

TEACHING AND LEARNING IN SCIENCE SERIES



DIALOGIC COLLABORATIVE ACTION RESEARCH IN SCIENCE EDUCATION

COLLABORATIVE CONVERSATIONS FOR IMPROVING
SCIENCE TEACHING AND LEARNING

*Allan Feldman, Jawaher Alsultan,
Katie Laux, and Molly Nation*



Dialogic Collaborative Action Research in Science Education

This engaging and practical book offers science teacher educators and K-12 science teachers alike the tools to engage in a dialogic mode of collaborative action research (D-CAR), a collaborative mode of action research focused on teachers' experiences with students, reflection upon these experiences, and peer learning.

Renowned science educator Allan Feldman and co-authors from across numerous settings in K-12 science education present the theory, methodology, case studies, and practical advice to support the use of D-CAR as a means to enhance teachers' normal practice and address the problems, dilemmas, and dissonances that science teachers must negotiate as they work to meet the needs of an increasingly diverse student population and engage with complex science teaching challenges that disproportionately affect marginalized students.

The book will be of use to science teacher educators, pre-service and in-service science teachers, professional development specialists, or any science educator invested in developing creative, reflective, and thoughtful teachers.

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Collaborative Conversations for Improving
Science Teaching and Learning

**Allan Feldman, Jawaher Alsultan, Katie
Laux, and Molly Nation**

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1 Introduction to the Book

Introducing Ourselves

As we write this book, we wonder who you are, the person who has picked it up and begun to read it. We're hoping you are a practicing science teacher who wants to improve your practice and the educational situation within which it is immersed. You might be someone involved in informal science education and you work at a zoo, museum, aquarium, nature center, or with groups like the Boy Scouts, Girl Scouts, Boy and Girls Clubs, or any other ways people are engaged in learning science outside of formal schooling. It's also possible you are a science teacher educator, someone whose practice is to help prepare new science teachers or to guide experienced teachers as they seek to improve their practice, or to study the ways in which science teachers learn to teach. We believe no matter who you are in relation to science education, you will find this book to be both useful and enlightening.

While we would need a crystal ball to know who you are, we can help you get to know us by providing some background about how we are involved in science teacher action research, and how that came about. To make this more personable, we will tell our stories in the first person. We'll start with Allan, who has had the longest experience with action research.

Allan's Association with Action Research

My explicit connection to action research began in 1989 when I stopped being a science teacher after 17 years and began full-time study for my doctorate. I was privileged to be able to do my doctoral work with some of the leading scholars in teacher education, including my advisor, Mike Atkin. I don't remember when we first began to talk about action research, but I believe during my first semester I did a literature review of action research as an independent study with Mike. As I was reading about what it was, I began to realize that I was somewhat of an action researcher when I was a science teacher. I tried out new teaching ideas, I thought deeply about them, I shared them with my colleagues at conferences of the American Association of Physics Teachers (AAPT), and even published some of my ideas in *The Physics Teacher*

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(Feldman, 1981a, 1984, 1991), and in a small journal published by the school where I taught (Feldman, 1981b, 1985, 1988). What I didn't do is to engage in the process we refer to in this book as conventional action research. I didn't identify a research question, collect data, analyze data, or use that analysis to inform my practice.

As a doctoral student in science teacher education, I also read the literature on teachers and teacher education. My biggest surprise was that I didn't see myself or my teaching colleagues in that literature. The primary research paradigm at that time looked at the effects of teaching practices and rarely included any information about the teachers themselves. When the teachers were described, they were not the reflective, engaged, professionals who I worked with in public and private schools. I began to realize that action research would be a way to engage with science teachers and decided for my dissertation to convene a group of physics teachers who would engage in action research, and to study how they learned from each other and how that affected their practice (Feldman, 1996). It was as a result of this study I began to explore the use of dialogue in action research. In later chapters of this book we return to the story of the Physics Teachers Action Research Group (PTARG), which is what the group called itself.

I was also lucky in my doctoral studies that my advisor was in close contact with a group of researchers in the UK who were instrumental in the resurgence of action research both in the UK and in Europe (Feldman, 2017). Among them was Peter Posch, who was on sabbatical at my university and was writing the first English edition of *Teachers Investigate Their Work* (Altrichter et al., 1993) while I was studying what was happening with PTARG. Since then I have taught classes on doing action research, facilitated groups of science teachers as they engaged in action research, and did action research on my own practice as a science teacher educator and facilitator of action research. I've also had the opportunity to work with doctoral students who had an interest in action research. My co-authors of this book all did their doctoral work under my supervision. We will hear from them next.

