

# FROM NORMAL TO REVOLUTIONARY SCIENCE EDUCATION

WOLFF-MICHAEL ROTH

*University of Victoria, Canada*

## ABSTRACT

This paper has the explicit aim to raise questions about ourselves, in fact, to question the very ways in which we science educators do business and understand ourselves. Would it come as a surprise if some readers were upset with me for raising such questions?<sup>1</sup> Negative responses to the issues I articulate in this paper are at the very heart of what my chapter is about. How does a community of practice renew itself when at the very moment that those of its members who propose change are often silenced by journal and book reviewers who see their power, which they have gained in the existing community, threatened by new or different ideas? And how can we begin talking about such issues without upsetting those who have different stakes and views? But then, we also need to ask, how can the science education community renew itself if there are gatekeepers who uphold the old order? That is, how can the science education community (of practice) change itself from doing normal science to doing revolutionary science?

## 1. INTRODUCTION

Over the past decade since leaving fulltime classroom teaching, I developed interests and conducted research that took me beyond my root discipline, science education including social studies of science, anthropology of the workplace, and linguistics (pragmatics). Working and publishing in these fields, I encountered theoretical frameworks, ways of relating to the research participants, and forms of scholarship that differ from our discipline. Upon coming back from time to time to my root discipline, I come to see it differently, see it struggling with issues that elsewhere have been settled. With more than a little concern, I frequently see my own discipline plodding along instead of engaging in efforts that change the world. In this chapter I hold up a mirror, thereby allowing the science education community (including myself) to look at itself.

The need for change in science education practices has emerged for me particularly while researching controversy and environmentalism in one community (e.g., Roth & Lee, 2002), on the one hand, and while researching in urban schools where approximately 90% of the students are from home conditions of relative poverty (e.g., Roth et al., 2004), on the other. In the first instance, I came to realize that it is not necessary for every citizen to know how to balance a chemical equation,

recite the Krebs cycle, or use Newton's third law to explain some phenomenon; rather, what we need are structures that allow citizens to solve problems and controversy in a collective manner. More important than everyone knowing scientific facts and concepts is that everyone, whatever his or her predilections, penchants, and beliefs, can participate in collective decision-making. In the second instance, I realized that science education contributes to reproducing an unjust, iniquitous, and inequitable society (Hein, 2004). More science education is continuously producing scientists who build weapons of mass destruction and work for ruthless multi-national companies that exploit a planet, which, as a proverb among the First Nations people on the Canadian Northwest Coast goes, we did not inherit from our ancestors but are borrowing from our children. What we therefore need is a discipline that goes beyond interpreting science teachers and students in various ways; the point of the existence of science education has to be the production of a better world.

When existing paradigms cease to function adequately—for example, in the exploration of an aspect of nature—substantial change (revolutions) is in order (Kuhn, 1970). Because of the nature of science education as an applied discipline, substantial change may occur at three levels. First, I think that there is a need to revisit the theoretical frameworks we use to understand the world. Second, there is a need to revisit the way in and for which we prepare future science teachers. Third, there is a need to theorize the second issue in ways that lead to change so that it contributes to the production of a more reflexive and equitable society.

In the remainder of this chapter, I present a framework that allows us not only to understand teaching and learning, but also to reflect upon our own actions and how these co-produce some of the phenomena we report in our journals. This framework has allowed us (my colleagues, students, and me) to bring about changes in the way we teach science teachers, the way science teachers teach in one school, and in the way students participate and take charge of their own learning. Most importantly, as I articulate below, this approach has led us to an active participation of university supervisors, teachers in training, science methods instructors, school administrators, and researchers in the teaching of students. This, readers will readily recognize, constitutes a substantial (revolutionary) departure from current practices in our discipline. I begin by briefly articulating the framework that allows us to theorize not only the phenomena of interest, but, much as quantum theory has done for physicists, also allows us to theorize how any observer participant mediates the production of data. I then use this framework to look at a range of activities in science education practice and research to show how they constitute a radical departure from what science educators have done in the past.

## 2. AGENCY AND STRUCTURE

In many disciplines, researchers recognize the productive nature of human agency: not only do humans react to sociomaterial (including their own bodily) conditions,