*CLEARvoz Journal Vol. 3, No. 2 (2016)*

**CLEARvoz Journal**

Center for Leadership Equity And Research
CLEAR

@ 2016

# The Supervision and Mentoring of Science teachers: Building Capacity in the Absence of Expertise in Classroom Science Supervisors

**John Craven,** *Fordham University Graduate School of Education*
**Bruce S. Cooper,** *Fordham University Graduate School of Education, NYC*

**Abstract:** The teaching of science to each new generation of children is critical to our society; and the quality and level of teaching and "science supervision" are too. We as a society and school system must move to prepare and support both the teachers of science – and the critical leaders who supervise and evaluate these teachers. This paper examines the problems and futures of quality of the following: (a) science teaching and teachers; (b) the importance of high-quality instruction and supervision in the sciences; and (c) what need to be done NOW to maintain and improve both the teaching of sciences in K-12 education, and (d) how to do it all now. It's now or never!

## Introduction

This article explores and explains the perils and challenges arising as science teachers are supervised, evaluated, and even fired by administrators (e.g., assistant principals and principles) who may lack the experience, skills, degrees, and training in any science subject (e.g., general science, physics, chemistry, earth science, and biology). We seek to assist both the science supervisor and the teacher in grasping the importance of improved science instruction and outcomes in the classroom by providing practical and useful recommendations for both non-science trained administrators and the science teachers whom they oversee.

## Defining the Problem

The current lack of certified, highly qualified teachers of science in K-12 schools has been well documented for the past several decades. However, another, equally troubling shortage has not received nearly as much attention – that of the shortage of supervisors and administrators who must do the following:

(1) Be directly responsible for supervising, mentoring, evaluating and improving science teaching in schools and classrooms; and (2) Be trained and experienced in science education; and (3) Be often in control of hiring, supervising, mentoring, and evaluating (and firing) science teachers in their schools and departments.

The problem started and has continued with an overall shortage of trained science teachers, as Shymansky and Aldridge (1982) explain: "Our nation faces unprecedented problems in science education, the severity of which is the critical shortage of qualified science teachers and supervisors at the secondary school level" (Shymansky & Aldridge, 1982, p. 1).

And school districts also recognize the problem, including, - for example, the New Haven, CT, public school leaders noted (Bass, 2012):

> This year, 18 of 120 science teachers are new to the district—the highest number in five years, according to Therrien [the science supervisor]. Teacher turnover among science teachers has remained high in New Haven, reflecting a national challenge that's particularly acute in more urban districts. New Haven is beginning to examine the problem and look for solutions as part of a $53 million federally-backed effort to improve the way it develops and retains teachers. (p. 1)

Schools should anticipate the increasing need to establish responsive administrative preparation and training systems designed to support the next wave of quality new science teachers -- and their supervisors. The failure to address the need for better training of administrators in the supervision of science teachers may indeed exacerbate the problems already connected to improvement, retention and turnover of science teachers in the field in U.S. public and private schools.

The problem may be made worse if and when the needs of science teachers are ignored -- and thus teachers do not receive the important feedback and support for greater professional growth, and improvement of their teaching. The New York City public schools recently published a list of teacher shortages in these science subjects:

- **General Science** - Junior High Schools
- **Chemistry and General Science** - High Schools
- **Earth Science and General Science** - High Schools
- **Biology and General Science** - High Schools
- **Physics and General Science** - High Schools

And the shortage of science teachers often starts in colleges, where fewer students are being credentialed in teaching the sciences. For example, as Mark Johnston (2015) explained as occurring in the state of Virginia:

> Yet, of the 27 Virginia state colleges and universities reporting, only 13 candidates completed teacher preparation programs in Earth Science in the 1999-2000 school year. This is out of a total of nearly 2,400 candidates completing programs in "high-need" areas, such as special education, English-as-a-second-language, physics, and chemistry. (Johnston, 2015, p. 2)

## Background Information

This issue is critical as we may also face a serious shortage of science teachers who start and persevere in the foreseeable future. Contributing factors to the low numbers of science teachers (and science supervisors) now include the following: high teacher turnover; the impact of high stakes accountability systems as connected to questionable methods of teachers' evaluation; poor teacher-administrator relations and interactions; and the overall lose of positive self-efficacy and persistence in the teaching of the sciences.

