Teacher Research

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Stories of Learning and Growing

Deborah Roberts, Claire Bove,
and Emily van Zee, Editors

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Foreword

I am honored to be invited to write the foreword for this book. I always consider it a privilege to be allowed into the classrooms of teachers, and that is what this book does for its readers. Learning is a complex process, and the learning environments of homes, neighborhoods, museums, classrooms, and such add to the complexity. When teachers share the results of their inquiry into their practice, especially into their own thinking or that of their students as they do in this book, we are able to add to our own experience as learners and teachers.

What is teacher research? It usually starts with wondering about some aspect of teaching or learning that comes from the phenomena of the classroom. As the chapters in this book suggest, the catalyst for the wondering may have come from looking at student artifacts or at some sort of data that relates to student performance. Other aspects of research often included in teacher research are collecting information, designing an intervention, predicting effects or hypothesizing what and why change will happen, formulating questions amenable to research, analyzing data to obtain results and answer questions, concluding what was learned, and communicating methods, results, and conclusions. A difference that sometimes leads some people not to include teacher research as research is the level of rigor in the application of the various aspects. In the chapters that follow, you will see these aspects included at varying degrees of rigor.

Typically, teacher research also involves engineering to solve an identified problem. In my own classroom, my career as a researcher began with me wondering why my students didn't perform well on certain test items. Usually these were the items my students called "tricky." They really weren't so much tricky as they were not simply repeats of essentially the questions they had already answered during class activities. As a teacher I designed an instructional intervention that I thought would change students' understanding and then probed to see whether the intervention effected any change. Having done this teacher research, I then went on to make my research methods or approaches more specific.

Why might a teacher want to conduct research? One reason is that the teacher research may be able to answer a question of direct and immediate interest to the teacher, a question whose answer would give the teacher information about student learning or the effects of instruction. The immediate value is to the teacher. If the teacher never shares the results, the new knowledge is limited to that teacher. Another key objective for teacher research then is to share the new knowledge with others, especially other teachers. That is part of what this book does.

Teacher Research: Stories of Learning and Growing has several potential uses. It can be used by individual teachers or by teacher groups. Individual

teachers can read it to become familiar with the sorts of queries other teachers have about their practice and how they went about their inquiry. Groups of teachers collaborating within a school system attempting to reform their instruction could read chapters at regular intervals and discuss their thoughts about the chapter and the possible implications it might have for teacher research around their own inquiries into teaching and learning in their collective classrooms. Teachers of teachers might have their preservice or inservice teachers read and discuss chapters as a way of stimulating their growth as professionals who think about the improvement of the practice of teaching.

As you read each chapter in this book, note the question(s) asked by the author, the data or information sources the author goes to, and the inferences the author draws from the data. Note also what adjustments to procedures, interactions with learners, or next lessons the teacher implements. It is this last step that tells us that (and what) teacher learning has resulted from the teacher research. How you change your practice as a result of reading this book will be evidence of your learning.

Jim Minstrell
FACET Innovations
Seattle, Washington

Preface

We invite you into the classrooms of the authors to get to know their students, their practices, and their experiences. What we have discovered, as these authors and others have too, is that once one experiences "doing" teacher research, one cannot let go. One question or discovery leads to another, a colleague's observation lends a different lens to view the classroom, or a conversation with a student sheds light on a multitude of issues. What we are hoping you will gain is some insight into a variety of classrooms and situations. We hope something you read piques a deep curiosity within you, a curiosity waiting to be satisfied by the understanding only you can gain by exploring your own questions. We hope you might look at your classroom in a different way, at your teaching in a different light, and at each of your students as vessels of great understanding, waiting to be understood in a way no one else has been able to understand them before.

Each teacher is unique; every classroom is different. In this collection, there are chapters by beginning teachers and chapters by very experienced teachers. There are chapters by teachers who have just begun to do research in their classrooms in an intentional way and by those who are undertaking doctoral studies. The book offers glimpses into a variety of situations, through the perspectives of a variety of individuals, and in a variety of formats.

