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EDUCATING TOMORROW'S SCIENCE TEACHERS

STEM ACT Conference Report: Policy Section

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

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Executive Summary

The University of Massachusetts (UMass) STEM Education Institute and the UMass School of Education hosted a National Science Foundation funded conference entitled “Science, Technology, Engineering and Math—Alternative Certification for Teachers” (STEM-ACT) in Arlington, Virginia on May 5-7, 2006. This white paper summarizes issues presented at the conference that are of importance to policy makers on alternative certification (AC). It focuses on issues concerning science teachers, analyzing the nature and scope of the policy endeavor as a solution to current and projected teacher shortages, and discussing the implications of AC policies on teacher supply and demand and on teacher turnover. Two similar papers have been prepared for academic researchers and AC program providers.

The term “alternative certification” applies to a variety of options outside of a full-time, four- or five-year university campus-based teacher preparation program for obtaining the state credentials required to teach in public schools. The participants of the conference agreed that rather than debating over which is the best teacher preparation model, traditional or alternative, it is becoming increasingly important for policy-makers to determine which programs are most effective and efficient in developing more and better teachers in high need areas, such as science, and what factors in school workplace influence teacher recruitment and retention. It was also recognized at the conference that compounding teacher shortage is the misalignment between supply and demand, and the high rates of teacher turnover and early attrition. Additionally, the uneven distribution of teachers across geographic and subject areas continues to be troublesome. That is, the need for highly qualified teachers at the middle and secondary levels in high demand fields, like mathematics and science, and in urban, low-income schools as well as remote rural schools, continues to be a reality. Thus, to solve the teacher shortage problem, education policy-makers must take into account the quality requirements for teachers in specific school contexts and specific fields, such as science, in addition to increasing the overall supply of teachers.

Despite the complexity of the AC policy landscape and the paradoxical nature of the AC policy involving the tradeoff between incentives and standards, that is, between teacher quantity and quality, this policy white paper provides a review of variables that influence the production, recruitment and retention of AC teachers in general and AC science teachers in particular.

STEM ACT Conference Report

Policy Section

Introduction

The University of Massachusetts (UMass) STEM Education Institute and the UMass School of Education hosted a National Science Foundation funded conference called STEM ACT in Arlington, VA on May 5-7, 2006. The focus was on what we know and what we need to know about alternative certification programs for science teachers. By limiting the discussion to science teachers, we could explore the issues that are specific to this subject area. The goal was to frame a research agenda while providing useful advice in the form of relatively short “white papers” to the academic research, policy maker, and provider communities; the second of these is the audience addressed in this document. The Appendix lists the papers presented in the policy thread.

Alternative teacher certification has become one of the most significant contemporary educational policy issues across America and a favored policy response of the U.S. Department of Education to the dual demands of improving teacher quality and increasing teacher supply. The U.S. Secretary of Education’s Third Annual Report on Teacher Quality (U.S. Department of Education, 2005) promotes alternative certification, and the federal No Child Left Behind Act includes participants in alternative certification programs in its definition of “highly qualified” teachers. The importance placed on alternative certification by policy-makers is evidenced by the fact that substantial increases in investment in alternative certification programs have occurred even when overall educational expenditures at the state and federal levels have been declining (Guarino, Stantibanez, Daley & Brewer, 2004). Nevertheless, the rapid growth of alternative certification has not been systematic and has generated a great deal of debate about what exactly is alternative teacher certification and how effective the various types of teacher training programs are in providing greater quantities and higher quality teachers for America’s classrooms (Dixon & Ishler, 1992; Feistritzer & Chester, 2002; Huling-Austin, 1986; Roth, 1986).



Much of the existing literature on alternative certification programs is in the policy domain and has looked broadly at teachers and teacher education, without a subject matter focus. This is problematic because one of the main issues currently being debated is the importance of subject matter knowledge and literacy skills compared to pedagogical and pedagogical content knowledge (Allen, 2003; Darling- Hammond & Youngs, 2002). Therefore, the purpose of this paper is to explore policy issues related to alternative certification for *science* teachers.

