Self-Study of Teaching and Teacher Education Practices 12

Shawn M. Bullock
Tom Russell *Editors*

Self-Studies of Science Teacher Education Practices

Springer

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Volume 12

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ISSN 1875-3620
ISBN 978-94-007-3903-1 ISBN 978-94-007-3904-8 (eBook)
DOI 10.1007/978-94-007-3904-8
Springer Dordrecht Heidelberg New York London

Library of Congress Control Number: 2012935584

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

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Garry Hoban is an associate professor of education at the University of Wollongong, Australia. He spent the first 14 years of his professional life as a secondary science teacher, department head, and K-12 science consultant in schools before moving into universities as a teacher educator. His research interests focus on teachers' long-term professional learning and the use of animation for teaching educational concepts supported by ICT.

Stephen Keast is a science teacher educator working in the Faculty of Education at Monash University, Australia. His research interests include self-study, teachers researching their own practice, articulating teacher educators' pedagogical knowledge, quality science teaching, understanding teachers' views of scientific literacy, and values in science. As a science teacher educator, he focuses on researching his own practice in ways that inform his practice for the benefit of his preservice teachers. He is also interested in the professional learning of science teachers and works in professional development programs to improve science teaching in Australia using the knowledge gained from his research interests.

John Loughran is dean of education at Monash University, Australia. Well-known for his many contributions to science education and the self-study of teacher education practices, he is the editor of this series of Springer publications in self-study. His most recent book is *What Expert Teachers Do: Teachers' Professional Knowledge of Classroom Practice,* published by Routledge. He was a founding editor of the journal *Studying Teacher Education: A Journal of Self-Study of Teacher Education Practices.*

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Chapter 1
Exploring the Intersections of Self-Study, Science Teaching, and Science Teacher Education

Shawn Michael Bullock

The challenges associated with teaching science and teaching about teaching science might initially seem linked to problems of creating technical knowledge. After all, science is often associated with concepts such as truth, rigour, and objective knowledge. Self-study of teacher education practices, by contrast, might initially bring to mind the epistemological challenges of knowledge that is constructed from personal experience. Of what relevance, then, is self-study methodology to issues of science teaching and science teacher education? Part of the answer, of course, lies in the fact that the disciplines of science are about far more than knowledge production. The discipline of teaching, similarly, is about far more than applying particular strategies to everyday classroom situations. Science teaching and science teacher education are complex endeavours that demand far more than the assumptions underpinning what Schön called technical rationality (1983, p. 21). Self-study methodology offers one way to move beyond technical rationality toward a more productive understanding of professional knowledge, one that is inextricably grounded in socially constructed understandings. Historically, the disciplines of science have also made use of socially mediated ways of knowing. In this introductory chapter, I develop a perspective from the history of science that helps to understand how self-study methodology relates to science education.

In science classrooms all over the world, students are asked to learn Boyle's law, which states that for a fixed amount of an ideal gas at constant temperature, the pressure and volume of a gas are inversely proportional. Many a chemistry student has dutifully memorized the formulae associated with Boyle's law and done countless mathematical questions ostensibly designed to demonstrate their understanding. Soon enough, perhaps even during the same lesson, students leave behind Boyle's

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S.M. Bullock and T. Russell (eds.), *Self-Studies of Science Teacher Education Practices*, Self-Study of Teaching and Teacher Education Practices 12,
DOI 10.1007/978-94-007-3904-8_1, © Springer Science+Business Media Dordrecht 2012

law in favour of Charles' law (which describes the relationship between the volume of a gas and its temperature), the law of pressure-temperature, and Avogadro's law (which states that the number of molecules is the same in equal volumes of gases at the same temperature and pressure). In many classrooms, the point of introducing Boyle's law is to get to the ideal gas law equation.

Unfortunately, focusing solely on the mathematical formulation of Boyle's law as a means to examine the ideal gas law robs us of the opportunity to consider Boyle's insight. In the mid-seventeenth century, a revolution was underway in the United Kingdom. The newly formed Royal Society consisted of a group of scientists devoted to pursuing scientific knowledge through experiments. Although it might now seem self-evident that experimentation plays a large part in the construction of scientific knowledge, most of the natural philosophers of the day came from a Scholastic tradition that favoured natural observations over the idea of setting up an experiment, which by definition is contrived and thus unnatural. Shapin and Schaffer (1985) outlined the tensions between the new approaches to experimentation in science and the old approaches to natural philosophy by considering social dimensions of constructing scientific knowledge in the seventeenth century through two protagonists, Thomas Hobbes and Robert Boyle.

