Drawing for Science Education

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An International Perspective

Edited by

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TABLE OF CONTENTS

PREFACE AND ACKNOWLEDGEMENTS

I began to think about a book on the use of drawing in science education when I gave a presentation at a conference about how I used drawings for research in the science enrichment program I headed. It elicited heated criticism about the degree of inference in interpretation. Having majored in English during my first round of higher education, I knew I had spent many hours interpreting words and their implications. With fellow students I argued the meanings of phrases by Shakespeare, Milton and James Joyce interpreting the word images. I also developed a healthy respect for punctuation (we could say, graphical clues) as more than linguistic rules from tormenting grammarians. Those small commas could certainly help clarify meanings. One humorous example is the difference between, "Let's eat Grandma," or "Let's eat, Grandma." As a consequence of my language studies, I found these challenges about excessive inference in the use of drawing data curious. I understood all human communication as inferential in its interpretations, colored by context, gesture and tone. Meanings come from an interaction between the observer and a phenomenon interacting within a culture. Reviewing the literature on the historic use of drawings in teaching and learning science I was struck by how pervasive and important this method of information sharing has been. And yet there was a disconnection between modern science education and the use or study of drawing. There has been some renaissance with the influence of graphical interfaces from computers, but there was little evidence that drawing was valued, taught, or encouraged among the skills of science or science education research. The increased use of verbal/literary communication had taken center stage. When science education developed in the late 19th century drawing skills were a part of the school curricula. Students were expected to be able to illustrate their observations. Drawing faded as the 20th century progressed. Cameras became readily available and affordable. Standardized short answer testing was an efficient way to compare results for individuals and across countries. Curricula became crowded with new study areas. However drawing, with its eye-mind-hand coordination continues to offer us opportunities for science learning and teaching. It is one of multiple tools that we can use to teach and investigate what people are thinking.

The original call for this book was about drawings as data—learning evidence that teachers and researchers could use in science education. However as the chapters were submitted, I had the opportunity to think more deeply about the illustrators' perspective and what the act of creating a drawing could mean to them. There are other books on the use of visual data. Pedersen and Finson (2009) edited a collection of examples of visual data for research in the general field of education. Later, they assembled a volume more specific to science education (Finson & Pedersen, 2013). Neither volume focused solely on drawings and their physical, mental, emotional and contextual effects, as well as contribution to both the creators and other interpreters. This book has gathered authors from around the globe working with drawing as one of their instruments. Some of their experiences coincide and some present us with alternate ways to use this tool.

As we have learned in social science research, a variety of methods can take us closer to consensus on what our students (or the public) is observing or retaining in the context of our work. I wanted to gather and provide evidence for what drawings have meant in science education. Furthermore, it is not at all clear to me that we can separate the learning of science from the act of drawing, whether by pen and pencil or, more recently, electronics. And that is part of the point in this book—that science and drawing have been intimately bound together. Drawing has been used to record (e.g. Audubon) to envision (e.g. Leonardo daVinci), and to invent (e.g. Alexander Graham Bell). In science education research, drawing has been used to gain insights into the illustrator's content information, attitudes, values, beliefs and motivations.

In my own work, I had found drawing a non-threatening way to obtain information in the afterschool science program I developed and which grew to a national scope with NSF funding. In encouraging children and their families to engage in afterschool science, we explained how it would be different from most science programs in school. We offered more freedom to express the children's own thinking of the world, smaller groups than the usual classroom, and lots of material manipulation. We also described the opportunity as one in which there would be no tests. That is one of the complementarities of out-of-school science education, or what I term *continual science learning* (CSL). Schools need to have data to show status and answer to their tax-paying or tuition paying public in terms of standards and goals. CSL settings concentrate on keeping excitement up, on developing identities as continually interested science learners, and in providing resources (places, materials, approaches) that may not be readily available anywhere else. And yet, we, too, had grant funders who wanted to know just what was being gained by being in our CSL science enrichment program. I turned to drawing because children do not associate it with testing. I was able to obtain thousands of drawings with no protest. Those of us who reviewed them were able to see trends of what made an impression on the children in terms of content and affect. I learned that this was a very limited use of drawing as a science skill.

