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Editorial

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Chemistry Teachers as Professionals: A Retrospective Analysis

Gregory T. Rushton*

Chemistry Department, Stony Brook University, Stony Brook, New York 11794, United States

ABSTRACT: National reform movements, such as the recent Next Generation Science Standards, can be viewed as an unnecessary nuisance or a welcome progression toward a scientifically literate citizenry. Teachers who view themselves as professionals can recognize the value in contributions from those within the K−12 community as well as external to it. The stance taken can likely influence how we are perceived (and treated) by our stakeholders, including ourselves.

KEYWORDS: *General Public, High School/Introductory Chemistry, Public Understanding/Outreach, Inquiry-Based/Discovery Learning, Testing/Assessment, Standards National/State*

I recently finished reading Melanie Cooper's editorial[1] about how large-scale adoption of the Next Generation Science Standards will require changes at all levels of science education, including those teaching chemistry in college and university settings.[2,3] In my searching about what reform might look like at the postsecondary level, I came across Cooper and Klymkowsky's CLUE (Chemistry, Life, the Universe and Everything) curriculum[4] at Michigan State and Talanquer and Pollard's Chemical Thinking (CT) at The University of Arizona.[5] As I considered our current choice of materials for teaching an upcoming introductory chemistry course and compared those materials to CLUE and CT, I kept feeling this strange sense of déjà vu. I realized that 20 years ago (in 1996), as I was completing my undergraduate chemistry degree and beginning my first high school teaching position just outside Columbia, SC, similar calls for wholesale changes about how and what we teach to our chemistry students were being "handed down from on high" in the form of the National Science Education Standards (NSES).[6]

NAIVE CONFIDENCE AND EMERGING PROFESSIONALISM

When I first began teaching high school chemistry in the mid-1990s, I remember how many of the teachers I met to talk about this new "Standards" movement felt these Standards were an affront to their notions of autonomy, pedagogical expertise, and perceived success with traditional textbook-based courses.[7,8] I was persuaded by these teachers that the NSES was just the latest in a long history of education fads, and really was just what we've always been doing with some fresh packaging and new buzzwords like "inquiry" (laboratory work), "conceptual understanding" (chemistry without the math), and "authentic assessment" (free-response questions on exams). So I took their cue to do with my students what I remember my teachers and professors doing with me: mostly memorizing some fancy words, using our graphing calculators to plot equations, and doing some boring laboratories that emphasized some technical skill and equipment setup to verify some predetermined outcome. I learned how to write lesson plans that aligned my conventional pedagogy and content to the state standards by simply trying to match the chapter in the book I was teaching at the time to a heading in a ten-page document that all of us were supposed to be teaching to, on the same pace so that quarterly exams could be given district-wide.

Within just a few years, I became fairly proficient at teaching this way, and even some of my advanced placement (AP) students were passing the AP exam and coming back to tell me how well I had prepared them for college-level chemistry classes at their prestigious universities. In one sense I couldn't have been happier, but I also began to experience a growing sense of what I later learned some called "pedagogical dissatisfaction", where I recognized my failure to help many of my students understand or even appreciate the topics I was presenting.[9] It seemed I was trying to teach way too much material in too little time; my students couldn't see the (obvious?) connections from one chapter to the next; and very few could get beyond simple calculations to actually understanding the concepts behind them. Over the next several years, I found some like-minded teachers who were having similar issues and began meeting together, going to local and state conferences to see how others were trying to improve their teaching, and found some articles in *The Science Teacher* and the *Journal of Chemical Education* that, although seemingly sparse in frequency, were pretty helpful. One article, for example, helped me teach empirical formulas in a more engaging way;[10] another, about how to address the frequent assumption that chemical bonds "contained" energy that was released when broken.[11] My teaching gradually changed, from mostly lecture/notes and worksheets to more student-led activities and exploration-before-explanation laboratory investigations.

