# Executive Summary

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# EDUCATING TOMORROW'S SCIENCE TEACHERS

## STEM ACT Conference Report: Executive Summary

*A report on a working conference on*
*Alternative Certification for Science Teachers*
*held May 5-7, 2006 in Arlington, VA.*

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Copies of the reports are available at www.stemtec.org/act/WhitePapers.htm. Print copies are also available on request at no charge while supplies last. Contact STEM Ed, 229 Hasbrouck Lab, University of Massachusetts, Amherst, MA 01003, or hq@umassk12.net.

A National Science Foundation funded conference entitled, “Science, Technology, Engineering and Math – Alternative Certification for Teachers” (STEM-ACT) was held in May, 2006 in Arlington, VA. The conference was designed to facilitate a significant exchange of information, which was then synthesized to produce white papers on the three threads of the conference, i.e., policy, practice, and research. This summary presents the highlights of the three white papers.

One goal of the conference was to identify key issues related to the alternative certification (AC) of science teachers to support a more systematic study of AC efforts. A second goal was related to the extensive research programs on science teaching and learning that have been funded for 30 years by NSF and other agencies (see for example, Lederman & Abell (2007)). We now know a great deal about the teaching and learning of science in schools. What is not known, however, is how to incorporate this knowledge into AC programs. Therefore, a guiding question of the conference was, *“What do we know and what more do we need to learn about how to incorporate the results of research on science teaching and learning into alternative certification programs?”*

On day one, all attendees presented their research and served as respondents to other presenters. Papers were available ahead of time (see http://stemtec.org/act) so that respondents could prepare thoughtful comments. In the morning of day two, small groups identified the major ideas and in the afternoon writing teams began the preparation of three white papers. This article provides an overview of the papers, beginning by addressing the questions:

- *“What are the policy issues in the alternative certification of science teachers?”*
- *“What is alternative certification and what does it look like?”*
- *“What research needs to be done?”*

***Policy issues for the alternative certification of science teachers***

Policy makers rely on studies that provide contradictory data about teacher supply and demand and the efficacy of alternative and traditional teacher education programs. Therefore, an important goal of the policy group was to frame the problems that alternative certification addresses. They found that there are deficits in the quantity and quality of science teachers. Therefore, teacher certification public policy is concerned with addressing incentives and standards to ensure that there are enough qualified teachers. And, there must be enough quantity before quality can be addressed.

.The policy group found that several factors affect the demand for science teachers, including the number of classes that need to be staffed, teacher retention rates, and retirements. Demand also depends on student demographics, and on the funds available.

Dominating the supply of new science teachers is the limited number of people who receive training in the sciences, and their multiple career opportunities. The conference found that it is necessary to pay attention to both salary and working conditions to attract qualified people. The quality of the science teacher employed in a school will depend on the total compensation package (i.e., salaries, benefits, working conditions, and intrinsic rewards).

To balance supply and demand, districts can make several tradeoffs:

- There can be a quantity-quality tradeoff. A district can choose to employ fewer teachers but maintain high quality standards (e.g., increase class sizes and/or offer fewer courses but of higher quality) or it can sacrifice quality by employing as many teachers as possible regardless of quality.
- The district can sacrifice quality in science teaching to promote quality in other subject areas.
- The district can find that it needs to sacrifice both quantity and quality just to stay solvent.

Science is costly to teach; laboratories require extra resources. High quality science teachers may cost more because of their short supply. The attractiveness of teaching relative to other occupations available may be lower for individuals trained in the sciences than for those trained in other fields, such as English. Attracting a high quality science teacher may require a relatively costlier compensation package.

*The district can find that it needs to sacrifice both quantity and quality just to stay solvent.*

The cost of high quality science teaching and the relatively low incentive to produce it combine to exacerbate the shortage of good science teachers, particularly in schools with highly constrained resources. Hard-to-staff schools are doubly challenged, needing to funnel scarce resources into the areas upon which their survival depends most heavily *and* being less likely to attract high quality science teachers than schools with more desirable working conditions.

The policy group found that the main motivation for AC for science teachers is to increase supply by speeding up licensure by reducing impediments. This raises questions because of the group's other findings. First, do traditional certification programs produce a significant restriction on the rate of production of new science teachers, and if so, how? Second, how many people knowledgeable in the sciences are available to be science teachers? That number may be more critical than the certification process. Third, can policy makers shape science teaching so that it is competitive as a career with the other options available?

***What is alternative certification and what does it look like?***

The term alternative certification is ambiguous. Many programs considered AC are housed in institutions of higher education and lead to both licensure and a degree. Some call only undergraduate programs "traditional," and label all other teacher education programs as alternative. In addition, there is as much variation within programs as there is between programs. For example, Marjorie Wechsler reported on a large-scale study that found large variations among AC programs in the characteristics of participants (e.g., their education

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backgrounds), previous careers and classroom experience; and in the components of the AC programs, including participant experiences with coursework, mentoring and supervision, and the context of their school placements (Wechsler, Humphrey & Hough, 2006).

There are large variations in program structure among those programs labeled as alternative, the differences in candidate backgrounds within and among programs, and the wide range in the school contexts in which candidates were placed, both within and among programs. This led the conference to concur with the statement that “there is no agreement about the definition of alternative certification and there is some confusion as well about what constitutes traditional certification” (Zeichner & Conklin, 2005, p. 656; Zeichner, 2006 ). Rather than trying to compare traditional and alternative programs, one should consider a continuum of teacher preparation and support programs designed to serve the varied needs of schools and of pre-service and in-service science teachers. All effective teacher education programs, as argued in the practice white paper, should:

- include solid partnerships involving the state licensing authority, institutions of higher education and local school districts in the preparation process of AC science teachers,
- select and recruit of the candidates for admission that match the design of the particular program,
- have responsive program design and delivery, and
- train teacher mentors in ways that addresses the specific needs of science teachers.