Perhaps better known today for his political philosophy in *Leviathan* than for his interest in physics and chemistry, Thomas Hobbes was one of the chief proponents of creating scientific knowledge through logic and natural philosophy as opposed to experimentation. One of Robert Boyle's early experimental projects involved the construction of an air pump—a device with which he could pump air out of a glass chamber in hopes of demonstrating the existence of a vacuum. The idea of a vacuum was horrifying to many Scholastic natural philosophers, including Thomas Hobbes, who went so far as to characterize Boyle's project with the air pump, as well as the process of experimentation that Boyle advocated at the Royal Society, as incorrect, irresponsible, and dangerous (Shapin & Schaffer, 1985).

Shapin and Schaffer (1985, p. 25) argued that Boyle employed three distinct technologies with his new approach to experimentation in science:

1. Material technology: "Embedded in the construction and operation of the air pump."
2. Literary technology: "By means of which the phenomena produced by the pump were made known to those who were not direct witnesses."
3. Social technology: "Incorporated the conventions experimental philosophers should use in dealing with each other and considering knowledge claims."

Hobbes was particularly put off by the idea that experimentation should be subject to social processes. Boyle, on the other hand, understood that knowledge production was possible not only through considering the physical, material technologies of experiment, but also through the ways in which experimental results were reported on (literary technologies) and the ways in which experimentalists engaged in discourse about their work with one another and with the general public (social technologies) (Shapin & Schaffer, 1985).

Of course, scientific experiments had been conduced countless times before Robert Boyle began working on his air pump. Medieval alchemists, for example, were frequent experimenters in their search for the transmutation of metals (Newman, 2006). Boyle's insight, however, was to recognize the importance of literary and social technologies to his work as an experimentalist. Boyle felt that it was important to debate and critique his work in public (Shapin & Schaffer, 1985).

Boyle's method of scientific experimentation clearly triumphed over the Scholastic philosophical traditions espoused by Hobbes and many of his contemporaries, yet both the natural and social scientific communities continue to debate what counts as evidence in experimentation and the validity of making knowledge claims from particular sources of data. In the 20 years since the original AERA symposium that was the catalyst for the self-study research movement (Loughran, 2004), the self-study of teacher education practices (S-STEP) research community has grown in both the scope of interests of its members and its impact on the educational research community as a whole. After the founding of the S-STEP Special Interest Group (SIG) of the American Educational Research Association (AERA) in the early 1990s, one of the early signals that S-STEP had arrived as a research methodology occurred when Zeichner used his 1998 Division K Vice-Presidential address to highlight "the new scholarship in teacher education" (Zeichner, 1999, p. 4). Beginning with the premise that "the new scholarship in teacher education is a much richer and more varied body of inquiry than that which existed 20 years ago" (p. 8), Zeichner went on to highlight five major categories of research in teacher education that had emerged since the late 1970s: survey research, case studies of teacher education programs, conceptual and historical research, studies of learning to teach, and examinations of the nature and impact of teacher education. Zeichner correctly pointed out the importance of teacher educators studying their own practices in much the same way that teacher educators expect their students to analyse their experiences in field placements. In particular, he noted:

> The disciplined and systematic inquiry into one's own teaching practice provides a model for prospective teachers and for teachers of the kind of inquiry that more and more teacher educators are hoping their students employ. These studies represent a whole new genre of work by practitioners that we will be hearing a lot more about in the years to come. (p. 11)

Zeichner was correct; the early part of the twenty-first century has indeed seen a proliferation of self-study research presented in a variety of top-tier journals, the publication of a two-volume international handbook (Loughran, Hamilton, LaBoskey, & Russell, 2004), and the founding of an academic journal, *Studying Teacher Education*, in 2005.