Next, we discuss some possible new remedies, including positive actions to recruit and retain more science teachers. Most recently, the severity of the shortage has led President Obama to call for the preparation of one-hundred thousand new, highly-qualified classroom teachers in the areas of STEM (Science, Technology, Engineering & Mathematics). This Presidential initiative is called in short, 100K-*in-10* -- meaning *100,oo new teachers of science in the next decade.*

The process calls upon the nation's top academic institutions, nonprofits, foundations, companies, and governmental agencies to train, support, and retain 100,000 excellent new STEM teachers to educate the next generation of science innovators and problem solvers within the next

10 years.

Together, this timing and planning represent a tremendous private and governmental monetary investment in K-12 education . . . but who else is trained to supervise, support, and evaluate all these science professionals in classrooms and in training?

**Improved Supervision and Evaluation**

Supervisory and evaluative decisions thus influence choices regarding hiring, tenure, professional mobility decisions, and continuous progress towards expertise in the classrooms. Given the rising science teacher turnover rates, a significant loss occurs when those moving and advancing upward through the ranks within schools in becoming more senior, getting tenure, being influential, and holding supervisory positions, and quit; thus, more and more administrators may find themselves charged with the responsibility of supervising and mentoring science teachers, even though these leaders themselves may have neither training nor experience in science teaching and science supervision.

Yet, the roles of supervision -- and the importance of feedback to science teachers -- are truly necessary for improving teachers' skills in instruction and facilitating progress from novice to expert classroom practitioners. This process involves supporters and supervisors who can provided accurate, helpful feedback, good examples of outstanding lessons, and the current "best practices" -- as envisioned by the "next generation of science education standards." Thus, these practices are critical in both the teaching and learning of science for the next generations of students -- and future scientists.

We suggest addressing three domains of practice including: (a) *content* knowledge of the sciences; (b) *methods* for teaching the sciences; and (c) the *goals* of the next generation of science education. Thus, a skilled supervisor in the science classroom must, first of all, be equipped with the knowledge in the content area. That content knowledge enables the expert observer to know when and where students are given misinformation in the content area, for science teachers may not always have a strong command of the knowledge in their discipline.

Expert science educators also use their knowledge both to anticipate and to address common student misconceptions (or naïve conceptions) in sciences. Expert science teachers can also draw upon their schema of content knowledge at times when "teachable moments" occur in the class. That is, they can go beyond the learning targets of a given lesson at times where students either raise important questions or reveal gaps or strengths in their understanding.

Supervisors of science teachers should also be keenly observant of the safety and welfare of students in the classroom. Imagine watching a science teacher about to pour one beaker of clear water into another beaker of clear liquid. This wouldn't be a problem unless the water is being added to a container of acid. As Antoine Frostburg (2015) warns:

> A large amount of heat is released when strong acids are mixed with water. Adding more acid releases more heat. If you add water to acid, you form an extremely concentrated solution of acid initially. So much heat is released that the solution may boil very violently, splashing concentrated acid out of the container! If you add acid to water, the solution that forms is very dilute and the small amount of heat released is not enough to vaporize and spatter it. So *Always Add Acid to Water*, and never the reverse. (Frostburg, 2015, p. 5)

Thus, supervisors of science teachers should understand the Next Generation of Science Education Standards' as well as safety in the labs and classrooms. These expectations focus instructional practices that help their students to understand "how we know," rather than simply "what we know".

