The Math and Science Teacher Pipeline in North Carolina

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EXECUTIVE SUMMARY

During the 2005-2006 academic year, the Program on Public Life at the University of North Carolina at Chapel Hill (UNC-CH), in conjunction with the UNC-CH School of Education, hosted a series of discussions about key issues in North Carolina public education. The central topic of one of these meetings was the status of the state's math and science teacher pipeline. At the request of the discussants, the Program on Public Life undertook the task of compiling a data-based study of both the supply and the demand sides of this issue.

The key findings of this study were:

Production

Only about half of all active licensed math and science teachers were trained in traditional in-state licensure programs.

- Traditional licensure programs at North Carolina colleges and universities — public and private combined — have provided around ***56%*** (about 7,400 out of 13,200) of the state's licensed math and science classroom teachers.
- The majority of traditional-route math and science teachers who were trained in-state — including the majority of early career[1] teachers — were educated in our public colleges and universities.
- The state does not produce enough math and science teachers to meet apparent demand; however, demand is largely a result of the number of teachers who leave the profession early - high teacher turnover as opposed to low Institute of Higher Education (IHE) production is the greatest contributor to the shortage. (See ***Retention***, below.)

Retention

Most math and science teachers are hired to replace teachers who leave the profession, the classroom, or the state - not to meet the demand of increasing student enrollment.

- Math and science teachers leave the classroom at a very high rate during their first two years of teaching, and they continue to leave at a lower but steady rate in successive years.
- For every 10 math and science teachers hired, over 7 are hired to fill vacancies and only a little more than 2 are hired to meet growth in the student population.

- The retention problem is a result not just of the state losing teachers due to retirement, career changes, and moves out of state, but also of schools having to deal with teacher movement among Local Education Agencies (LEAs, or school districts) in-state.

Quality

Many school districts employ a high proportion of early career math and science teachers.

- In forty Local Education Agencies (LEAs) about one out of every four math and/or science teachers is an early career teacher (a teacher with 0 to 3 years of experience); in 11 of these LEAs, early career teachers make up one-third or more of their licensed math and science teacher populations.

- Most of the state's licensed math and science teachers (around 90%) are designated as highly-qualified; however, middle school science license holders lag behind other math and science teachers in earning the highly-qualified designation.

Presence

Teachers trained in-state in traditional licensure programs are not present in equal proportions across all LEAs.

- School systems of similar size employ sometimes widely different numbers of licensed math and science teachers.

- Many of our active and licensed math and science teachers (over 2,000, or roughly 13%) are not working in middle or high school classrooms.

- Teachers trained in-state in traditional licensure programs are not employed at the same rate across all LEAs. This problem is more prevalent among early career teachers: in 2005-2006, there were 17 LEAs that employed no traditional-route early career math or science teachers from the state's top-producing IHEs.

- Many of these inequalities may be related to rurality, but the inequalities do not appear to be related to low or nonexistent local salary supplements.

Overview: Background and Questions Addressed

There are four main factors to consider when analyzing the math and science teacher pipeline: ***teacher production, retention, quality, and presence***.

Production

Nationally, annual math and science licensure rates are declining[2], and the prevailing policy responses for addressing the teacher gap resulting from this decline have included signing bonus incentives, programs to encourage and support career changes for mid-career professionals, lateral entry programs, and various direct-to-classroom programs for graduating college seniors who do not hold state teaching licenses[3].

The first component of this study is an estimation of the production of math and science teachers - whether via traditional or alternative routes - at all of the institutes of higher education (IHEs) in North Carolina (both public and private) that house state-recognized middle and/or high school math and/or science licensure programs. Rather than just examining the number of candidates who pursued state licensure, however, this study also estimates the number of licensure-eligible candidates produced - that is, the number of candidates who met the requirements for licensure, whether they chose to apply for a North Carolina license or not. By doing so, it is possible to begin to draw conclusions about the potential size of the math and science corps and to estimate how many potential licensees either choose not to pursue licensure in-state or choose not to enter the profession at all.

Retention

Teacher demand in general has increased since the mid-1980s due to larger student enrollments and an increase in teacher retirement, among other things. The greatest contribution to the shortage, however, has been the departure of pre-retirement-age teachers, and the turnover rate for math and science teachers is higher than it is for teachers in many other subject areas[4].

Nationally, dissatisfaction with working conditions has been the main reason given by those who either left the profession or changed schools. Compared to other teachers who left the profession, math and science teachers were much more likely to leave for a job in another occupation[5]. Also, more so than their teaching peers, these teachers were more likely to note job dissatisfaction (as a result of chronic discipline problems, low salaries, little input into school decision making,

etc.) as a reason for leaving the profession[6]. It is important to note that higher salaries alone, while a good start, probably will not attract and retain math and science teachers, especially in hard-to-staff high-needs schools. The package must also include strong school-level leadership and a better working environment[7].

The second part of this study attempts to estimate patterns in math and science teacher retention at the state level. It examines possible links between years of experience and decisions to leave the math or science classroom, as well as estimates of teacher positions created due to student population growth versus positions created due to turnover.

Quality

The third component of this study is an examination of the relative quality of the state's math and science teachers, statewide and per Local Education Agency (LEA, or school district). There is disconcerting evidence that, without high-quality math and science instruction, particularly at the secondary level, many students choose not to pursue careers in science- and math-related fields. As a case in point, overall postsecondary enrollments are up, but enrollments in science, technology, engineering, and mathematics (STEM) degree programs are down. Poor elementary and secondary school preparation, often in the form of poor science and math teaching, is one of the factors many postsecondary students cite as a reason for not pursuing a STEM degree[8].