The focus on science teachers is particularly significant given the ever increasing importance of science in daily life throughout our society and the world, the intensification of global competition in science, and deepening concerns about the ability of the United States to produce

highly skilled scientists. These points drive the recent report entitled “Rising Above the Gathering Storm” (2005), in which it is noted (p. 5):

In a world where advanced knowledge is widespread and low-cost labor is readily available, U.S. advantages in the marketplace and in science and technology have begun to erode. A comprehensive and coordinated federal effort is urgently needed to bolster U.S. competitiveness and pre-eminence in these areas.

This congressionally requested report made four recommendations, including: “[a]nnually recruit[ing] 100,000 science and mathematics teachers . . . , thereby educating 10 million minds.” (p. 5). Clearly, science teacher supply and demand is a timely topic of great importance, not only within education, but for American society as a whole.

A survey of urban school districts indicated that 95% of responding urban school districts had an immediate demand for high school science and mathematics teachers. Eighty percent reported a need for middle school science and mathematics teachers (Urban Teacher Collaborative, 2000). Lawrenz, Appleton, Bequette, Ooms, & Wassenberg (2006) note that recent studies (Ingersoll, 1999; 2003) show that 56% of secondary students in physical science are being taught by teachers without a major or minor in physical science, and 27% of students in mathematics are being taught by teachers lacking even a minor in mathematics. Furthermore, the authors cite that students in high-poverty schools are 77% more likely to be taught by an out-of-field teacher. Clearly, fields such as science and math require high levels of attention as we strive to improve the teaching corps in American schools.

Given this policy context, this paper focuses on identifying key policy issues and strategies related to better understanding and improving the alternative certification of science teachers. The paper starts with the definition and scope of alternative certification in general, and then addresses current contextual issues related to the supply and demand of science teachers respectively. The paper concludes that alternative certification policy makers need to be better informed of empirical evidence based on systematic documentation so as to address more effectively the issues relating to both teacher supply and demand.

It is also clear that much more research is needed on teacher preparation programs of all kinds to better define policy issues. Conference keynote speaker Ken Zeichner stressed the difficulty of conducting meaningful work in this field, and concluded that most of the existing literature focused on surface characteristics and not deeper issues (Zeichner, 2006).

1. Defining the Nature and Scope of Alternative Certification

<p><i>Blurring of the lines between alternative and traditional routes seems likely to increase.</i></p>	<p>“Traditional” teacher certification refers to public school teaching credentials acquired by completing a state-approved program at an institution of higher education. “Alternative” teacher certification may be generally defined as any significant departure from the regular/traditional undergraduate route through teacher education programs in universities and colleges (Oliver & McKibbin, 1985, Mitchell 2006).</p>
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Based on a state-by-state analysis of alternative certification programs, Feistritzer and Chester summarize the definition of the term “alternative teacher certification” as follows:

[The term] historically has been used to refer to every avenue to becoming licensed to teach, from emergency certification to very sophisticated and well-designed programs that address the professional preparation needs of the growing population of individuals who already have at least a bachelor’s degree and considerable life experience and want to become teachers (Feistritzer & Chester, 2002, p. 3).

Alternative certification programs typically offer qualified teacher candidates a streamlined preparation program that places them in the classroom as the teacher of record more quickly than traditional university-based programs. Furthermore, while traditional programs are generally structured around coursework and a culminating student teaching experience, many university programs are increasingly integrating coursework and student teaching. This blurring of the lines between alternative and traditional routes seems likely to increase.

A review of literature shows that there is a myriad of alternative teacher certification programs across the states with variations regarding program objectives, duration, content, training approaches, characteristics of teacher candidates, and certainly program effectiveness. For example, some alternative programs are traditional teacher education programs in a different package delivered at night for working adults; others are college-based programs for teachers hired with emergency certificates to complete a certain amount of coursework; still others are “fast-track” programs providing accelerated entry for prospective teachers to move through the basic curriculum and quickly begin classroom teaching (Feistritzer & Chester, 2002; Huling-Austin, 1986).

There are various forms of alternative teacher certification programs at national, state, and local levels, although prospective teachers have to meet the specific certification requirements of the particular state. National programs focus on preparing particular types of candidates for teaching, such as recent, high-achieving college graduates (e.g., Teach for America) or retiring military personnel (Troops to Teachers). State programs, such as the Massachusetts Institute for New Teachers (MINT), typically focus on statewide shortages as well as building a diverse pool of candidates. District-run programs tend to focus on specific shortages, often in urban areas (e.g., Los Angeles Unified School District’s alternate route).



