Whole-Class Inquiry

Creating Student-Centered Science Communities

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EDUCATION

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Foreword

This book is all about teenagers involved in inquiry in a chemistry classroom. For us teachers and for board members, teacher educators, and researchers, this resource brings a powerful imagining to life. One simply has to watch one of the DVDs and listen as Craig, Frank, Maria, Nick, and Mark try out their can-crush experiment to know and understand what inquiry can be in a classroom. There is no doubt that this is truly their experiment; they have creative and conceptual control of it. These teens own what they are doing, why they are doing it, and what they expect to find. Beginning with some as-yet fuzzy notion of why they will be able to see some different results, they develop their ideas in a process toward a deeper understanding. They mount the argument as an explanation, connecting cause to evidence and in so doing exhibit trust in their knowledge. They amend process as they see the tests unfold; error means something real and tangible to them; and their interest is vested in these tests. Their full physical, conceptual, and emotional engagement is undeniable. They are doing science, and they are into it.

I do not know of any science classroom enterprise like this one, engaged in whole-class inquiry across the year. Inquiry is a term very much in vogue in science education circles, especially since the National Science Education Standards (NSES) placed it centrally. As usually happens with an in-vogue term, however, there are now a large number of descriptions, definitions, and interpretations for it. Inquiry has become a buzz word; a meme with myriad, conflicting understandings. The word gets mixed up with discovery, another word problematic in its usage. I have often heard teachers express misunderstandings, such as "I'm confused because I don't know what I am supposed to do when the students are confused. I know I am not supposed to tell them anything in an inquiry/discovery lesson." But the authors are not confused; they offer a clear, practical, sound, and innovative approach to the fundamental idea of inquiry in science classes.

For me, the foundation of inquiry in schools is that students engage in scientific knowledge making. Knowledge making involves students in creating increasingly secure arguments from evidence, arguments that result in deep understanding. The students own these arguments and have a strong stake in producing arguments that make sense. The teens in the classrooms depicted in this book construct chemical knowledge about, for example, particle behavior and interactions. It is scientific knowledge. They are not doing "product testing" on which coffee cup keeps coffee hot longer or which diaper holds the most water. This product-testing kind of activity often passes for inquiry in science classrooms. These students are building chemical understandings as they do inquiry. That's the point of it. The work of inquiry is integral to the year-long chemistry course; it is not an add-on nor is it a minor topic to be addressed in a few days at the beginning of the course.

The authors push this concept of inquiry to include another dimension, to "whole-class" inquiry. The whole-class piece of the practice for the authors is as important as the inquiry. This is an interesting addition and new direction from several perspectives. We now understand that science itself proceeds via the human connections among and within the scientific community, so this classroom example of whole-class inquiry has students mirroring that aspect of real science.

The sense of community the students get from working together as a class extends connections in another way. The frame of these whole-class inquiry projects connects the teens and their work to a business and a firm. We need young people who are ready for the world of work, and these projects push an explicit connection from chemistry class to possible avenues to work and employment in a useful way.

As well as building secure and accurate chemical knowledge, these young folks gain confidence and competence in their chemistry classroom. As we watch them on the DVDs, we see young people who trust others, themselves, and themselves working with others in the classic science lab setting. One reason for the call for a foundation of inquiry in science classrooms is the need to develop young people adept at working in groups, at solving problems together, and at developing their own knowledge and strengths along with those of others. The projects in this book embrace many roles and interests, from the chemistry and the product to marketing and finance. It seems as though there is a place for everyone's gifts and interests. In the end, knowledge making—i.e., inquiry—is synergistic.

As we read about the perspectives of the teacher for every video scene, we understand all of the ways in which she holds the edges of safety, deadlines, and student freedom. As we watch a teacher who pays very little overt attention, we find that her attention is focused relentlessly; she just works hard at seeming invisible. One large and persistent misunderstanding about inquiry is that the teacher is not allowed to be "present." Joan shows how critical it is to be truly present, and when and how. We understand how her understanding of adolescents, chemistry, curriculum, sequence, pacing, implementation, assessment, and self-awareness promotes this work. Joan makes her thinking wonderfully transparent. We get the force of her decision to play her roles fully in this whole-class inquiry work and see how playing those roles to the hilt allows her to be present but absent at the same time.