The practice of teaching, even for teachers who do not think of themselves as researchers, is one in which the elements of research are present. Asking questions about practice, collecting evidence, making sense of the evidence, and sharing conclusions with others: These activities are happening all over schools during every school day, and they are elements of research. The job of a teacher is to facilitate student learning, not to produce and publish formal research findings, but these elements of research are embedded within facilitating student learning—sometimes as part of normal practice, sometimes as intentional acts, and sometimes as a more formal research process.

Table 1 on p. xi presents a spectrum of research practices for the elements of questioning, collecting evidence, making sense of the evidence, and sharing findings. Writing in a lesson plan book, for example, is, in our view, an act of research because a teacher briefly documents what happened and notes ideas for making changes next time. Choosing and making copies of examples of student work is an intentional act of research in which a teacher also documents student learning. A formal documentary practice would be to create an archive of lesson plans, copies of student work, tapes of instruction, and other artifacts.

The authors of this book are sharing with you the records of their research. Each of these teachers views the practice of teaching as a research activity. Some have just begun to see their practice in this way; others have long viewed their teaching practice as an act of research. We have identified what we see as the elements of each teacher's research in a box at the end of

Table 1: Elements of research

Elements of Research Embedded in Normal Teaching Practices	Intentional Research Practices	Formal Research Practices
QUESTIONING		
Noticing and wondering in the act of teaching	Generating issues to be explored Becoming aware of relevant literature	Formulating a formal research question Developing a theoretical framework within which that question will be examined
COLLECTING EVIDENCE		
Having stacks of student work	Choosing and copying examples of student writings and drawings	Audio- and videotaping instruction
Noting what happened and ideas for changes in a lesson plan book	Keeping anecdotal records of student progress	Archiving lesson plans, student work, e-mail messages, and other artifacts
Having students assemble portfolios of their work	Writing a reflective journal	Generating data such as responses on surveys
MAKING SENSE OF THE EVIDENCE		
Thinking about what happened Talking with colleagues	Discussing copies of student work Writing descriptive accounts of what happened Making connections to others' relevant findings	Watching and discussing video clips of students in action Writing analyses of students' actions and utterances Analyzing survey responses Writing about ways that findings support or disconfirm results reported elsewhere
SHARING		
Talking with colleagues	Meeting with a teacher inquiry group Facilitating discussion of student learning during a staff meeting	Presenting at a conference Writing for publication

each chapter. In reading our interpretation of these classroom stories, you will be able to see and identify these elements in your own practice.

The demands of classroom teaching are overwhelming. Each year, in this era of high-stakes testing, standards, and accountability, those demands increase. At the end of the year, it is easy for a teacher to feel that he or she has been insanely busy, but it is sometimes difficult for that teacher to feel a sense of having accomplished anything beyond survival. You may wonder what possible reason there could be to add teacher research to the burden.

Our answer to this excellent question is that the inquiry process—the act of asking a question, of gathering evidence, analyzing the evidence, drawing conclusions, and sharing those conclusions with others—is a way for a teacher to recognize teaching as the intellectual endeavor that it is. Inquiry is an exercise in critical thinking. It is a creative act. Even with today's top-down reforms, scripted curricula, and teacher-proof lessons, inquiry can rekindle

the fire of enthusiasm that brought us to teaching and keep that fire burning as we share our enthusiasm with our students and with our colleagues.

These authors have reflected on their own science teaching and the learning of their students in ways that show their continuing efforts to push forward the reforms advocated by the *National Science Education Standards* (NRC 1996) and *Benchmarks for Science Literacy (*AAAS 1993). The *National Science Education Standards* advocates that teachers have experiences "to learn and use the skills of research to generate new knowledge about school science and the teaching and learning of science" (NRC 1996, p. 68).

Teacher educators may have expectations for teacher research that differ from some of the examples in this collection. A common approach in a master's program, for example, is to require a research course in which teachers focus on specific ways of investigating aspects of what is happening in their classrooms and schools. Reports of such research tend to be shaped by traditional formats, such as sections stating research questions, describing methods, presenting findings, and discussing what has been learned and actions taken. The perspective taken in this book represents a broader view of teacher research: What can teachers do to deepen their own understandings of their teaching practices and students' learning and to share that wisdom with other teachers? From this perspective, teacher research can be reported as a poem, story, or descriptive account of what happened as well as a formal research report.