In my fifth year of teaching, I began graduate school in chemistry and started reading the research literature in education, mostly in the area of pedagogical content knowledge (PCK) and science teacher professional development.[12,13] Some of the articles were summarily incomprehensible, while others seemed irrelevant to my daily work as a high school chemistry teacher; but there were some that actually influenced me to think about cognitive load, critical thinking, learning cycles and progressions, and conceptual change. As I learned more about how to conduct and evaluate studies in both organic chemistry and science education, I became more

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reflective about my own ability to justify instructional or assessment decisions and whether or not they should be advocated for when I met with other teachers about these issues.

CHEMISTRY TEACHERS AS SCHOLARLY PRACTITIONERS

In my current position as chemistry teacher educator I'm often placed in a position where I am either asked for or expected to share my views on what the relative merits of different teacher practices and trends are for the improvement of high school teaching and learning. The responses I try to convey converge around the construct of teacher as professional, and one that Sheila Tobias summarizes well in one of her recent books (with Anne Baffert) on the subject.[14,15] To me, high school chemistry teaching won't be broadly perceived by either its practitioners or their constituencies as a profession, along with the associated prestige, status, and autonomy that is hoped for, unless certain features of the work become evident. In this contribution I'll only focus on one, and sadly one that was not very descriptive of me for my first several years: chemistry teachers should be scholarly practitioners.

As a community, we should be aware of the history of our craft: what issues and problems have been identified and how have they been addressed; whether or not they have been sufficiently overcome to be reified as a best practice or as part of our PCK. Further, as professionals, we should be recognizing what present challenges exist, thoughtfully considering how to work collaboratively and disseminate our conceptions and outcomes to each other for both edification and critique. This includes trying to understand what others who care about the same issues as we do (e.g., student motivation, standardized testing, teacher accountability, and diversity) have learned that we could benefit from knowing and using in our classrooms.

What I began to realize over time was that the same perplexing and agonizing aspects of my daily teaching experience were the focus of others' attention; but their positions as academic researchers, education policy analysts, and even school administrators were, for one reason or another, invisible or irrelevant to me. Some of these dedicated teachers, teacher educators, science education researchers, and scientists even took the time to help write those same standards I mentioned above: intended to improve the educational experience for both myself and my students, but that I had perceived as intrusive, illegitimate, and unworthy of my attention. In retrospect, it was this stance that might have placed me and some of my peers in a position where those outside of our chemistry teaching community would have perceived us as being something less than professionals.

SHIFTING TO TEACH HOW CHEMISTS THINK RATHER THAN WHAT CHEMISTS KNOW

So this fall, I'm abandoning a traditional textbook for my introductory chemistry course and working with two of my colleagues in similar settings to attempt to teach "how we think" as chemists, rather than "what we know".[5] I am making this choice because I believe that this will best serve my students to be prepared for the various majors and careers which they will enter when they complete their time with us. Instead of a canon of chemical knowledge that can be just as easily Googled as presented in class, the goal for the course will be to help my students learn how to approach problems of increasing complexity, as these skills can hopefully be transferred and generalized to other contexts they encounter. I believe that the course materials were developed using cutting-edge understandings of student learning, aligned to outcomes that I advocate for as an educator, and rigorously tested prior to large-scale adoption. To serve my community as a professional, I will be studying the implementation and sharing what we find in various outlets where my colleagues are likely to be present, and expecting their comments and feedback for the intended benefit of teachers and students across the country.

More likely than not, if you're reading this article you already function in a way where collaboration, reflective practice, and ongoing professional development are familiar and regular aspects of your daily work.[16] I hope that I can meet you one day soon, either face-to-face or in a virtual space, so that I can be further encouraged, informed, and connected to your passion for teaching. Some of my high school chemistry teaching colleagues have been sharing their experiences at our *Journal*'s partner Web site, ChemEd X, for example.[17] Perhaps you have ideas on professionalism, too, and how we should be working together to improve our condition locally and nationally. I invite you to do so and will endeavor to share that story with those who need to hear it.

AUTHOR INFORMATION

Corresponding Author

*E-mail: grushton@jce.acs.org.

Notes

Views expressed in this editorial are those of the author and not necessarily the views of the ACS.

Gregory T. Rushton is an Associate Professor of Chemistry at Stony Brook University, where he teaches undergraduate and graduate chemistry and science education courses, and conducts research in science education. He currently also serves as a precollege associate editor for the *Journal of Chemical Education*.

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