There are also alternative teacher certification programs designed for substantially different populations of candidates from those of traditional teacher preparation programs (Huling-Austin, 1986). Examples include career switchers (e.g., the teacher education program at Bank Street College of Education), paraprofessionals becoming teachers (e.g., programs for paraprofessionals in SREB states), and new college graduates entering teaching after graduation (e.g., Attracting Excellence to Teaching in Massachusetts). Most of these programs are designed

for candidates who already have a bachelor’s degree and are employed as teachers while earning

a regular teaching license by completing the program. It is claimed that alternative teacher certification programs serve candidates “who will most likely be placed in teaching positions that are difficult-to-staff for any of a variety of reasons” (Huling-Austin, 1986, p. 52).

Although Feistritz and Chester (2002) contributed a comprehensive working definition, the term “alternative certification” itself is inherently problematic. Roth (1986) distinguishes between “alternate” and “alternative” route programs, with the former defined as a program for an individual with a bachelor’s degree

“only if fully certified personnel are not available”, while the latter indicates a “choice” that a school district makes of “hiring an individual who is fully certified or hiring an individual without teacher preparation” (p. 1). While Roth’s semantic distinction has policy implications, Dixon and Ishler (1992) delve into the differentiation between “alternative routes to certification” and “alternatives to certification” and the underlying beliefs about the role of pedagogy in teacher education. They posit that “alternative routes to certification” recognizes the need of providing non-traditional educational opportunities for culturally diverse students to be pedagogically prepared, while “alternatives to certification” indicates that teaching is an innate ability and pedagogy is just classroom survival tools (Zhao, 2005).

Debates about the meaning and definition of alternative certification are not merely over semantics; they reflect competing ideological beliefs, pedagogical implications, and political agendas.

Debates about the meaning and definition of alternative certification are not merely over semantics; they reflect competing ideological beliefs, pedagogical implications, and political agendas. As Hawley (1990) stated, alternative certification is “evidence of the relative political strength of the opponents and proponents of the art and craft view of teaching and the intensity which these parties bring to the debate” (p. 5). What should be added to this comment or made more explicit is that alternative teacher certification is also evidence of where the opponents and proponents stand in the context of a multicultural, unevenly distributed student population, with diverse needs and wants, that a generic engineering process of teacher preparation is not able to meet (Zhao, 2005). In his review of current and future trends in alternative certification, Fenstermacher concludes with a prescient observation:

Given that both traditional teacher education and alternative certification have some distance to travel in meeting the profound ends of teacher education, there may be value in ceasing to think of them as oppositional to one another. Perhaps the best course of action lies in blending these ideas, wherein in the benefits of being close to practice are maintained, but so are the advantages of reflective and critical approaches to pedagogy. This blending of the best from both approaches to teacher preparation would require new models of teacher education. The invention and implementation of such models may be one of the lasting benefits of alternative certification’s challenge to traditional teacher education (Fenstermacher, 1990, p. 182).

As discussed above, the complexity of the alternative teacher certification phenomenon is far beyond the structural characteristics of the programs, such as duration, participants, training approaches, and programs goals, and reveals the fact that “alternative certification” carries different meaning to different people.

Apart from the debates regarding the definitions and legitimacy of alternative teacher certification, many have suggested that the increase of alternative certification has occurred in order to increase the supply of qualified teachers to meet projected demands for teachers (e.g., Hayes, 2006; Hussar & Gerald, 1998; Shen, 1997). The goal has been not only to increase the numbers of new entrants into the teaching profession, particularly in hard to staff subjects and schools, but also to develop new teachers that are more likely to remain in their chosen profession and at the schools in which they were initially hired (Guarino et al., 2004). Thus, alternative teacher certification is an issue with many sides centering upon the supply and demand of high quality teachers.