Any list such as this requires a means of evaluating whether programs have these qualities and whether they have the desired effect. The evaluation of science teacher certification programs has two dimensions: teacher knowledge and teacher skills. Clearly science teachers need to know science. However, how do certification programs to ensure this? How do they determine the candidates’ knowledge and how do they augment it when necessary? Science teachers also need knowledge of educational foundations and strategies. How do programs ensure this, and more importantly, how well versed are the candidates in the theories and practices that have emerged as a result of research on science teaching and learning, including research in areas such as culture, language, ethnicity, and gender? Candidates also must have the skills needed to create environments in which students learn. To evaluate this, programs need to look both at what their candidates do in classrooms, and what the candidates’ students learn.

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As the practice white paper notes, much of what is believed about the quality of teacher certification programs, in general, is not supported by evidence. It also notes that both supporters and critics of AC base their opinions on a very thin research foundation. Therefore, further research is needed.

### *A research agenda for science teacher education*

The wide variety among alternative and traditional programs means that little can be learned with comparative studies. However, the research group was able to identify three “divides” in teacher education that can be highlighted for research purposes:

- The divide that separates programs that have as their primary purpose teacher licensure from those that have as their primary purpose the education of teachers;
- The divide that separates science teacher education from the education of other teachers; and
- The divide that separates preservice and in-service teacher education.

The first divide distinguishes between the programs that exist solely to help candidates meet the state minimum requirements, while the latter help teacher candidates to develop the knowledge, skills, judgment and wisdom for teaching. The challenge is to design programs that have the benefits associated with credentialing programs yet prepare teachers to be effective science educators.

The second divide highlights the knowledge and skills that are particular to the teaching of science. It also focuses on the difference between the content knowledge of school science and the content knowledge of the academic disciplines as practiced by scientists and presented to college students (Hill & Ball, 2004; Stengel, 1997). The third divide, between preservice and in-service teacher education, has blurred as more and more novice teachers are already employed as teachers as they do their initial teacher education. Hence we see the distinction between novice and expert as being more fruitful than that between pre- and in-service.

These divides suggest that we need insight into

- what kinds of learning opportunities support diverse learners' science engagement and understanding,
- what science teachers need to learn in order to provide such opportunities for their students, and
- what kinds of experiences teachers need to learn what they need.

That is, if we want science teacher education to be research-based, then we need to have evidence that what, and how, we teach teachers benefits their students in meaningful ways. The research white paper argues that this research agenda requires mutually reinforcing activity on three fronts – conceptual, methodological, and empirical (see Figure 1).

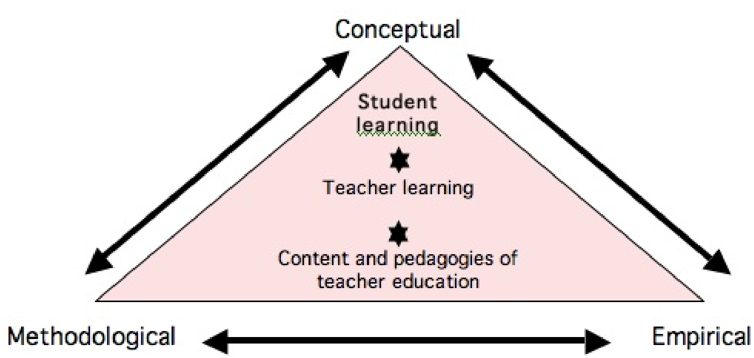


Figure 1: Conceptual, methodological, and empirical fronts of research on science teacher learning.

If teacher education programs are to have the qualities identified in the practice white paper, then there is a need for conceptual clarity about what and how science teachers must learn. Ongoing discussions about defining, and refining, research interests in useful ways for science teacher education would be a helpful step towards greater conceptual congruence. Rigorous research not only requires conceptual clarity but methodological support as well. In particular, there is a strong need for robust tools for measuring teacher change over time. Finally, we need to develop empirical warrants for our science teacher education practices. Without them, we cannot assume that our vision of science education reform "works" unless there is evidence necessary to back up claims.

The research white paper concludes with a list of questions proposed by STEM-ACT research participants. They include.

- What science content and in what form do science teachers need to know?
- How do we bridge traditional separations of preservice and in-service teacher education to create a professional continuum of science teacher education that includes the induction phase?
- How do diverse teachers acquire the beliefs, knowledge and skills across a variety of educational settings and opportunities?
- Who are the science teacher candidates? How do age, race, ethnicity, and gender; prior experience; science knowledge; and context and societal influences relate to candidates' learning to be science teachers?
- How do we transform credentialing programs into research-informed educational programs?

***Conclusion***

There were several expected outcomes of the STEM-ACT conference. One was that it would explore what is known about the alternative preparation of science teachers and identify the agenda for future research. The second was that by bringing together experts in science education, teacher education, and educational policy with educational administrators and policy makers it would help to shape the dialog on alternative and traditional certification programs. In addition, by asking salient questions about the alternative certification of **science** teachers, the conference would change the unit of analysis from all **teachers** to **teachers of science**. This in turn would open up for inquiry the importance of the large body of research on the teaching and learning of science on the preparation of science teachers, and insert it into policy discussions about how best to incorporate this knowledge into the training and certification of science teachers. The third was that it would impact the development, implementation and evaluation of AC programs for science teachers that would help meet the national demand for more science teachers who know and can use the knowledge generated through science education research. With the publication and dissemination of the white papers, the hoped for national conversation can begin to shape the research and development of science teacher certification programs.

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