Supervisors of science teachers should also support teachers with resources and ideas. The loss of expertise and institutional memory is a significant problem facing many science teachers in the profession. A skilled and knowledgeable supervisor should be equipped with a repertoire of teaching strategies and resources that can be recommended to science teachers. Indeed, the "brain drain," results from attrition rates of teachers who take with them the knowledge and skills associated with operating equipment in the laboratory.

Thus, supervisors and administrators must have sufficient training and experience in the discipline to provide teachers with the depth and breadth of feedback needed by the practitioner who, in turn, will need to reflect upon and deliberately practice these techniques to improve.

Given the lack of sufficient training and experience in the sciences, the approaches to both the supervision and evaluation of teachers should be reconsidered. First, we must acknowledge that we do not expect all administrative staff to have or gain expertise in all the areas they supervise. However, it should be acknowledged that many schools, particularly in high needs communities, often lack enough seasoned science teachers or science department chairs who can be used to evaluate – and support -- science teachers in their classrooms. Furthermore, it should be acknowledged that more, and more often, the supervision and mentoring of (particularly) new teachers in those schools fall upon the shoulders of principals and their assistants who often do not have training in the sciences.

Thus, if the points of concern raised in the paper are valid, then we should consider alternative and/or supplementary approaches to the supervision and mentoring of science teachers. After all, if the United States government -- and its citizens -- are now prepared to invest large sums of money and effort into recruiting and mentoring of quality science teachers into the classrooms, then we need to be better prepared to develop both the support and supervision mechanisms to keep them there.

**So What Can Be Done, Now and in the Future?** Administrators and their representatives -- charged with supervising science teachers -- can conduct pre- and post-observation debriefings and ask the science teachers the following:

- What misconceptions do they intend or intended to address during instruction?
- What are made and taken for the precautions and plans to ensure the safety and welfare of students?
- How might supervisors help embed more opportunities for joint classroom observations. That is, supervisors should have practicing science teachers to work cooperatively within their schools and district administrators, during supervisory processes that are designed to provide meaningful feedback to teachers for growth and improvement in the classroom.
- How could supervisors adopt (or adapt) specific observation *rubrics* for science instruction (see Cooper, 2004, *Kappan*). Many readily available rubrics can provide domain-specific criteria not found in more general tools, such as the Danielson Framework.
- And leaders should support their science teachers (Redish, 2003) by providing financial support to send their science teachers to regional, state and national conventions and programs, such as those offered by the National Science Teachers Association (See FLINN SCIENTIFIC INC, Material Safety Data Sheet, MSDS).

**WHO Should Be Served Safely?** All teachers, including particularly teachers of science, should receive basic training in "classroom safety". Free, online classes are available to anyone interested in providing safety in classes, particularly in chemistry and biology classes (see Flinn Scientific; Materials Safety Data Sheets).

-- Identify, encourage and incentivize promising science teacher(s) to seek National Board

Certification. The administrators can follow the development of the portfolio and other requirements in a collaborative effort to improve science instruction in their schools.

-- Select and read one key section from the Next Generation Science Education Standards (see below; they will include MSDS). Then ask their science teacher(s) to explain that section, and ask how he/she will address these component during an observed lesson:

- Science Practices
- Core Disciplinary Ideas
- Progressions
- Science and Engineering Practices
- Cross-cutting Concepts
- Nature of the Sciences

**Positive, Practical Suggestions**

Finally, what practical suggestions can be made to improve science supervision?

**1. Support strongly (financially, professionally, and in other ways) the training of more new science teachers and supervisors:** The improvement process begins with the education and preparation of new science teachers, and their supervisors. We might even conceive of a national Science Teachers Program, for preparing both supervisors and teachers. Time is now.

**2. Encourage skilled, outstanding science TEACHERS to demonstrate, supervise, mentor, and advise newer staff in their fields.** Why not consider freeing and helping quality and qualified science teachers to work with newer, less qualified, and less skilled teachers of science as part of their jobs? Mentoring is critical, teacher-to-teacher, and between supervisors, each other, and their teachers (see Cooper & McCray, 20015; McCray & Cooper, 2015).