Part One includes four examples of research in progress by teachers who wrote about aspects of integrating science and literacy learning. Part Two presents a variety of inquiries about learning and teaching in science contexts at a variety of grade levels in a variety of formats. In Part Three, the authors reflect upon the process of researching while teaching.

For us, teacher research encompasses this broad spectrum of activities and products. We invite you to join us in this enterprise!

Deborah Roberts
Claire Bove
Emily van Zee

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About the Editors

Deborah Roberts is a founding member of the Science Inquiry Group, whose commitment to teacher research inspired the establishment of Teacher Research Day at national NSTA (National Science Teachers Association) conferences. Now a fifth-grade teacher in Arizona, she also has served as a district and state instructional specialist for science in Maryland. Roberts earned her bachelor's degree in elementary education and her master's in science education from the University of Maryland.

Claire Bove has taught science at Bancroft Middle School in San Leandro, California, where she chaired the science department for many years. She also has served as a cooperating teacher for Mills College, a district mentor teacher, and Beginning Teacher Support and Assessment mentor. Currently she facilitates teacher professional development activities for Mills College. Bove is a graduate of the University of California at Berkeley with a bachelor's in molecular and cell biology and a master's and a credential in science and mathematics education.

Emily van Zee founded the Science Inquiry Group with funding from the Spencer Foundation. She organizes Teacher Researcher Day for national NSTA conferences. She has taught middle school science as well as introductory physics and undergraduate and graduate courses in science education at several universities. She is now an associate professor of science education at Oregon State University. She earned a bachelor's in physics from Radcliffe College and a master's in physics and a PhD in psychology from the University of Washington.

Part one Introduction

Integrating Science and Literacy Learning

Literacy learning includes not only learning how to read with comprehension but also learning how to write clearly, to question appropriately, to listen respectfully, and to speak effectively. This set of case studies explores integrating science and such literacy learning. These are works in progress by teachers who identified issues that interested them and collected data to inform their thinking about their students' learning. Kathleen Hogan describes how she engaged first-grade students in writing sequential directions while exploring motion. Elizabeth Kline reports on ways she engaged her fifth-grade students in integrating reading and writing in a science context. Trisha Kagey Boswell reflects upon questions her fourth-grade students asked while exploring electric circuits. In demonstrating a *science talk*, Monica Hartman tracks fifth-grade students' ideas about why they see water drops on the outside of a glass of ice.

Chapter 1

How Can Playing With a Motion Detector Help Children Learn to Write Clear Sequential Directions?

Kathleen Dillon Hogan

Kathleen Dillon Hogan is a kindergarten teacher in the Calvert County, Maryland, public schools. When this paper was written, she was a first-grade teacher at Hyattsville Elementary School in Hyattsville, Maryland. Kathleen heard a colleague describe how her first-grade students were using motion detectors and computers to learn about line graphs (see Chapter 13). She interested her school's reading specialist in trying this with her students, and together they invented a new way to teach a language arts objective, writing clear sequential directions by using these devices. She documented her students' learning by videotaping their actions and comments. She also made copies of their writings and drawings as they designed motions, predicted graphs, and tested their predictions.

An earlier version of this chaper was presented at the 2002 National Association for Research in Science Teaching annual meeting in New Orleans.

Teaching young children is a daily challenge, yet very rewarding. I always strive to find ways to keep my students motivated because I feel that motivation is the driving force that enables students to make good progress, and I want to help all of my students do so, especially those students who struggle academically. When I wrote this account, I was teaching at Hyattsville Elementary School in Prince George's County, Maryland, where my first-grade students came from many different cultures.

I know I must present material in a variety of ways to ensure that I give every learner in my care the opportunity to make progress. This has led me to become involved in a line of practice in teaching coined *teacher research* (Cochran-Smith and Lytle 1993; Mills 2000) in which I focus specifically on my students as individual learners. Along with this, I continuously analyze my practice—trying to make the learning environment optimal for everyone. Data collection enables me to delve more deeply into each child's reactions and responses as I develop or implement activities. My data sources are student work samples, audiotapes, videotapes, photographs, interviews, surveys, anecdotal notes, and journals.

