Being and Becoming Scientists Today

CULTURAL AND HISTORICAL PERSPECTIVES ON SCIENCE EDUCATION: *RESEARCH DIALOGS*

Volume 7

Series Editors

Research Dialogs consists of books written for undergraduate and graduate students of science education, teachers, parents, policy makers, and the public at large. Research dialogs bridge theory, research, and the practice of science education. Books in the series focus on what we know about key topics in science education – including, teaching, connecting the learning of science to the culture of students, emotions and the learning of science, labs, field trips, involving parents, science and everyday life, scientific literacy, including the latest technologies to facilitate science learning, expanding the roles of students, after school programs, museums and science, doing dissections, etc.

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Reconstructing Assumptions about Science and Science Education to Reclaim a Learner–Scientist Perspective

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In loving memory of Geraldine Chapman Kirch (1941–2012) who was proud to call her daughter a scientist.

To my wonderful parents Joe and Angie Amoroso, who inspire me to reach for the moon and smell the roses along the way.

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INTRODUCTION

As the title suggests, this book is about teaching science from a learner or what we will call a learner–scientist perspective. It presents an approach to being aware and mindful of learner questions, puzzlements, wonderings, motives, goals, and experiences. In order to teach from a learner perspective we must necessarily challenge assumptions about science and science education and we must reconstruct what it means to be and become a scientist. For example, what do we mean when we talk about "scientists"? In this book, we are referring to a person who is interested in understanding the natural world and questioning the status quo by using, modifying, and creating tools for thinking critically and scientifically—tools such as questions, explanations, facts, ideas, laws, concepts, theories, schema, rules, norms, social practices, skills, and even algorithms. In this book, scientists are not limited to people who are certified career scientists, but include citizen scientists, science enthusiasts, science educators, and science learners of all ages and from all walks of life. Broadening more traditional definitions of scientist is not a new idea (especially for elementary school science teachers), but it has been an uphill battle since the word was widely adopted in the late 1800s. Just saying everyone is or can be a scientist isn't adequate to ensure everyone can learn to be a scientist. In fact the assertion, everyone is or can be a scientist, often faces many contradictory practices and assumptions in science education.

First, science education, as an enterprise, presents science from a disciplinary perspective rather than from a learner perspective. This means that learners are viewed as people who need to learn (1) canonical explanations of the world, (2) specific methods of investigation, and (3) the norms and schema for knowledge production accepted by various scientific disciplines. These top-down directives are rarely coupled with the bottom-up motivation of the learner who doesn't understand why she is being told to learn these explanations, methods, and norms of knowledge production. How can science educators reclaim a learner perspective and position students as the primary agents in control of their own learning activities such that they see purpose and meaning in these aspects of science (knowledge, methods, norms) deemed important by the enterprise?

Second, the notion of a scientist usually reflects either a historically famous scientist (e.g., Einstein, Carson, Curie, Newton) or a fictional career scientist who, according to classroom teachers: "works hard," "is very smart," "observes carefully," "takes good notes in his notebook," "waits to talk," "sits quietly," "uses evidence to back up her claims," and "uses the right science words." These portraits of scientists might be appealing to some students, but others might be intimidated, uninterested or discouraged. As we know, the students in the latter category often start to think they are not good at science or that science is not for them. How can science educators change the images of scientists we create (consciously or unconsciously) and teach in a way that supports students as already being scientists?

Third, not only is science presented as a career field that recruits and employs gifted and talented individuals, it is also presented as a static body of knowledge, an anonymous, authoritative industry, and a standardized process of describing and explaining how the world works. As a result, learners see scientific knowledge as facts to be remembered or memorized rather than as tools and knowledge-actions people can create in collaborative transformative practices for self- and community development. How can science educators rethink how we conceptualize contributions to science to be more inclusive of young people who are eager to learn and be what Joe Kincheloe and Shirley Steinberg (1998) refer to as "players" in the world?

Fourth, another difficulty with adopting a disciplinary perspective of science is how scientific problems are presented. This is related to the second problem. The lack of social, cultural, and historical contexts in science education often results in the absence of any connection between knowledge production and a human story. Alternatively, a focus on famous or genius scientists leads to a single story of knowledge production. How can science educators represent scientific problems and tools for thinking in a way that encourages students to expect and seek out the multiple stories of scientific knowledge production and see themselves in these stories now and in the future?