Some proponents of alternative certification programs have argued that they are likely to attract a more diverse population. However, in at least one study, it was found that these programs have the same difficulty attracting significant numbers of women and people of color into STEM teaching. Women who do choose STEM teaching careers are more likely to be found in biology than in any other specialization. People of color continue to be underrepresented in STEM specializations, except Asian-Americans who comprise a greater proportion of math teachers than would be otherwise expected (Chin, 2006).

A question facing AC programs is evaluating the content knowledge of its candidates. One way to assess this is with the state teacher tests. However, in a study of AC candidates at the University of North Texas, the level of the candidate's content area coursework, grade point average, and the time elapsed since the last upper-level content area course were not statistically significant predictors of success on the Texas Examinations. One reason for this is the mismatch between college science course contents and the material tested by the exams. A further concern is the failure of the tests to provide any measure of pedagogical content knowledge (Harrell, 2006).

Much of the controversy around alternative certification is about the effectiveness of such programs in producing teachers who can improve student performance. This has been addressed in a large scale study in New York City of participants in two selective AC programs, Teaching Fellows and Teach for America, and graduates of conventional teacher education programs. It finds that in some instances the Fellows and TFA members produce higher student achievement gains than the temporary license teachers they replace, but more typically, alternate route teachers are no worse than these teachers in their classroom results. When compared to teacher education graduates, the AC teachers often provide smaller gains in student achievement, at least initially. Many of these differences are not large in magnitude, typically about 2 to 5 percent of a standard deviation, and the variation in effectiveness within pathways is far greater than the average differences between pathways (Boyd, 2006).

It should be noted that the issues relating to alternative certification are not solely an American concern. Similar questions are being addressed, for example, in Canada (Vázquez-Abad, 2006) and in Australia (Harrison, 2006).

... teacher shortages are distributed unevenly depending on localities and specialties...

2. The Supply Side of (Alternative) Teacher Certification

A “qualified” teacher in the United States typically is defined as an individual who holds a bachelor’s degree in education. The label can also refer to someone “who has gone through a college education program approved by the state department of education which has the authority to then confer a license to teach” (Feistritzer & Chester, 2002, p. 10). Based on the latter definition, only a third of fully qualified teachers nationwide are actually teaching the following year. Meanwhile, some 20 percent of all new hires leave the profession within three years, and in urban districts, nearly 50 percent of new teachers leave the profession within the first five years (National Education Association, 2002, 2003). Seventy-five percent of current teachers have a bachelor’s degree in education, and the rest have a bachelor’s degree in a field other than education (Feistritzer & Chester, 2002).

The projected shortage of qualified teachers is based on student enrollment increases, increased retirements of teachers, teacher attrition, and class size reduction (Feistritzer & Chester, 2002). However, researchers agree that severe nationwide shortages of teachers exist today in specific subjects and in regions that are considered less desirable for working and living. Therefore, teacher shortages are viewed in part as an issue of distribution rather than production (e.g., Darling-Hammond, 1999, 2000a, 2000b, 2000c; Darling-Hammond & Sykes, 2003; McDiarmid, Larson, & Hill, 2002, Ingersoll, 2001, 2003; Feistritzer & Chester, 2002). In other words, teacher supply/shortage is a context-specific issue. Teacher shortages are distributed unevenly and depend on geographic and subject areas (www.recruitingteachers.org). It is particularly acute in urban and rural communities. It is also acute for high-need subject areas such as mathematics and science, English as a second language, bilingual education, and special education, as well as for teachers of color and male teachers in some subject areas. There is some overlap of geography and subject as well. “In 1993-1994 only 8% of public school teachers in wealthier schools taught without a major or minor in their main academic assignment — compared with fully a third of teachers in high-poverty schools” (Darling-Hammond & Sykes, 2003, p. 17). Hard-to-staff schools actually experience shortages even in specialties with a surplus of licensed teachers, such as English (McDiarmid, et al., 2002).

Based on data drawn from the two most recent cycles of the Teacher Followup Survey (1994-95 and 2000-01), Ingersoll (2003) unpacked the teacher shortage and used the term “teacher turnover”, which includes both teacher attrition and teacher migration. Teacher attrition refers to teachers leaving the profession altogether (the leavers); teacher migration refers to teachers transferring or moving to different teaching jobs in other schools (the movers). Studies on teacher shortage usually focus on teacher attrition assuming that teacher migration does not affect overall teacher supply. Nevertheless, it is a serious problem for certain types of schools to find qualified teachers. Thus both teacher attrition and teacher migration are the contributing factors to uneven distribution of teachers, and they are the major reasons for increased demand for teachers, rather than student enrollment and teacher retirement, which only accounts for 13% of total turnover, and 25% of leavers (Ingersoll, 2003, p. 3). The math/science teacher shortage serves as an example.