Jawaber's Connection with Action Research

My connection with action research started after finishing my bachelor's degree, where I worked as a physics teacher at a private school in Saudi Arabia. While there, other science teachers and I met weekly with the science department supervisor to discuss our struggles and success, provide each other with advice, and share materials. These meetings opened our horizons to how we can enhance students' desire and passion for the science field. Together we learned fundamental strategies of teaching and learning through attending workshops, observing each other's classrooms, and designing after-school activities. Through the years I worked in public and private schools, where I continued creating communities of science teachers and maintaining my connection with previous ones. Back then, I did not know the appropriate

terminology for these meetings. The first time I was introduced to action research terminology was during the first year of my doctorate program. I had the privilege to work with Allan on several research projects that focused on science teachers conducting action research. For example, we worked with ten high school science teachers to support them in finding ways to engage their students online in inquiry, discussion, and argumentation at the beginning of the COVID-19 pandemic.

Another example is when we engaged middle school math and science teachers in action research to develop methods and materials to deliver high-quality, reform-based instruction through online platforms. The purpose was to increase students' knowledge of public health issues and their ability to serve their communities as COVID-19 public health ambassadors. Similarly, in my dissertation, I recruited four high school science teachers from large school districts in the eastern region of Saudi Arabia. They participated virtually in digital game-based learning professional development (DGBL-PD), which consisted of five training sessions during the summer of 2020 and three community of practice meetings and teachers' action research presentations during the fall of 2020. We will discuss each of these projects later in the book. My work with Allan was somewhat different from what I read in the action research literature as it was focused on the enhancement of the teachers' daily practice rather than teachers' implementation of social science research.

After earning my doctorate, I continued my connection with action research by facilitating several communities of practice for in-service science teachers as well as being a member of The Professional Fellowship in University Teaching and Learning program team at Imam Abdulrahman Bin Faisal University, which is an academic-year professional development (PD) program intended to advance teaching and learning knowledge, skills, and practice for university educators, leading to the recognition of outstanding teaching and learning practices in Saudi higher education. One essential step of this program is for faculty members to conduct and present their action research that focuses on solving dilemmas encountered in teaching and learning practices.

Katie's Involvement in Action Research

After four years of teaching middle school science, I left public education to focus on my doctoral studies. I first learned about action research after taking a course with Allan. He eventually became my advisor as well. When I was first learning about action research, I did not understand why there was not more of a focus on this in the K-12 setting as it seemed like it would have great benefits for both teachers and students. At the same time, I also became interested in student voice. This led to my dissertation, which focused on me working with high school science teachers as they engaged in action research with the goal of promoting student voice in their classrooms.

As a graduate student, I worked on projects that included action research in the design. For example, along with Allan and Molly, I engaged in dialogic

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collaborative action research (D-CAR) with marine science teachers as they attempted to include more inquiry, discussion, and argumentation into their classes. After graduation, I worked as a science administrator at Hillsborough County Public Schools in Florida, and facilitated action research groups with science and math teachers as they attempted to improve their practice through discussions of equity and inclusion of students in science, technology, engineering, and mathematics (STEM).

In my current role as an assistant professor of education at Upper Iowa University, I use action research principles with my classes. I teach them activities such as analytic discourse (see Chapter 5) that they can use with other teachers in their professional learning communities (PLCs). I am currently beginning an action research project where I will reflect on how I encourage student voice in my classes and how this benefits my students.

Molly's Relationship with Action Research

I am currently an associate professor of environmental education in The Water School at Florida Gulf Coast University. Before getting my doctorate in science education, I was a middle and high school science teacher. I now use that experience to engage K-12 educators in environmentally focused curriculum. I have focused my scholarly efforts to promote climate change education in my teaching and with professional development (PD) of K-12 educators. Through collaborative action research and creating communities of practice, I align education and research to promote the practice of teaching and learning science. Controversy and public debates surrounding issues such as climate change have led to mistrust around science and science education. This was a big part of my dissertation, and I have written about it in the journal *Science & Education* (Nation & Feldman, 2022). Through my dissertation work (Nation, 2017), I found teachers wanted to engage their students in discussions and argumentation when teaching global climate change (GCC), but were reluctant to because they were concerned about curricular time constraints, were reluctant to give up control of the classroom, and were unsure how to do it properly. Engaging in D-CAR in a friendly, supportive environment helped the participants to assuage their concerns and learn how to engage their students in discussion and argumentation. The PD designed as a result of these findings was focused on incorporating inquiry, discussion, and argumentation into the marine science classroom as part of the existing curriculum.