Finally, students are rarely put in the position of authentic researchers. We believe this is primarily because it feels disingenuous to ask students to rediscover a canon of basic science concepts listed in our school's science standards for learning. For example, asking students to research how things move in order to reinvent Newton's laws of motion through inquiry is not a trivial instructional goal. More often than not, it ends with teachers telling students the so-called right answer when students fail to replicate classroom investigations in a way that demonstrates each of the laws (which, in the case of Newton's laws of motion, cannot be replicated in the classroom or laboratory because they are idealized). Most of the concepts and ideas we expect students to learn in science took years of dedicated study by many people and often represent theorized observations and concepts therefore, the form of rediscovery needs to be carefully planned and managed, and there are few tools to help teachers do this. How can we position students as researchers in a way that allows them to lead inquiry projects and free educators to serve as radical listeners and instructional designers?

These are the contradictions and questions we attempt to address in this book.

THE AUDIENCE

This book is intended for elementary school teachers (including generalists, special educators, and science specialists) who want to further develop their own practice and understandings of classroom interactions and develop ways to uncover the perspectives of the young learners with whom they work. It is also intended for science teacher educators who want to introduce teacher candidates to tools to help them be and become scientists and radical listeners. Education leaders (principals, supervisors) who are considering new and innovative ways to work with their faculty and staff to evaluate elementary school science program activities may also find this book useful. Finally, parents may find the text helpful in placing elementary science education in a broader social, historical, and cultural context and in providing information necessary to support teachers that want to foster authentic science activity in their classrooms and in children's homes. Although many of the ideas, conclusions, and recommendations in this book are the result of our work with children approximately 7 to 10 years old, we believe most are appropriate for science learners of all ages (including their teachers).

THE SETTING

We (Sue and Michele) began working together in 2003 and have co-taught or worked in parallel at different schools in New York City since then. We have audiotaped and videotaped hundreds of hours of classroom conversations (small-group and whole-class discussions) and research interviews for review and discourse analysis. Sue conducted research with Michele when Michele was teaching second grade, and has also conducted research with several other classroom teachers (third through fifth grade) since then. The populations of the schools where our research and teaching took place were varied. Our early research took place in a professional development school (grades preK–8) affiliated with a local university. At the time of our co-teaching and research, this school had a diverse student population of approximately 250 individuals (it was a new school that had not yet reached its maximum student capacity). According to census data available at the time, the students categorized themselves on city registration forms as Black (45%), Asian/Pacific Islander (30%), Hispanic (15%), White (10%), and American Indian (1%). Three percent of students were classified English language learners, and 10% of the population was eligible for special education services. According to the principal, 30% of students qualified for free or reduced price lunch. Enrollment was determined by a lottery.

Sue's most recent work (featured primarily in Chapter 5) took place in a public elementary school classified as Title I eligible. It served children primarily from the surrounding neighborhood, which included a temporary housing facility and a nearby housing development managed by the New York City Housing Authority. Research participants included students (N = 126) and teachers (N = 9) from three fourth-grade classrooms (9–10 years old) and three third-grade classrooms (8–9 years old). Approximately 17% of classroom participants were eligible for special education services and 29% were eligible for English as a second language services, and their predominant language was Chinese (Fukonese or Mandarin). Four general education elementary teachers each led one of four classes, and two classes were co-led by two teachers: a general education elementary teacher and an elementary teacher with special education certification. This collaborative team teaching (CTT) model was common practice in the public schools in the district. According to the census data at the time of the study, students categorized themselves as Hispanic (29%), Asian (58%), Black (10%), and White (3%). The majority of students were from low-income families with about 70% qualifying for free lunch.

What is the point of sharing these demographics? Although our classroom experiences may not mirror yours, we would like to claim that the ideas we've developed and described here have worked well across these varied populations and with several teacher–researcher partners.