Although more new teachers are produced than needed, there is a shortage of mathematics and science teachers (Darling-Hammond & Sykes, 2003; Ingersoll, 2003). The turnover rate for math/science teachers is higher than that for teachers in a number of other fields, but the reasons

why they depart from their teaching jobs, according to Ingersoll (2003), do not greatly differ from other teachers. “A large proportion indicate they depart for personal reasons (34% of migration and 44% of attrition). A large proportion also report they depart either because they are dissatisfied with their jobs or to seek better jobs or other career opportunities (40% of math/science teachers and 29% of all teachers)” (p.6). For every kind of community, reasons for both teacher migration and attrition include low salaries, student discipline problems, little support for new teachers, and little faculty input into school decision making. Schools with these characteristics tend to lose teachers to schools without these problems (Ingersoll, 2003). There are certain factors that policy changes cannot impact, such as teacher departure because of personal reasons, but how can alternative teacher certification address problems such as low salaries and inadequate new teacher school support which exist in schools with high turnover?

The key policy issues regarding the supply of alternatively trained science teachers revolve around the question: *What factors influence the attractiveness of science and math teaching to potential workforce entrants?* Policy-makers need to consider how a range of variables influences the supply of teachers. More specifically, in line with the purpose of this paper, policy-makers need to be aware of the factors associated with ensuring that the millions of dollars being invested in alternative certification are efficiently and effectively increasing the teacher supply, particularly in high need areas such as science. Moreover, given the diverse range of programs that fall under the rubric of alternative certification, policy-makers should consider which types of programmatic features are related to different categories of factors that are likely to influence supply.

A synthesis of much of the literature cited above suggests the supply of teachers is dependent upon four broad categories of variables:

- Training
- Licensure Testing Requirements
- Income & Compensation
- Working Conditions

Each of these categories can be conceptualized as representing different points in the supply pipeline – traditional and alternative – through which the supply of teachers is produced throughout the country. Training is typically the first segment of that pipeline as prospective teachers are trained and socialized as preparation for entering the professional role. Licensure testing requirements follow training, as an assessment of how well prepared potential teachers are as a result of the training. Income and compensation are key factors in both recruitment and retention, while working conditions have been shown to be a key influence on teacher retention (Guarino et al., 2004). It is worth noting that there is little empirical evidence on the influence of these factors on science teacher supply.

Each of these factors can be broken down into sub-categories that should be taken into consideration by policy-makers as they make decisions about the issues that must be addressed to promote an increased supply of science teachers. Within the category of “Training”, issues such as pre-requisites (e.g. content knowledge, previous experience, contextual congruence), length (number of courses, years, etc.), cost (including foregone earnings and opportunity costs), difficulty of requirements and value or quality (perceived benefit in relation to cost) are all

potentially important sources of influence. Similarly, licensure testing requirements vary in terms of cost (exams, applications, etc.) and level of difficulty (which tends to vary greatly by state). Income/compensation can be quite complex. Various aspects of income compensation include entry salary, future earnings, salary increments gained through experience, salary increments gained through career advancement opportunities (e.g. master teacher, head of department, etc.) and retirement. The list of potentially influential working conditions is quite long and includes:

- Number of Preps
- Supplies and Equipment
- Curriculum Resources
- Student Behavior
- Parental/Community Support
- Balance of Autonomy and Collegiality
- Administrative Support
- Mentoring, Induction Programs (etc.)
- Class Size
- Schedule Flexibility
- Intrinsic Rewards
- Professional Prestige
- Community-to-community and state-to-state differentials

“The sheer size of the teaching force combined with the relatively high annual turnover of the teaching occupation means that there are relatively large flows in, through, and out of schools each year”