Our Approach to Action Research

You may already be familiar with the idea of action research. To us, its purpose is to investigate your own practice and practice situation in order to improve either or both, and to produce new understandings that can be shared with other science teachers. In most books or articles about action research it is described in a way that is similar to academic research in the social sciences. It

begins with the identification of some type of problem the science teacher would want to address or solve; the collection of preliminary data that can be used to develop an action plan; the implementation of that plan along with the collection of data about its effects; and analysis of the data, which then leads to modifications in the action plan and so on. We refer to this model of action research as *conventional action research* (see Chapter 6 for information about how to do conventional action research). We call it conventional for two reasons. First, conventional is usually taken to mean traditional, usual, standard, or normal. Conventional action research is simply our way of stating the usual way that action research is depicted and presented to practitioners. Conventional can also mean “relating to convention or general agreement; established by social convention; having its origin or sanction merely in an artificial convention of any kind; arbitrarily or artificially determined” (Oxford English Dictionary, 2022). This is our second reason for using the adjective “conventional” – the reason that action research is formulated in this way is because it has been agreed upon, either explicitly or implicitly, to consist of doing these steps.

Conventional can also mean conformist, predictable, or unadventurous. Our approach to action research is non-traditional, adventurous, non-conformist, and possibly unpredictable. We call it *dialogic collaborative action research*, or D-CAR. Rather than focusing on a particular way to do research, as does conventional action research, we focus on what can happen when a group of science teachers get together to talk with one another about their teaching and educational situations and how to make changes and improve them. D-CAR draws on the power of conversation as research (Feldman, 1999) and the power of the crowd (Landmore, 2012) to share and construct knowledge. In addition, it is better than conventional action research at meeting the immediate needs of teachers and the rhythm of teaching.

D-CAR does the above by building on the long tradition of the accumulation and construction of knowledge by craftspeople. For thousands of years, knowledge of how rather than knowledge of what or why was accumulated by artisans who engaged in practices such as metallurgy, architecture, cooking, engineering, and medicine. Often the knowledge generated by trying things out was shared within workshops and guilds, but also shared among practitioners, which led to the knowledge of how to, for example, cast a metal lizard or set a broken bone (Grafton, 2022), being distributed and improved upon by other practitioners. The same has been true for science teachers. Knowledge of teaching science has been developed by individual teachers. Often that knowledge has stayed with the science teacher. Sometimes it is shared with other teachers in the school, with a student teacher, or more rarely in workshops, presentations, or publications. Therefore, among science teachers most of the knowledge of how to teach science remains with individual teachers or is shared locally. D-CAR encourages the sharing within a group, which leads to the trying out of this knowledge by other teachers, and the construction of new knowledge by the group. It also encourages the sharing of the knowledge

beyond the group, because as Lawrence Stenhouse (1981) argued, for an activity to be defined as research, its results must be made public.

D-CAR and Wicked Problems

Before we give an overview of how to engage in D-CAR, we want to make clear that we believe this process can assist science teachers to go beyond the technical problems of teaching to help to alleviate or mitigate the “wicked problems” of education (more information about wicked problems can be found in Chapter 4). Wicked problems are ones that are too complicated to define or describe explicitly, and do not have straightforward or clear-cut solutions (Rittel & Webber, 1973). Wicked problems permeate all aspects of science teachers’ practice. For example, issues of class, race, ethnicity, gender, and socio-economic status affect our schools, individual students, and their communities. These issues are tied together tightly and loosely, and affect how we teach and how students learn. Clearly no one science teacher can solve wicked problems like these. But when working together in groups, they can help alleviate or mitigate them locally.

The role of science teachers in helping to alleviate wicked educational problems begins with their classroom practice, shared and critiqued with other teachers, and made public. This happens in D-CAR when it is employed by science teachers to construct and share knowledge about how to teach, and is then shared more broadly through workshops, presentations, blogs, websites, articles, and even books. But as Smith (2022) noted, for other science teachers to be successful in implementing this new and shared knowledge requires time and practice doing so in their own classrooms. This is how we see the role of D-CAR in helping to alleviate educational wicked problems.

How to Engage in D-CAR in a Nutshell

In Chapters 5–8 we go into details about establishing a D-CAR group, how to engage in conversations as research, ways to address possible barriers, and making your research public. In this section of this introductory chapter we provide a brief overview of the D-CAR process.

Establishing a D-CAR Group

An important early step in the D-CAR process is to find a number of like-minded science teachers to form a collaborative group. You can do this either before or after you identify an issue, problem, dilemma, or dissonance in your practice that you want to address. If you start with the issue then you would need to find other science teachers who share that concern. Or you could begin by convening a group of teachers who have as their goal to improve their science teaching. The teachers may be from within one school, or from multiple schools. We’ve found that a good way to recruit teachers is to make presentations at workshops or local

conferences. Personal connections are particularly effective – you invite teachers you know and they invite ones they know. In the past D-CAR groups have met face-to-face. This can still be an option, but as video conferencing technology has improved, we've seen that virtual meetings can be very effective. For D-CAR groups that go beyond one school, virtual meetings eliminate travel time, and can better fit into teachers' busy schedules.