Using Motion Detectors

When I first began doing teacher research, through a seminar sponsored by the University of Maryland, I met a teacher, Deborah Roberts, who was documenting how she was using motion detectors with her students (Roberts 1998 and Chapter 13). A motion detector uses infrared signals to detect where an object is. The detector sends signals to a computer, which displays a line graph representing the motion—position versus time, velocity versus time, or acceleration versus time, or all three. The following school year, I developed ways to use motion detectors with my first-grade students. I felt that this technology would be an excellent tool to help motivate all of my students.

First, I connected the motion detector to a computer, along with a graphing program developed to go with it *(http://elementary.vernier.com).* Next, I briefly discussed motion detectors in general. Then, I gave a classroom full of excited students permission to move in front of the detector any way they chose to move—with just a few safety reminders. Finally, the students were on their way to conversations about the lines that the computer displayed on the position-versus-time graph as they moved in front of the motion detector. My goals for this activity were twofold: engagement and explanation. I wanted the students' full attention, and I wanted them to talk about what they discovered. I had no intention to discuss x-axes or y-axes, or, for that matter, go into great depth about line graphs. That could come later.

Interpreting Line Graphs

At the onset of their "play," it was apparent that I had discovered something that kept the interest of the entire class. Each student was wholeheartedly engaged in what was going on. Not one student was unhappy or unwilling to participate. Having every student engaged at the same time is a teacher's dream! Initially they discussed the resemblance of their line graphs to things they knew—they noticed "mountains" and "icicles," "a cow's udder," "lots of letter *M*s," "the letter *W*," "those things in caves that hang down." One student even said that the lines "look like stocks." (When I agreed, she added that her father knew about stocks.) They couldn't get enough.

These discussions eventually began to shift. The students began making observations about what one person's line graph looked like compared to another person's graph. We began to test their thinking. How could a person moving in front of the motion detector recreate the same line graph? Could another person make a line graph just like a previous one? Was anyone willing to make a prediction about what a line would look like if someone moved a certain way? These new conversations were actually interpretations of the position-versus-

time line graphs. They had to think about their movement in relation to what the lines looked like (Hogan 1999, 2001). They were learning how to interpret line graphs by participating in this activity, as has been reported for other students in other research (Mokros and Tinker 1987).

They began to notice that, when someone moved away from the motion detector, the line "went up." When someone moved toward the motion detector, the line "went down." When someone stood still, the line "went straight." They were working together to gain understanding about these things, and I was impressed. I allowed the conversations to continue as I gave them more opportunities to participate. Students moved to specific directions, first making some predictions as to what the line graph would look like when they were finished.

Integrating Writing

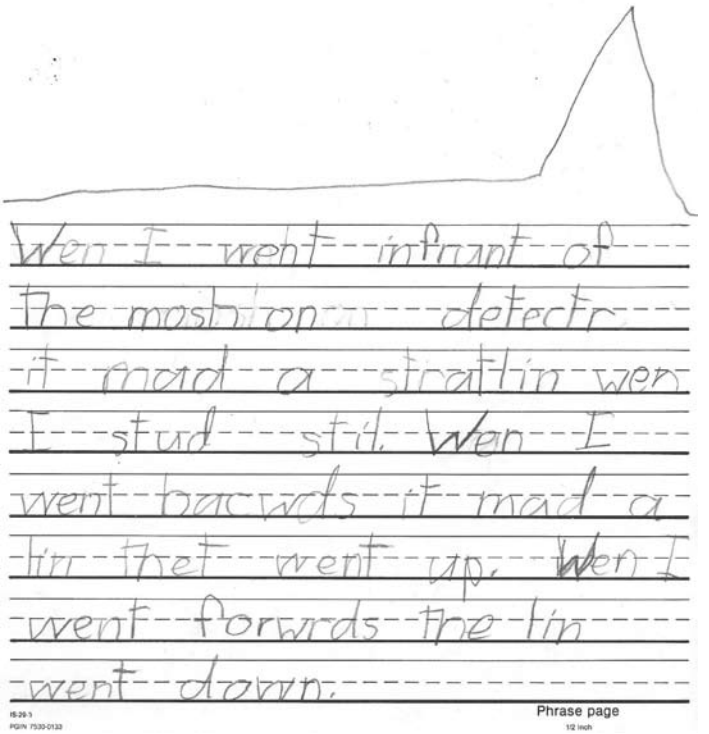
I always try to integrate writing into every subject so I created a written task for this activity. The students were given a paper on which they could draw and write about their experience with the motion detector. I had them write down their predictions, observations, and thoughts as we worked together. I knew that the students had some new understandings of the relationship between the line graph and their own movements, and they demonstrated this as they wrote about their thinking. One student wrote (spelling corrected) "When I went in front of the motion detector, it made a straight line when I stood still. When I went backwards, it made a line that went up. When I went forward, the line went down." (See Figure 1.)