Teaching represents 4% of the entire nationwide civilian workforce, and has a relatively higher turnover rate than other occupations. “The sheer size of the teaching force combined with the relatively high annual turnover of the teaching occupation means that there are relatively large flows in, through, and out of schools each year” (Ingersoll, 2003, p. 3). The instability of staffing, which does not apply to all schools and districts, not only causes problems for school administration, but also affects student learning. Teacher turnover, the driving force for demand for new teachers, indicates that generic teacher recruitment policies and strategies alone, in certain schools and districts, will not solve their school staffing problems without the issue of teacher retention adequately addressed in a context-sensitive way. Thus the conclusion seems to be that the core of the problem is not exclusively teacher supply/shortage, but includes the other side of the coin – teacher demand.

3. The Demand Side of (Alternative) Teacher Certification

Teacher shortages occur in a labor market when demand is greater than supply. This can be the result of either increases in demand or decreases in supply or both. The extent to which the demand for teachers is either unmet or exceeded generally determines the motivation for changes in policy. Guarino et al. (2004) have developed a conceptual framework that is helpful for thinking about the policy context of alternative certification of science teachers as a particular type of labor market. Their conceptual framework defines the demand for teachers as “the number of teaching positions offered at a given level of overall compensation” and the supply of teachers “as the number of qualified individuals willing to teach at a given level of overall compensation” (p. 174). The authors further note that overall compensation includes not just salaries and benefits, but also other types of intrinsic rewards such as working conditions and

personal satisfaction. Therefore, the types of compensation “packages” available in any school or district will determine how many teachers can be employed and how many qualified teachers will be willing to be employed in each setting. When elaborating on teacher turnover as a context-specific phenomenon, Ingersoll (2003) noted that schools across the country with significantly lower levels of teacher turnover bear the reverse characteristics of those that tend to lose teachers. That is, schools with good support from the school administration for new teachers, such as induction and mentoring programs, with higher salaries, fewer student discipline problems, and enhanced faculty input into school decision-making, have higher teacher retention rate.

This part of the report is intended to explore why and where these strategies and conditions for teacher recruitment and retention are not a reality. Sources of influence on science teacher demand include:

- Accountability Systems
- Resource Allocation
- Screening and Selection
- Career-changer Bias
- Retention

Accountability systems are the flip side of license testing requirements; except, rather than focusing on the standards set for individual teachers to meet, the focus is on the ways in which teachers and schools can demonstrate that they are providing quality education for students. Particularly for science teachers, the difficulty of entry standards and the rigidity of subject-specific certification requirements are potentially significant policies that may dampen incentive in order to ensure quality.

Resource allocation also influences teacher demand. At the macro-level, the funding available through federal and state support plays an essential role in defining the demand for teachers at district and school levels. Local property values also affect demand, since in most cases that determines the ability of communities to support their schools. The choices made by district and school leaders about how best to spend resources – for example, on recruitment and retention, and the number of science and math teaching positions – are some of the most powerful sources of influence on teacher demand.

Screening and selection overlap with the first two categories. The resources allocated to screening and selection processes are important to consider. Also, it is likely that higher entry standards will reduce the quantity of available teachers.



These strategies and conditions indicate a policy “trade off” for alternative certification, in which one type of emphasis (e.g. alternative certification as an incentive to attract individuals who might not otherwise pursue teaching as a career) may be negated or curtailed by another initiative (e.g., higher standards to ensure higher

quality teachers by eliminating those who are, or appear to be, less qualified). In other words, incentive policies represent attempts to increase the quantity of teachers necessary to meet demand. Policies of standards are designed to increase the quality of teachers, but may have a negative effect on quantity.

This “incentives vs. standards” dilemma is not atypical in the paradoxical world of public policy. It is likely that alternative certification also creates tensions around short-term versus long-term effects. Incentive policies may generate larger pools of entering teachers in the short-term, but may also create a long-term retention problem once the allure of initial incentives is replaced by the realities of teaching in under-resourced public schools. Conversely, standards may eliminate candidates early in the pipeline, but may promote better retention by promoting higher levels of preparation. These are empirical questions for policy analysts that should be addressed in future studies. Examination of such questions and paradoxes is particularly important in a policy environment in which limited resources have been (and will be) available to serve multiple and sometimes competing needs within the American education system.