Conversations as Research

The power of D-CAR is in the use of conversations as a research method. Allan first saw this when working with the physics teachers in PTARG, and then explored it in his teaching of action research (Feldman, 1998). We go into how and why conversations can be a research methodology in Chapter 3 and provide many ways to engage in conversations in Chapter 5. When you engage in conversation as a research methodology, you need to provide a structure that transforms it from chit-chat or "shooting the breeze." This can be done with an agenda for the meeting the group agrees on; having a mechanism for keeping track of what was said, shared, and decided upon; and a set of norms to guide how the group functions.

Making Research Public

As we noted above, making your research public is a fundamental aspect of D-CAR (see Chapter 8). This happens at several levels. First, because you are not going alone with this, your research group itself serves as the first level at which you are sharing your work. You can do this by sharing short stories or anecdotes about your teaching that illuminates your concerns or provide details about ideas that you've tried out to improve your teaching or educational situation. In doing so, the other members of your group provide constructive critique, learn about what you're doing, and gain ideas about what they can do to improve their practice or educational situations. The other levels are distinguished by the audience and the formality of how you report what you've learned. In the US, secondary science teachers are usually part of a science department. If this is the case for you, then you can report what you've learned to the rest of your department, either in a formal or informal presentation. Most school districts in the US have opportunities for teachers to present or run workshops. In many areas there are local or regional science teacher associations that are prime venues to share your work. It's also possible for you and your group to present at national conferences. Finally, you can share your work via the Internet or print science teacher journals.

The Possibility of Conventional Action Research

As you'll see as you read this book, we believe that D-CAR can serve the needs of science teachers to work together to improve their practice and educational

situations, and generate new knowledge and understanding about the teaching and learning of science. However, you may find the desire or need to use the methods of conventional action research. One reason may be that you want to dig deeper into the issues and feel that gathering certain data will give you a better sense of what's happening in your classroom, school, or community. Another reason, which we discuss in Chapter 8, is that among many policy makers and administrators, teachers' knowledge does not have the same legitimacy as knowledge produced by university researchers. Engaging in conventional action research could convince them otherwise.

Overview of the Book

In this book, we move the thinking of action research beyond the conventional by shifting from the use of social sciences' demanding methods to highlighting the importance of dialogue among science teachers seeking to improve science teaching and learning. We now provide an overview of what you will find in the rest of this book.

The primary goal of Chapter 2 is to provide readers with foundational knowledge about action research and an overview of the different ways it has been conceptualized and implemented in science education. Chapter 3 presents our view of action research, D-CAR. D-CAR relies on the power of structured conversations among small groups of science teachers to go beyond the solving of day-to-day technical problems engaging with complex and unclear issues in teaching science, including wicked problems. Chapter 4 further explores how D-CAR can help you to alleviate or mitigate the wicked problems in science education you face in your educational situations.

Chapter 5 gives guidance about how to develop a D-CAR group, and how the group can initiate and sustain dialogue among its members. The purpose of Chapter 6 is to provide information and methods for when science teachers want to or are required to gather and analyze data by engaging in conventional action research. Conventional action research requires significant time commitments from science teachers as well as learning the methods of the social sciences; therefore, in this chapter, we describe the process in detail step by step.

In Chapter 7, we address some of the obstacles to integrating conventional action research including deprofessionalization of teaching, the difficulty in changing practice, and time constraints; and how we can mitigate them using D-CAR. In Chapter 8 we explore how you can make your knowledge public. Chapter 9 provides examples of science teacher action research that used conversations and dialogues as a primary research method.

Summary

Our purposes in this chapter were to introduce readers to us, the authors of this book, and to what makes our approach to action research, D-CAR,

different from other more conventional forms. We began with our stories and how we were introduced to action research and made use of it in our practice as well as with practicing science teachers. As we're sure you've seen, our stories are not much different from those of other science educators. We also sought to begin to familiarize readers with the advantages of using the D-CAR approach, especially for helping to mitigate the wicked problems faced by science teachers. Finally, we provided readers with the nutshell version of D-CAR to serve as an advance organizer (Ausubel et al., 1978) so that the ideas we present later in the book have a cognitive framework to hang on. We believe it is also important for readers to know some of the history of action research in science education. Therefore, we turn to that in the next chapter.

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