Students who were unable to write complete sentences and often agonized over any writing assignment clearly demonstrated, in writing, without any complaints, that they understood the connection between their movement and the line. One student wrote, "stood still, straight." The written part of this activity not only documented the students' thinking about the relationship between their movements and the line graph, but it helped me stay focused on my goals for the lesson. It also reinforced my thoughts about first graders and writing: Given the right topic all students can enjoy writing and view themselves as writers.

Learning to Write Clear Sequential Directions

With this in mind, I extended this activity by collaborating with a colleague, Pamela Barton, the reading specialist at Hyattsville Elementary School. We wanted to know if using a motion detector would help students learn to write clear sequential directions, a first-grade language arts learning outcome.

Figure 1: Student observation of motion detector

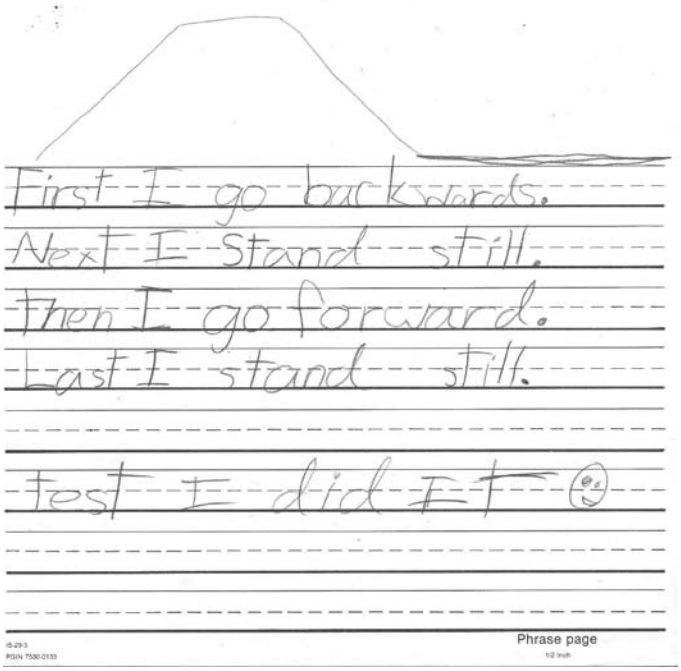


First we led an oral exercise. The students practiced giving directions to each other about how to get from one place in the classroom to another place. They could clearly see that they were missing important information about how to do this. Merely saying, "Go over there and turn right" wasn't enough. They needed more specific words.

Next, we had them write directions down, telling someone how to get from one room in the building to another room. They were reminded about trying to add enough information so that the person could easily get from the starting point to the final destination. They were able to test their directions by walking through them, either while writing them or when they were finished. Still, they saw that there was something missing.

From here Pam and I linked the process of writing clear sequential directions back to the motion detector. We gave the students the necessary sequential words (*first, next, then, last*) and guided them as they wrote sequential directions about their movement in front of the motion detector. A student wrote, "First I go backwards. Next I stand still. Then I go forward. Last I stand still." (See Figure 2.)

Figure 2: Student observation of motion detector



They tested what they had written and were able to see that these words helped them give clear-cut directions.