In addition to the sources of influence listed above, a less obvious one is the context for career-changers. This is particularly germane to alternative certification policy as districts and schools make choices about the use of such policies to recruit career-changers and there is documentation that many career-changers face in-school biases against them (Churchill, Berger, Brooks, Efrat, Griffin, Magouirk-Colbert, McDermott, Sharick & Shaheen, 2002).

Collectively, all of these sources of influence can affect retention: in the profession, in the school, and in high need districts. While retirement plays a role, Ingersoll (2003) and others have demonstrated that competition for talent within the education systems and competing opportunities outside of education contribute greatly to teacher turnover; particularly in high need districts and for individuals with science backgrounds who are likely to have attractive career opportunities outside of teaching.

Conclusion

Alternative certification has arisen as a policy response to concerns about supply and demand imbalances in the teacher labor market; this is particularly true for science teachers. Yet, there is little empirical research documenting the specific effects of potential sources of influence on individuals’ decisions to join this labor market as science teachers, nor has there been much data systematically gathered about the ways in which demand for science teachers is constructed at national, state and local levels. A better research base to inform policy-makers is clearly needed. This is particularly true at a time when the need for science teachers is so great and at a time when greater amounts of resources are being devoted to alternative teacher certification. Moreover, the diversity of alternative certification programs has been demonstrated to attract a wider variety of individuals (e.g. career changers) into the profession. However, it is not clear which, if any, of these programs are more attractive for science teachers and which, if any, of these programs prepare science teachers well enough to increase the likelihood that they will be well grounded in content-specific knowledge and persist as science teachers. These are important questions that policy-makers should be seeking answers to through research as we strive to improve the practice of teaching science through more and better qualified teachers.

Appendix: Policy Presentations

The practice and research presentations are listed in the respective reports. Abstracts and papers for most of these presentations are available at www.stemtec.org/act.

Keynote: *Ken Zeichner, University of Wisconsin-Madison*

Title: WHAT DO WE KNOW ABOUT THE CHARACTERISTICS OF GOOD TEACHER EDUCATION PROGRAMS?

Emily Feistritzer, National Center for Alternative Certification

Antoinette Mitchell, National Council for Accreditation of Teacher Education

Title: THE NATIONAL COUNCIL FOR ACCREDITATION OF TEACHER EDUCATION AND ALTERNATIVE PROGRAMS: AN UNEXPECTED CONVERGENCE

Cassandra Guarino, RAND

Title: TEACHER RECRUITMENT AND RETENTION: A REVIEW OF THE RECENT EMPIRICAL LITERATURE

Frances Lawrenz, James J. Appleton, Marjorie Bullitt Bequette, Ann Ooms and Deena Wassenberg, University of Minnesota

Title: TRIPARTITE SYNTHESIS OF RESEARCH AND DATA ON RECRUITMENT AND RETENTION OF STEM TEACHERS

Hamilton Lankford, University at Albany - SUNY

Title: HOW CHANGES IN ENTRY REQUIREMENTS ALTER THE TEACHER WORKFORCE AND AFFECT STUDENT ACHIEVEMENT

Elaine Chin, California Polytechnic State University

Title: CHARACTERISTICS OF SCIENCE AND MATH TEACHERS PREPARED THROUGH ALTERNATIVE CERTIFICATION PROGRAMS IN CALIFORNIA

Allan G. Harrison, Central Queensland University, Australia

Title: RECRUITING AND EDUCATING SCIENCE TEACHERS IN AUSTRALIA

Jesus Vázquez-Abad and Jean-Pierre Charland, Université de Montréal, Canada

Title: PREPARING SCIENCE TEACHERS FOR QUÉBEC'S HIGH-SCHOOL AT UNIVERSITÉ DE MONTRÉAL

Pamela Esprivalo Harrell, University of North Texas

Jennifer K. Jackson, Western Governors University

Title: TEACHER KNOWLEDGE MYTHS: AN EXAMINATION OF THE RELATIONSHIP BETWEEN THE TEXAS EXAMINATIONS OF EDUCATOR STANDARDS AND FORMAL CONTENT AREA COURSEWORK, GRADE POINT AVERAGE AND AGE OF COURSEWORK

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