There has not, however, been a concurrent increase in the use of self-study methodology for articles published in science education journals such as the *Journal of Research in Science Teaching* and *Science Education*. At first consideration, the disconnect between the rise of self-study methodology and its concurrent use in the broader science education literature seems strange, particularly given that many members of the S-STEP SIG and research community began their careers as science teachers (including many of the authors in this book). Perhaps many self-study researchers with an orientation toward science education prefer to focus on broader issues in pre-service teacher education than on particular approaches to working with future science teachers. In my own work, for example, I use self-study methodology as a "basis-for-knowing" (Bullock, 2009, p. 269) about how particularly pedagogical approaches have caused me to think about my practice in different ways. A recent study of how I attempted to incorporate digital technologies into my pedagogy of teacher education focused on big picture issues in teacher education, such as how Web 2.0 tools might be used productively to foster relationships with teacher candidates that enable critical analysis of practice (Bullock, 2011). The fact that participants in the research were pre-service science teachers was almost inconsequential.

The recent *World of Science Education* series (Roth & Tobin, 2009) also sheds light on the role of self-study methodology within the broad science education research community. In the first volume of their series (*Handbook of Research in North America*), Roth and Tobin gather a community of well-known science education scholars to discuss issues such as science literacy, equity in science education, and technology to support science education. No mention is made of self-study methodology in the chapter devoted to qualitative research methods. The chapter entitled *Exploring Science Teacher Education: Research in the Community* (Luft, 2009) begins with this statement:

> Educational researchers now more readily recognize the complex process of teacher education, in which the teacher is part of a dynamic system. This has resulted in science teacher education research that focuses on the teacher as learner in the classroom, professional learning communities that are composed of teachers, the interactions of teachers and students in the learning process, and the cognitive side of teaching. (pp. 547–548)

Although Luft (2009) acknowledges that science teachers "have important experiences and understandings to share with the research community," she goes on to admonish the research community for being "negligent in giving teachers the voice they deserve in the research process" (p. 563). Yet one might level the same criticism at her chapter devoted to science teacher education. Given her thesis that teachers construct professional knowledge that is worthy of analysis, interpretation, and dissemination, it follows that teacher educators—those who teach future science teachers—should also have a voice in research on science teacher education. Throughout her chapter and the rest of the book, however, science teacher educators are framed as those who are doing research on the practice of *other* science teachers, both pre-service and in-service. No attention is paid to the ways in which science teacher educators teach their own pre-service students.

If we return to the three technologies (physical, literary, and social) used by Robert Boyle to usher in his experimental approach to science, we begin to see some of the problems associated with excluding, by accident or design, the voices of science teacher educators as *practitioners* of science teacher education pedagogy. Boyle's physical apparatus—the air pump—has as a modern analogue the physical data collected via quantitative and qualitative research traditions. The literary technologies are alive and well in the academy in the form of scientific journals, books, conference papers, and technical reports. It is the social technology, however, that is of particular relevance to this discussion.

Academic discourse clearly has a set of social norms and patterns that encourage the analysis of research findings and construction of scientific knowledge. Until the self-study of teacher education practices movement, however, the voices of teacher educators, those who teach future teachers, were largely silent on important issues such as the way they enacted particular pedagogical approaches, the tensions they felt as they attempted to live particular values in practice, and the development of professional knowledge of teacher educators. From its beginnings as a Special Interest Group at AERA, S-STEP researchers have sought to use a variety of social technologies to make their practice and research findings available for public consideration and scrutiny. One of the most important social technologies is the biennial "Castle Conference," first held in 1996 at the International Study Centre of Queen's University, Canada, at Herstmonceux Castle, UK. The relatively small number of conference participants (100) combined with on-site accommodation creates a unique environment in which conversations about research findings and shared interests can continue after a presentation and into a meal or a late night at the castle pub. The SIG also prides itself on organizing atypical paper presentations at AERA. A key feature of these sessions is a reduced amount of time for traditional presentations projected on a screen and an increased amount of time for small-group discussions between presenters and participants. The focus on making research available for discussion is a critical feature of self-study methodology, as self-study requires the researcher to "formalize our work and make it available to our professional community for deliberation, further testing, and judgment" (LaBoskey, 2004, p. 860).

