connected to the world and

invites students to become part of the conversation of science. "The history of mathematics or of the natural sciences is also a part of the history of the human spirit and reflects its destinies" (Gadamer, 2004, p. 284). Science and the students are both rooted within the same world, which means that science education becomes an opportunity for students to take part of the conversation as well as part of the understanding that is always already ongoing (Gadamer, 2004).

In my current doctoral research, which explores the question "What does it mean to teach biology well," I interviewed both teachers and students to explore their experience of high school biology using a hermeneutic framework. One of the questions I asked both teachers and students was: "If teaching biology is mainly about memorizing facts then is teaching biology becoming redundant in the age of instant information through Googling? What is the role of biology classrooms?" The responses from both students and teachers indicated that, in a good science class, there was something more happening than just amassing knowledge. There was the connection between ideas and theories and their lives that helped them understand the world of biology. They described how biology became a narrative that helped understand appreciate the complexities of the world.

At the 2011 National Science Teachers Association conference in San Francisco, keynote speaker astrophysicist Dr. Jeff Goldstein, Director of the National Centre for Earth and Space Science in Washington, DC, described how science taught as a "book of knowledge" did not do it justice, and in fact, was allowing the inheritance of science to be lost. Instead, he argued that in order to continue the legacy of science exploration, we need creative imaginative people who wonder about the world. Science teachers have to teach not only what we know about our world, but more importantly, how we have come to know it. The journey is where the science lives, and not in the isolated facts that have resulted from the journey. We need to understand where we came from and explore how each generation has added to the book of knowledge, which can then be passed onto the next generation.

(Re)visiting the Biology Classroom

If we return to the classroom with the young student teacher but this time she was allowed to go ahead and talk to the students about the tsunami in Japan, what would a classroom that takes up science hermeneutically look like? Jardine (2003) asked us to recognize that the living discipline of biology goes beyond "fixed and finished givens that are beyond question and simply indoctrinate the young into such acceptance" and instead take up the discipline as "not fixed and finished but is rather, ongoing, still 'in play', still 'open to question' in our human inheritance" (p. 85). One way this could have been experienced is if Megan had taken a picture on the internet of the Tsunami as it hit Japan and displayed it to the students, questions about the impact that this would have on the biological systems could emerge. For example, one picture shows an agricultural field, carefully manicured, with straight, well organized rows of crops growing beside large covered cultivated crops. The top half of the picture shows a black thick sludge of water filled with houses, vehicles and other debris sweeping over and swallowing the pristine fields. Allowing the students to begin to ask questions about that one picture would open up the opportunity to understand the impact of that one moment of the tsunami on the ecosystems of Japan. In many science classes, student questions are seen as a disruption. In a classroom where science was taken up hermeneutically

the questions would come to life and become a part of the discipline of science. As these questions emerge, the teacher's role would be to pay attention to which questions were meaningful and rich to explore, and through this process, introduce the students to the field of biology emerging from their questions and their understanding of the world.

Often child-centered inquiry projects become shallow when a topic is given. Students are asked select something that they are interested in and to go off on their own, research, and return to share this information. The students are fragmented into their own area of interests and often their inquiry remains superficial. To take up the topic hermeneutically, the focus has to be topic-centered, where students can take up the topic in multiple ways in order to understand the topic. The topic demands that the students and teacher pay attention to the discipline of biology it demands an academic rigour in order to understand and contribute to the ongoing conversation that this event calls up.

As the questions surrounding the impact of the tsunami emerge from this one picture and as the teacher and the students explore the topic, it allows them to become part of the discipline of biology that is always already in the world, as a result the curriculum outcomes become re-rooted into the world in which they live. For example, the Biology 20 Alberta Program of Studies (2009) knowledge outcomes include biogeochemical cycles, ecosystems, and population change and equilibrium as a few examples that need to be understood in order to make sense of what is happening in Japan as a result of the Tsunami. A teacher who is open to allowing ambiguity, messiness, and complexity to live within the classroom, as opposed to being focused on finality and finding definitive answers would allow student questions to find a voice and a life in the discipline of science. As Caputo (1987) reminded us, hermeneutics "does not lead us back to safe shores and terra firma; it leaves us twisting slowly in the wind" (p. 36) this is rooted in the complexity of where biology lives in the world.

If students' questions lead to the resulting nuclear plant destruction, the part of the Program of Studies (2009) that asks students to understand that "Science and technology have both intended and unintended consequences for humans and the environment" has meaning and context from which to take up this understanding. Questions on how we could come to the point where a nuclear power plant would be built on a major fault line in a country that experienced the bombing of Hiroshima would emerge as part of the greater understanding of science. The connection of the curriculum to the world would, out of necessity, allow the students to:

> experience, to suffer, to endure, or undergo the arrival of an unfixed future and the questions it might hold, questions we might not have even imagined or desired. This open, living endurance, we suggest, is basic to the disciplines taught in schools. (Jardine, 2003, p. 85)

Students would have the opportunity to realize that "even in the arena of making sense of the natural world, science is a limited discourse" (Blades, 2001, p. 86).

Conclusion

Gadamer argued that the disciplines that we have been given responsibility for "live in their openness to being handed along" (Jardine, 2006, p. 85) and are still open to questions, not only as part of our inheritance

but also where new understanding and learning emerges. Clifford and Friesen (2003) argued that "far too little of what most students do in school engages their imagination, fuels their passion to learn, connects them deeply with the world, or wins their hearts and minds" (p. 93). The work our students do is "memorizable… but it is rarely especially memorable" (Jardine, 2006, p. 87). The implications of this goes beyond the classroom and trying to increase engagement which, although important, is only one piece of the interconnections that need to be explored as a teacher and a researcher. Looking at the ecological implications of students being immersed in the discipline of science also helps the students to experience the interconnectedness of the world, so that they learn not about the earth but how they are part of the earth.

Capra (1996) wrote that the major world crises of our time are interconnected and interdependent, and recognizing that we cannot study these issues in isolation is essential. Education is part of the perpetuation that allows the individualization and progress to be the primary discourse of the "developed" world. Education, as it stands today, helps equip people to be more "effective vandals of the earth" (Orr, 2004 p. 6). The tsunami disaster in Japan is not just an interesting topic to help students become engaged in science, instead it demands that we bring forth the world of science and the understanding that emerges to help make sense of what is happening and where to go from here. This means that the topic demands the academic rigour and clarity that we, as science teachers, want the students to be able to leave the class with which includes not only the content, but the skills and attitudes that are part of the Alberta Program of Studies. Clifford and Friesen (2006) asked, "what can happen in schools when teachers take seriously the power and the right of children to name and to shape their experience of the world?" (p. 94) What would have happened if that student teacher had the opportunity to explore the biological issues that the tsunami has brought forth? Hopefully, some students would have understood why biology is an essential discipline in order to live well in this world - what Gadamer (1996) calls "being in the world as a wakeful presence" (p. 74).

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