**3. Encourage teams of science teachers and supervisors to collaborate and share outstanding lessons, materials, and methods in their classes.** Like doctors and lawyers, why not place each science teacher into a team with colleagues, to learn and support one another's science information, methods, lessons, and teaching skills? Teaming is key. As one observer found:

> All experiments involve collecting observations or observing actions to try to answer a question or solve a problem. However, there are differences between technical and teaching experiments. Classroom experiments do this as part of a class to help students learn more about the material they are studying. In this case, the hypothesis to be tested will generally be derived from material contained in a textbook or other course materials. Research experiments generally involve both control and treatment groups to facilitate comparison. In the classroom, an observational experiment where students "see what happens" can also be useful.

**4. Build and share software demonstrations and physical methods to enhance classroom and laboratory learning — and outcomes.** Teaching science to students, using technology in the classroom and at the students' homes, should be both interesting and technological. Bergstrom and Miller (1999) explain one approach to good classroom demonstrations:

> We got tired of it. Lecturing to sleepy students who want to "go over" material that they have already highlighted in their textbooks so that they can remember the "key ideas" until the midterm. We wanted to engage our students in *active learning*, to exploit their natural curiosity about economic affairs, and to get them to ponder the questions before we tried to give them answers. We found that conducting experiments in class, with discussions before, during, and after the experiments, is an effective and enjoyable way of moving from passive to active learning. (Bergstrom & Miller, 1999, p. 11)

**5. Promote and recognize high quality and outstanding science teachers -- sharing lessons and techniques -- across the fields of science (life science, physical sciences, and physics).** Finally, it is critical to praise, revere, and recognize the nation's outstanding science teachers and supervisors, soon! Thus, promote, recognize, and reward the best in the field of science teaching – and related supervision -- to do three things: (a) Give impetus to outstanding teaching/supervision in the nation's science classes; (b) Build a stockpile of quality, successful teaching methods and outcomes; and (c) Raise the standards for instruction and the education of all the nation's children. And produce a generation of children who think and act like scientists and engineers. We need them.

For as Carl E. Weiman (2013), a Nobel Prize laureate in physics, and a former White House director of technology, explained in the *New York Times*,

> The good news is that we know how to make introductory science courses engaging and effective. If we have classes where students get to think like scientists, discuss topics with each other and get frequent, targeted feedback, they do better. A key element involves instructors designing tasks where students witness real-world examples of how science works. (p. 2)

## References

Bass, P. (Feb. 6, 2012). Time out! *New Haven Independent, Branford Eagle,* p. 1.

Bergstrom, T., & Miller, J. (1999). *Experiments with Economic Principles*. New York: McGraw-Hill/Irwin.

Cooper, Bruce S., & McCray, Carlos (2015). *Mentoring for School Quality.* Lanham, MD: Rowman & Littlefield.

Cooper, Bruce S., & Gargan, Anne (2009). Rubrics in education: Old term, new meanings. *Phi Delta Kappan.* (May/June/July, 2009), pp. 54-55.

Frostburg, A. (nd.) Why is acid always added to water, and not the reverse? FAQL Chemistry Operations.

Johnston, M. (2004). Earth science careers in K-12 education. AGI-web.org.

McCray, Carlos, & Cooper, Bruce S. (2015). *Mentoring with Meaning.* Lanham, MD: Rowman & Littlefield.

Redish, E. F. (2003). *Teaching Physics with the Physics Suite*. New York: Wiley and Sons.

Shymansky, J. A., & Aldridge, B. G. (1982). The teacher crisis in secondary school science and mathematics. *Educational Leadership,* 54(1), pp. 61-73.

National Science Foundation (2015). *Where Discoveries Begin.* (Division of Undergraduate Education: Robert Noyce Teacher Scholarship Program).

Wieman, C. E. (2013). Ideas for improving science education. *New York Times,* Science Section, September 2, 2013, p. 1.