AN OVERVIEW OF THIS BOOK'S ORGANIZATION

In our own practices we have been reconstructing assumptions about science and science education from the perspective of the learner–scientist and have written this book to convey what we have learned so far. In each chapter, we unpack a related set of questions posed from the perspective of young learners based on our research and experience. We attempt to provide a commentary that reflects social, cultural, and historical trends related to questions such as where has elementary school science been, and where might we go? Most important, we present and explore a variety of resources for creating elementary school science teaching and learning environments that respect young learners and honor their eagerness to learn about the world as guided by these questions.

Chapter 1. Rethinking Science Education from a Learner Perspective: A Framework for Being and Becoming Scientists Today (BBST). *In this chapter we introduce our framework for science education (BBST) and compare it to the current dominant views of what science learners can and should do. We outline the types of questions learners might be expected to ask as they establish themselves as learner–scientists.*

Chapter 2. Being and Becoming Scientists. *In this chapter, we address the learner questions: What does it mean to be|become a scientist? Who can be|become a scientist? How do I be|become a scientist? How am I a scientist today?*

Chapter 3. Contributing to Science. *In this chapter, we consider the learner questions: What is scientific knowledge? How does one contribute to science or scientific knowledge? Could I contribute to science?*

Chapter 4. Representing Scientific Problems and Tools for Thinking in Instruction. *In this chapter, we consider the Next Generation Science Standards as we explore answers to the learner questions: What kinds of problems do scientists work on? Do I like to work on the problems of science? Would I like to become a scientist?*

Chapter 5. Classroom Results from a Knowledge and Knowing Study (KKS). *In this chapter, we present a method to engage students in the research questions from learners: How do I know what I know? How do scientists know what they know?*

We have organized these chapters around the learner questions proposed in our framework for science education (see Figure I.1 for an overview of the book).

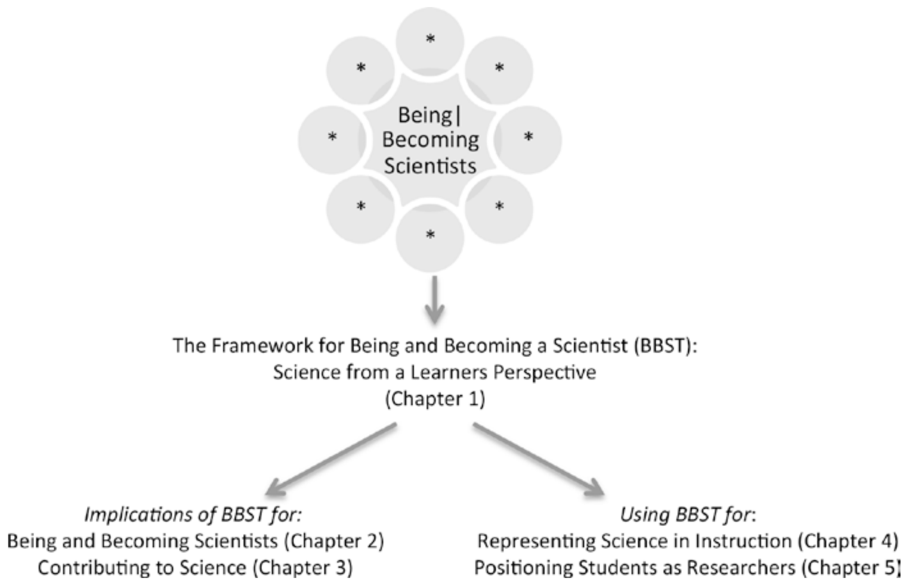

Figure I.1. A graphic overview of the book's organization

In addition to the five chapters that make up the central body of the book, readers will find we included some additional guidelines and reflections. A section at the end of the book includes a more detailed scholarly autobiography for each of us (Sue and Michele), a reflection on how we met and a brief dialog in response to two questions that arose after we finished writing and began sharing parts of this book with colleagues. We have also provided a glossary for a few key terms used in the book. In the Appendices, we have included the transcription conventions used in all of the transcripts featured throughout the text, as well as templates of several instructional tools for reproduction and classroom use. We are always honored when colleagues find our work useful, and we hope you share this book with many others; when you do, all we ask is that you cite our work even if you modify the tools. Recommended citations are included as part of each tool. Let us know what works for you. We hope you find here many useful resources, ideas, and recommendations to use and share.