The unique social technologies of the S-STEP SIG are also manifest in discussions around validity, quality, and rigour in self-study research. Bullough and Pinnegar (2001, p. 14) asserted that "to study practice is simultaneously to study self: a study of self-in-relation to other." The authors also provided guidelines for quality in self-study (pp. 16–20) that are frequently cited by other researchers; some of the most relevant to our discussion include "autobiographical self-studies should ring true and enable connection" (p. 16) and "biographical and autobiographical self-studies in teacher education are about the problems and issues that make someone an educator" (p. 17). More recently, Pinnegar and Hamilton (2009) made a case that the traditional notions of validity and quality that arise during traditional research are grounded in old traditions of epistemology and claims about knowing. Specifically, the authors report: "Most recently we have realized that fundamentally establishing self-study as a methodology centres on a look toward ontology. The basic question is actually more about what is than about claims to know" (p. 2).

> An ontological stance when developing a study better situates researchers in self-study methodology. Here we stipulate ontology to mean a focus on what is real, constructed from our place within that experience with a commitment to shaping what is real to conform more closely with what we value. (p. 5)

Self-study methodology has much to offer science education research, particularly when one considers the powerful impact that the social technologies of the methodology can have on making the tacit knowledge of science educators and science teacher educators explicit. As LaBoskey (2004, p. 859) noted, the overall goal of self-study is self-improvement; it "looks for and requires evidence of the reframed thinking and transformed practice of the researcher."

The self-studies presented in the following chapters provide considerable evidence of the power and potential of self-study research methodology to engage with science education research. Each chapter presents an author, or group of authors, engaged in research that uses self-study methodology to inform their practice as science teacher educators and their research in science education. Before we became academics and teacher educators, each of us spent time in a profession that required specific conceptual understanding of scientific concepts. We were classroom science teachers, physical education teachers, and research scientists before becoming teacher educators. It would be foolish to ignore the fact that we each have a home discipline—the sciences—that forms a part of our identities and research agendas. We have each found self-study of teacher education practices methodology to be important for helping us to understand our work with pre-service teachers and with other teacher educators and academics. In particular, we are interested in exploring intersections between self-study literature, our own practices, and science education literature. There are several themes that might be drawn from the chapters in this book. In the final chapter, Tom Russell provides a discussion of the big ideas presented in this collection, but for now, it is useful to frame the book around three broad themes: becoming a science teacher educator, self-study and pedagogical content knowledge, and self-study as professional learning for science teacher educators.

There is considerable literature exploring the idea of becoming a teacher educator, with a particular focus on the tensions manifest in reconciling prior identities (as teachers, researchers, and graduate students) with developing identities as teacher educators. The concept of becoming a teacher educator is at the forefront of the ideas presented by Fletcher, Garbett, and Santau. Brown and Russell provide a unique glimpse into the challenges faced by a new science teacher who is trying to live his values in his teaching and by an experienced teacher educator who is trying to support a former student. Self-study methodology provided these five authors with the opportunity to understand teaching and learning in new ways. Fletcher, for example, came to understand why many elementary school teachers adopt a "custodial approach to teaching with aims to preserve its traditions and customs" as a result of teaching non-specialist teacher candidates a physical education methods course. Santau found that self-study provided her "with opportunities to bridge what her doctoral program could not prepare [her] for"—the complexities of teaching future science teachers. Garbett expressed a newfound appreciation for "no longer knowing exactly where the sessions are leading or what exactly [her] students are learning about teaching during [her] courses." Brown and Russell comment on the challenges inherent in creating learning environments that are different from the normal patterns of school: "Giving up control is far from simple; unless we teach very young children, expectations for the teaching-learning relationship have been shaped and constrained by many previous teachers. For the new teacher in particular, the process of constructing a new set of reflexes is both intellectually and emotionally demanding."

The construct of pedagogical content knowledge (PCK) has had a significant impact on research programs concerned with teachers' professional knowledge.

For Shulman, PCK "goes beyond knowledge of subject matter per se to the dimension of subject matter knowledge *for teaching*.... Pedagogical content knowledge also includes an understanding of what makes the learning of specific topics easy or difficult" (1987, p. 9). Berry, Loughran, and van Driel's (2008) review of science education research revealed that, despite intense effort from researchers around the globe, there has been little consensus around how to conduct research into and provide evidence of teachers' pedagogical content knowledge. Nilsson and Loughran's chapter takes on that challenge by providing insight into how (science) student teachers' PCK develops and how knowledge of that development matters for a teacher educator's teaching about teaching science. Their self-study emerges from the teacher educator's learning through a number of critical incidents she recognized when analysing her student teachers' learning experiences. Trumbull uses the case study of her teacher candidate—who went on to become a successful high school teacher focused more on success on the state examination than developing her PCK—to highlight the tension of idealism vs. realism for science teacher educators. Her self-study also reminds us of the tension between teaching about science teaching for educational reform, particularly with a focus on inquiry learning, and the demands of a high-stakes system of accountability that is very real to teacher candidates.