After this, we had them write directions again, telling someone how to get from one room in the building to another room, using these same sequential words. As with previous activities, all students attempted to write clear directions. Nobody gave up. Some students paired together for support, while others eagerly set out alone to master the task at hand. A student wrote: "First go out the door and go left. Next go past the lunchroom. Then go through the stairs. Then go down the hall. Then go to the first class on the left and stop. Last, look around, you are there, go in." Every student was interested in completing the assignment and able to write better directions than on his or her first attempt. Those children who had trouble actually writing down their words because of their poor writing abilities also were able to give better directions than they had on their first attempts.

Table 1: Standards demonstrated by motion studies

The following National Mathematics Content Standards were demonstrated:
- Attention to data analysis, statistics, and probability.
- Use communication to foster understanding of mathematics.

The following Maryland State Performance Standard for mathematics was demonstrated:
- Interpret, compare and make predictions based on tables and graphs.

The following National English/Language Arts Content Standard was demonstrated:
- Generate written communication and use various stages of the writing process.

The following Maryland State Performance Standards for English/Language Arts was demonstrated:
- Writing: students produce informational writing that demonstrates an awareness of audience, purpose, and form using stages of the writing process as needed.

The following National Science Education Teaching Standards were met. They complement the National Science Education Content Standards for Science as Inquiry:
- Standard A: Teachers of science plan inquiry-based science activities.
- Standard B: Teachers of science guide and facilitate learning science.
- Standard C: Teachers of science engage in ongoing assessment of their teaching and of student learning.
- Standard D: Teachers of science design and manage learning environments that provide students with the time, space, and resources needed for learning science.
- Standard E: Teachers of science develop a community of science learners that reflect the intellectual rigor of scientific inquiry and the attitudes and social values conducive to science learning.
- Standard F: Teachers of science actively participate in the ongoing planning and development of the school science program.

The following Maryland State Performance Standards for Science were met:
- Employ the language, instruments, methods, and materials of science for collecting, organizing, interpreting, and communicating information.
- Demonstrate ways of thinking and acting inherent in the practice of science.

Enacting Standards

When educators consciously work hard for the benefit of all of their students, it is easy to see that national as well as local standards can be met. For these activities, English/language arts, mathematics, and science were integrated (see Table 1). Standards help educators question, think about, and act upon their thoughts about their students' learning.

Indeed, my students were willing to work hard on these assignments. I feel that I would not have had the attention of all of my students if it had not been for the use of the motion detector as a tool for teaching this type of writing

activity. Although I might have been able to get the same concept across to many students without this piece of technology, I know that, *because* I used this piece of technology, I was able to get also the full attention of those students who would normally grimace at the mere thought that they had to do some writing. This alone is the reason I strongly advocate that all educators find ways to reach all of their students. With perseverance, it is possible to find ways to help every student make progress. When my students have a feeling of accomplishment, it makes all of the hard work worthwhile.

Recently, at a teacher researcher conference, someone said to me adamantly, "But we don't need these [motion detectors] to help students learn about graphs or to learn to write clear directions." My response to this person was, "No, we don't, but I do." My students needed it too. And that is what we should do as educators—find ways to help our students. Likewise, if we share our experiences, we can help motivate each other to continue finding ways to present material to our students, ensuring every student is given the opportunity to be successful.

Reflections

One element of teacher research is gathering evidence. Kathleen collected student work and then copied it for use in this research project. She paid attention to what her students were saying, and she recorded what they said on audiotape and videotape. She thought about what was happening in her classroom and kept a journal of her thoughts. Each of these evidence-gathering practices is an example of how the process of doing teacher research takes a part of daily teaching practice and develops it in such a way that it can be captured, shared, and revisited after time has passed. Kathleen deepened her teaching practice by her conscious methods of gathering classroom evidence.

As a classroom teacher, Kathleen couldn't focus on just one aspect of her teaching and neglect the others. She was thinking about student engagement, about collaborating with her reading specialist, about teaching graphing and literacy simultaneously, and about the national and state standards she was required to address. She integrated her evidence-gathering practices into all these areas of her teaching practice.

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