I was intrigued by how White and Gunstone (1992) used drawings to better understand how their students represented connections and processes. I had followed the use of drawings in the 1980's that were employed to develop evidence about gender bias and other conceptions about who did science (Chambers, 1983; Schibeci & Sorenson, 1983; Kahle, 1985). Working with Dr. Randy McGinnis at the University of Maryland on Project Nexus, we used drawings over the course of years to observe how the answers to "Please draw yourself teaching science," and "Please draw you students learning science," changed during and after the teacher preparation program (Katz et al., 2011, 2013). As I read the developing literature on the subject, I came to see that drawing continues to be an essential tool for science work and science education. Coincidentally, I had recently read Noah Gordon's book *The Physician* (1986), set in the eleventh

century. It tells the tale of an English orphan who is driven by his interest in medicine to travel to Isfahan in Persia to study with the famous Avicenna. In this novel, the dedicated protagonist is nearly executed for his efforts to draw (from post mortem dissection) the physiology of a man who has given his permission for others to learn from him upon his death. Religion forbid it. Medicine suffered. How important drawing was before photography and electronic imaging. The physician in this book on science drawing is also a medical illustrator. Gary Wind is a surgeon who helps put the combat-wounded back together. He tells you in his own words (Chapter 4) how he melded his interests in drawing and healing. His textbook on the vascular system is a beautiful and finely detailed teaching tool (Wind & Valentine, 2013). Medicine needs drawings just as contractors need blueprints. All of science needs drawing. There was no one book that brought a variety of these rich multiple drawing uses together. This book had its start as a result of my accumulated experiences.

I read about work being done by my colleagues around the globe. Some have invented ways to interpret the communication of drawings. Some have asked questions that are new to the use of drawings in science education. Some are replicating studies and comparing results across cultures. I find it exciting.

ACKNOWLEDGEMENTS

I have been fortunate to be able to work in science education and to contribute to the field. I thank Michel Lokhorst and his team at Sense Publishers for bringing to fruition the vision within my original book proposal. While I had personal contact with many of the authors, I approached others because of their work within our journals. I thank all of them, both those who knew me and those who trusted me sight-unseen, for sharing their use of drawings in our field.

I would like to acknowledge the late David J. Lockard. He encouraged me to become a researcher as well as a practitioner. David was a world expert on mushrooms, as well as science teaching. I think of him every time I make my stuffed mushroom recipe and of his wonderful course in medicinal and poisonous plants. I drew many times in that course. There was an added pleasure to his mentorship. My father had given me a copy of the UNESCO book, *700 Science Experiments* (1958) when I was a child. It was exciting to know that my graduate mentor was an editor of this childhood treasure. Randy McGinnis was my next advisor and mentor. I used drawing data in my dissertation on mothers as science teachers, revisited recently as a chapter on science teacher identity development (Avraamidou, 2015). Dr. McGinnis encouraged me to foster my own identity as a science education researcher as I led the team at the organization that was developing and delivering afterschool science options. Those were challenging years and it is a pleasure to see how our work has now coincided once again in this book. Randy has continued to use drawing as a data collection technique (Chapter 21). Most importantly, I have also been fortunate to have my husband, Victor, as a scholarly partner. We spend many hours discussing our work and its implications. For this book, in addition to collegial talks, he made time to input my edits, as he is a much speedier typist than I am. Together, we have been tolerant of how our work impacts on a quirky lifestyle of suppers and bedtimes that vary by how intense our projects and grandparent demands are.

There are several people who fostered this book in small but meaningful ways. When I exchanged emails with Kevin Finson, who has the two books cited above on visual learning in science education, his response to my wanting to produce another volume was to offer assistance, if needed,—a gentleman and a scholar. Julie Thomas and Donna Farland-Smith, likewise had preceded me in publishing about the use of drawings and were gracious in sharing their thinking.

There are people who have facilitated my work in pervasive ways. George Tressel was my first program officer at the National Science Foundation. After he left the Foundation we developed a friendship. He has been my guru in many ways and I have always appreciated his blend of philosophy and practical knowledge. We discussed this book's material among our many science education conversations. My children have always been a cheering team and are each teaching now in different ways. Sharon Katz Cooper is responsible for science education dissemination for one of our ocean exploration vessels. She and I have talked about the use of images in our work. My son, Ari, is generous with his thoughts on international teacher education, global needs, and technology. Our talks have included visual evaluation. Naomi teaches through art. A costume designer by training, she has studied the ways in which art communicates, making me more aware of intentional techniques. This has given me clues to consider in the unintentional—that is, what people draw to communicate science learning without an artistic product as a conscious result.

Most of the chapters in this book are research reports. There are, however, two essays that don't conform to that genre. One is the chapter mentioned above by Gary Wind (Chapter 4). The second is by a middle school teacher in Botswana. Shiellah Keletso tells us of an action research project in which she utilized drawings after finding Project Nexus' *DrawnToScience* website through an internet search. She was seeking a way to improve her teaching so that she could become a more inclusive teacher (Chapter 20). Both of these chapters bring to the reader a different perspective from that of a professional science education researcher. They enrich this book, meant to provide examples for both science education researchers and teachers, whether in classrooms or other learning settings.

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