The final group of authors shed light on the ways in which self-study methodology fosters professional learning for academics. Hoban and his colleagues collected data from regular meetings of a professional learning community of academics and from journal entries of participants in the community after teaching the group how to engage in self-study. One member of the self-study professional learning community commented that "it's essential to self-study to uncover dilemmas and problems and we have to have a safe place to talk about them." Morrell and Schepige used design-based methods to enact a particular approach in their methods course, with the goal of thinking about how they teach pre-service teachers about analysing the field placement experience. By examining the coursework of their science teacher candidates, they were able to have a sustained professional learning dialogue about which research-based approaches to teaching science were most in need of attention during their coursework. Keast and Cooper engaged in another iteration of an ongoing, collaborative self-study in order to explore the differences between their pedagogy as science teachers and their pedagogy of science teacher education. They report the power of "learning more about ourselves, beginning to understand the values we promote and how our students perceive them" and conclude "that our often shared values manifest in different ways in our teaching."

Although the word *technology* might easily bring to mind electronic devices with integrated circuits, it is more productive to think of a technology as a craft or process that helps us to move forward in previously unimagined ways. At the beginning of this chapter, I mentioned the tension between Thomas Hobbes, the natural philosopher, and Robert Boyle, the experimental philosopher, at the beginning of the scientific revolution in the seventeenth century. Today, just as in Boyle's time, the key catalysts for thinking about new ways to construct knowledge are the new social technologies available to researchers. For Boyle, it was discussions with members of the Royal Society and the general public. For science teacher educators who are interested in analysing their practice and subjecting the results of that analysis to public scrutiny and interpretation, the social technology is self-study of teacher education practices methodology. Self-study methodology can shed considerable light on science teaching and science teacher education. The intersections between self-study and the pedagogy used in science classrooms all over the world, be they elementary, secondary, or tertiary classrooms, have much to contribute to the science education research literature. This book helps to begin that discussion.

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Chapter 2
A Collaborative Self-Study of a Physics Teacher's First Two Years of Teaching

C. Liam Brown and Tom Russell

This chapter describes and interprets a beginning science teacher's electronic conversation over a period of 2 years with the teacher educator who helped to shape and extend that new teacher's strong instincts about how he wanted to teach. After an 8-month preservice teacher education program at Queen's University in which the two of us met and built an initial relationship, Liam taught for 2 years in Mexico while Tom continued teaching new physics teachers at Queen's. Teaching in Mexico was inspired by Liam's strong interest in travelling outside Canada.

Liam's self-study of his teaching practices began when he started to write to Tom, at first virtually every day, about the experiences, challenges, successes and frustrations of his first year of teaching. This became a collaborative self-study when Tom undertook to respond quickly to Liam's messages with a view to supporting Liam's commitment to the ideas we explored during his teacher education experiences. Liam entered teacher education with a strong sense of what good learning is, and he carried this into his first year of teaching. This self-study reveals how his most frustrating students led him to understand the importance of good relationships with individual students as well as with classes as a whole.

Liam's Introduction

When my studies at the Faculty of Education at Queen's University came to a close, Tom suggested that we maintain a correspondence as my teaching career got underway. I was glad he suggested this, because I was already feeling the

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S.M. Bullock and T. Russell (eds.), *Self-Studies of Science Teacher Education Practices*, Self-Study of Teaching and Teacher Education Practices 12,
DOI 10.1007/978-94-007-3904-8_2, © Springer Science+Business Media Dordrecht 2012

panic of having to move from the comfortable waters of the university out into the raging rapids of my first teaching post, and I knew that I would be tempted to write him for advice.