I love Joan's musing with respect to Craig and company: "They really care about the outcome of their work …." Because we can see in the videos exactly what Joan is talking about, we are persuaded by the classroom evidence, just as she is. We see work across the year, warts and all. The frank and self-aware openness of this teacher-author is helpful, accessible, and useful. Her writing predicts readers' questions, and she adds details from the most practical of standpoints. It is as though we have been invited into her classroom for the full range of class sessions that the whole-class inquiry projects and assessments cover. There is no hint that the authors think this is a perfect kind of chemistry class or that a perfect chemistry class is even the goal. The point is for a group of young folks to progress, to get better at doing something important in chemistry class, and to make themselves effective and independent learners.

Some readers may not be persuaded that this approach can inform their own teaching. One issue may be a lack of well-stocked, well-designed lab classrooms such as those seen in the DVDs. Many teachers and students don't have such resources, and to pretend that lack of resources doesn't affect teaching and learning is ludicrous. But there are processes in this book that can be modified for and adapted to poorly resourced classrooms without losing the essential core of whole-class inquiry. Some readers might feel that the ethnic and socioeconomic homogeneity of the student groups in the videos reduces the potential for successfully transferring the whole-class inquiry process to their own classes. I would argue, to the contrary, that the empowerment that whole-class inquiry offers to and inculcates in students might be especially applicable to any students who are under-resourced. Those who know adolescents strongly advocate that teens be offered choices in their course work to allow them a sense of ownership over their studies. A short time spent with the students in the classrooms portrayed in this book provides incontrovertible evidence that these teens own their projects and their understandings.

Other readers may feel that their English language learners would be disadvantaged in this setting. Many, however, are persuaded that if students are to construct meaning, real understanding, there must be interstudent conversations about the real-world phenomenon at hand. In fact, whole-class inquiry is a particularly important strategy to use with English language learners, and whole-class inquiry should serve them well.

Perhaps the biggest worry science teachers might have is that they have enough time for their students to take on such lengthy projects in science. A common view holds that the standardized tests our students must take determine that teachers have to cover an enormous amount of material. The results of not doing so are thought to be that students will not perform well and that teachers and schools will suffer consequences. The authors, however, have made this more than a story of an unusual chemistry classroom by asking what the costs and benefits for their students were when a teacher took the time for whole-class inquiry. They asked the hard question about how well their students did on standardized tests compared to other students. Most research on inquiry has focused on outcomes of attitude, interest, and motivation. It is as though everyone expects a certain outcome: If we work on promoting better attitudes and more enjoyment in science, then we have to give up real content achievement in high school science. But the authors found that Joan's chemistry students had improved attitudes and enjoyed science more because of whole-class inquiry. They also had an unwavering focus on the question of how well the students built chemistry understandings. They found evidence that these students' standardized test scores, or achievement, did not suffer; their scores were comparable to those of other students. Further, we see that these teens gained much as learners. This is a solid foundation on which to build impressive edifices. We do not have to succumb to the trap that our chemistry students can either enjoy science or score high on the tests, but not both.

Science classroom teaching is a challenge for all teachers. It can be hard to hold on to one's imagination of what could be in the face of what is. The challenge of thinking about teaching science differently and moving toward inquiry is especially difficult for beginning teachers whose visions reflect their own lack of experiences with inquiry as students.

I am looking forward to using this book with my own teacher candidates. This well-told story of a chemistry class, a class that worked for its students, is pure inspiration for all of us who care about science teachers and science teaching. Not just because we should immediately try whole-class inquiry—although many might do exactly that—but because whole-class inquiry stimulates our imagination of the magic that can happen in our own science classrooms, and to and for our own science students.

Jean Lythcott
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Chapter 1
Introduction

Imagine a high school science classroom in which two student managers orchestrate activities at the front of the room, sixteen students purposefully gather data in the laboratory for experiments they have designed, three students prepare computer graphs for a class presentation, two students debate what homework should be assigned to the class, three students record information in journals, and one teacher quietly types on a laptop at the back of the room as she observes and assesses. Her recorded observations will be used as a tool for prompting discussion with students about their experiences with this project and will also provide them with feedback to be used as a guide for future similar projects.

The above vignette portrays what occurs in our classrooms when we give our students the periodic opportunity to work together as a whole class and solve a problem that we have posed. It also illustrates the level of collaborative independence our students are able to achieve and exhibit in a multiday problem-based project that occurs about one-third of the way into a school year. In a recent book (Gallagher-Bolos and Smithenry 2004) intended for teachers who were interested in science education reform, we provided an anecdotal account of our whole-class inquiry (WCI) teaching strategies that have enabled us to transform our classrooms into student-led scientific communities such as the one portrayed above. A National Science Teachers Association review (Baca 2004) of this book said it was "the first…for high school chemistry teachers that aligns with the idea of inquiry as defined by the National Science Education Standards" (NRC 1996). This endorsement has been backed up by the hundreds of science teachers who have responded to our book and other related publications (Bolos and Smithenry 1996; Smithenry and Bolos 1997) with repeated requests for more systematic details on how we implement the WCI curriculum.