As part of a class assignment, Tom had created blogs for each teacher candidate to use to discuss practicum experiences, and it seemed natural to continue to use mine to record our conversations. Much later, with my first 2 years of teaching completed and over 100,000 words written between the two of us, I was finally able to step back and read through the blog from beginning to end. By then, I had learned just how valuable this kind of conversation could be, as it made possible a kind of in-depth self-study of my teaching practices that I could carry out with the guidance of a mentor who had years of experience as both a physics teacher and a teacher educator. The blog had become the perfect forum for me to express my professional successes and frustrations, and it pushed me to examine all aspects of my teaching in detail. It had given me a chance to ask for help during my most challenging times as a teacher, and Tom's constant interest, advice and encouragement gave me the impetus to continue to try to improve my teaching and helped me to survive stressful periods. The three major themes of my 2 years of teaching that played out on the blog were (1) managing the relationships in my classroom, (2) dealing with lowered academic expectations, and (3) continuing to develop a full and holistic pedagogical approach.

Starting the Conversation

What I learned about teaching and learning during my 8-month bachelor of education program made me more eager to walk into my own classroom than I had expected. Although each of my professors had something to pass on to me, it was in my Physics Education class that I encountered a way of thinking about teaching that felt complete and important. I came to refer to the set of ideas and techniques that Tom led us towards as active learning, and I myself was engaged in active learning from our first class together.

One of the first things Tom introduced us to was the POE (Predict, Observe, Explain, see Baird & Northfield, 1992) teaching procedure, a group activity that I found staggering in the variety of positive effects it can have on students. By observing a physical phenomenon and working together in an open and low-risk manner to try to explain what they observe, students gain the confidence to try to explore physical explanations on their own before hearing answers from a teacher. POEs foster curiosity and interest in science, replicate the scientific process, build trust and teamwork skills in a group, and encourage students to examine their preconceptions and the ways those ideas can change after scientific investigation. In other words, a POE can completely engage students in their own learning.

It was this model that Tom exemplified during each class session. We teacher candidates were expected *not* to sit back and be told how to be good teachers. Instead, Tom encouraged us to work independently and with our peers, to question our ideas about teaching, and to pay careful attention to how we were learning how to teach. Just as in the POE process, Tom avoided the familiar role of teacher as the controlling dispenser of wisdom, choosing instead to guide and coach us in our learning. He listened carefully, asked a lot of questions, and challenged us to improve our work. It was clear that Tom took his role in our professional development very seriously and that he was committed not just to teaching active learning but to modelling it in his own classroom.

In this context, communicating with Tom in a blog format while I was away at my practice teaching sessions felt like a natural extension of our work on campus. In other assignments for other courses, I was sometimes asked to write about my experiences in a reflective essay answering a specific question; however necessary such work might be, it was not the organic and productive work of self-directed learning. In the blog, I was able to explore those topics that felt most pressing at the time. The writing happened at the end of the day while the events were still fresh in my mind, and Tom's prompt responses gave me a little push to go back and try again the next day. This process can be seen clearly in a series of posts about getting feedback from two groups that I was having trouble engaging. I had handed out an index card to each student at the end of my classes and asked the students to write anonymous comments on the cards about how the class was going.

When I looked over their responses, I realized again that asking a vague question yields little helpful information. I had assumed that my students were thinking as hard as I was about their learning in my classroom—a mistake I would continue to make in the months that followed. I was particularly disappointed in the results from my math students, and the blog seemed a good place to vent my frustrations and think about a way forward. The selections below, as in the rest of this chapter, are excerpts from longer posts and comments:

> The main question on my mind (and which I should have asked more specifically) was whether or not the students wanted the class to involve them more. The way I'm proceeding mostly involves me just standing at the board and telling them things. I've been taking this approach partly because I just don't know how to start teaching math any differently (as I've said), and partly because the overwhelming impression I get from these kids is that they don't like math, or school in general, and want to just show up, hear what I have to say, do a bit of work, and get their passing grade (maybe). And I was hoping to find out whether I was just giving up by not doing anything differently, or if I was in fact doing things in a way that would serve them best. (Liam, Feb. 26, 2008)

> Excellent reading, Liam, and more power to you. You've taken risks and found out more of what individual students are thinking than most teachers do. Have I mentioned that I have incredible confidence in such writing as one of the only ways to become the teacher you want to be?… If they don't change in one day, that's normal, VERY normal. Try again on Monday, perhaps telling them what math concept or procedure they will master if they do all their homework. (Tom, Feb. 26 & 28, 2008)