The student-led scientific communities we have created represent a transformation of the typical science classroom (Smith 2002) and align with the vision of science education reformers (AAAS 1993; NRC 1996, 2000; NSTA 1992) who have been urging educators "to provide students with inquiry experiences that allow students to participate in a community of scientific practice" (Anderson and Helms 2001). According to the National Research Council, inquiry in the classroom should be concerned with both the product (scientific ideas) and the process (how scientists study) of science (NRC 2000). To help students focus on the process side of science, we allow our students to periodically inquire together as a whole class (thus the term *whole-class inquiry*) on its own through multiday WCI projects. Much like real scientists, our students must consult with one another, make decisions for themselves, and carry out their own investigations as they seek to solve the challenging scientific problems we pose for them in our projects. Although the core of our innovative curriculum arises from these projects, students still experience a wide range of teaching strategies, such as lecture, collaborative group work, journaling, demonstrations, labs, and tests.

THE NEED FOR VIDEO CASES

Teachers who read our first book were inspired by these stories and wanted to apply these ideas in their classrooms, but we found they needed more information. Through a host of experiences, we realized that the information they needed could not adequately be provided through dialogue or more writings. We realized these avenues were limiting and that teachers wanted a literal look into our classrooms. An infinite number of subtle combinations of details go into making the mental shift necessary to implement WCI. And defining and accepting new teacher and student roles is difficult to convey through the written word; it implies that there is a formula or correct way to go about it. As evidence that more information is needed, teachers who are familiar with our publications on the WCI curriculum still ask us questions like the following:

- What do you do if a student in a class does not contribute?
- How do you give feedback to each class, even those that fail?
- How do you assess community work?
- How do the students decide who does what?
- What do you (the teacher) do while the students are working on the project on their own?
- How can you do these lengthy projects without sacrificing content?
- How do you know that the students are learning the chemistry concepts?

These questions indicated to us that our audience would benefit from observing our classrooms in action. They also suggested that teachers wanted to see some of the fine-grained details that occur as WCI projects are enacted rather than only to read retrospective descriptions of past events. At science education conferences, teachers have asked us if they could view video footage recorded in our classrooms, implying that this video would help them imagine themselves and their students in the new roles that must be assumed in the WCI classroom. In effect, these teachers were asking for video cases that document the particulars of teaching and learning in the WCI classroom. They were also asking for images of what is possible in the high school science classroom (L. S. Shulman 1992). Like other teachers and researchers (Ball and Cohen 1999; Lampert 2001; Putnam and Borko 2000; J. H. Shulman 1992b), they believe these video cases hold the potential for them to experience vicariously, explore, and learn about the complexities involved in enacting the WCI curriculum.

During the 2005–2006 school year, with generous funding from the Spencer Foundation, we embarked upon a research study to catch the WCI curriculum in action and develop several sets of video cases. The study focused mainly on documenting and analyzing the events that occurred as Joan Gallagher-Bolos implemented several WCI projects over the course of the school year in one of her chemistry classes. With data collected through structured field notes, classroom videotapes, teacher interviews, student interviews, and a teacher journal, Dennis Smithenry's research was guided by the following questions:

- How does an expert teacher introduce, implement, and assess a WCI project?
- What path of inquiry does the class take and how is the work distributed among individual students during a project?
- How do students respond to and utilize the teacher's feedback after each project?
- How does the WCI curriculum, when compared to a more conventional chemistry curriculum, affect learning outcomes?

The main product of the study has been the four sets of video cases that illustrate the events that occurred in Joan's classroom as her students experienced the WCI curriculum. We expect these video cases will be useful to both inservice and preservice teachers as they build a clearer image of what the WCI curriculum looks like and come to a better understanding of how to apply it in their classrooms. As mentioned, these videos also provide a clearer response to the questions formulated by teachers who want to implement our innovative WCI methodology and demonstrate the benefit of making these changes. In separate chapters dedicated to each video case, prompts for viewing video segments are interspersed with text that introduces the case or analyzes it from both the teacher's (Joan) and the researcher's (Dennis) perspectives.