In North Carolina in 2003-2004, around 8% of all secondary math and science teachers taught without full credentials[9] – well above the national average of 3.6%[10] – but the numbers may be higher than that if we were to include credentialed teachers teaching out-of-field. Nationally, the percentage of high school math and science teachers who are teaching out-of-field is between 17% and 28%[11], and some estimates suggest that sometimes startling percentages of math and science teachers in certain subfields are teaching without a major or minor and licensure. For example, in 2002, 45% of biology and life science high school students and 30% of high school math students were taught by teachers who did not hold a degree in the field being taught[12], and, according to recent NCES data, the same may be true for over 70% of all physical sciences teachers[13]. Many of these figures represent increases compared to figures from fifteen years earlier[14].

These problems may be more extreme in areas with higher proportions of students from lower-income families and in some rural schools, where nearly 90% of the math and science teachers come to teaching via lateral-entry routes. While No Child Left Behind (NCLB) legislation aimed at eliminating out-of-field teach-

ing has made inroads into addressing this problem, most states report that they still have not placed highly qualified teachers in every classroom[15].

While there is much debate about valid and reliable ways to determine teacher quality, for the purposes of this study, only licensure status and the NCLB highly-qualified designation were investigated. Alternative licensure pathways such as lateral entry programs have helped to increase the teacher supply, but some research indicates that they have done so at a cost[16], and therefore disaggregation of math and science teachers by licensure type in future studies may be warranted.

Presence

Coupled with the high-quality teacher shortage is the dual problem of equal and equitable distribution of the teaching workforce. Teachers, like many other professionals, tend to migrate toward certain geographic locations (predominantly suburban districts), and away from others (such as inner-city and rural districts and high-needs schools), and they do so for a variety of reasons. They also tend toward certain licensure areas, such as elementary education, and away from other high-needs licensure areas, such as mathematics and science[17]. The end result is an imbalance in teacher distribution across disciplines and across regions that is often masked by aggregated state licensure numbers.

The fourth and final part of this study considers differences in the presence of licensed math and science teachers across LEAs. In addition, this part of the study also details the degree to which the state's largest math and science teacher preparation programs serve each area of the state by estimating where their graduates currently hold teaching positions.

* * *

Questions Driving the Report

<u>Production</u>

- How many math and/or science licensed teachers are teaching in North Carolina?
- Of those teachers, how many earned their licensure in-state?
- How many teachers eligible for math and/or science licensure do North Carolina institutes of higher education (IHE) produce each year?

- What incentives are in place for attracting applicants to math and science licensure programs?

Retention

- At what rate is the state losing math and science teachers?
- What are some of a typical LEA's teacher retention challenges?
- How do math and/or science leavers compare to new math and/or science hires?

Quality

- How many math and/or science teachers in North Carolina are considered to be highly qualified, and where are they teaching?
- How many are early career teachers, and where are they teaching?
- How many unlicensed teachers are teaching math and/or science in North Carolina?

Presence

- Where are our math and science teachers teaching?
- To what degree do the state's largest math and science teacher preparation programs serve the entire state?
- What has been the demand for math and science teachers for the past several years, per local education agency (LEA)?
- What is the relative distribution of licensed teachers across the state? In other words, which LEAs have the highest and lowest percentage of licensed teachers in their schools?

A list of the questions left unanswered by this report can be found in ***Appendix B***.

* * *

A full description of the data and methodology used for this report can be found in ***Appendix D***.

Findings

1 Production

Only about half of all active licensed math and science teachers were trained in traditional in-state licensure programs.

Finding: Traditional licensure programs at North Carolina colleges and universities - public and private combined - have provided around ***56%*** (about 7,400 out of 13,200) of the state's licensed math and science classroom teachers.

> Of the over 13,200 license holders who were actually teaching in a middle or high school classroom during the 2005-2006 school year, only 7,400, or 56%, were trained in traditional in-state licensure programs. The rest completed their licensure work out-of-state. In other words, at least 44% of the state's math and science teachers either received all of their training out-of-state or entered the teaching profession through an alternative licensure program (34%), or are currently enrolled in a lateral entry program (10%), indicating a far greater need for math and science teachers than is currently being met by traditional in-state teacher education programs. *(See Supplemental Table E.)*

Finding: The majority of traditional-route math and science teachers who were trained in-state - including the majority of early career[18] teachers - were educated in our public colleges and universities.

> Active state employees (local central office staff as well as classroom teachers) with math and science licensure who were trained in traditional in-state programs (around 8,600 employees) hold approximately 9,900 degrees from colleges and universities with math and science licensure programs. At least 7,500 of those degrees came from public Institutes of Higher Education (IHEs); at least 2,000 of those degrees came from private IHEs. (The remaining 400 earned licensure via an RALC or were not clearly linkable to an IHE with a math or science teacher education program.) *(See Supplemental Table B.)*

Finding: The state does not produce enough math and science teachers to meet apparent demand; however, demand is largely a result of the number of teachers who leave the profession early - high teacher turnover as opposed to low IHE production is the greatest contributor to the shortage. (See ***Retention.***, below.)

At a rate of about 500 candidates per year (of whom in 2005-2006 only about 320 completed traditional-route programs and chose to teach in-state), the state's IHEs are not producing as many teachers as are needed to meet an estimated annual demand that may be as high as 1,200 teachers or higher.

However, it would be inaccurate to conclude that the state's IHEs are not producing "enough" math and science teachers. The state's IHEs are, indeed, not producing enough new teachers to meet demand, but there are multiple reasons for high demand. In addition to a growing student population, a high teacher turnover rate and decisions to teach out-of-state also contribute to the shortage. In addition, it is important to note that several IHEs support many active classroom teachers who are still enrolled in lateral entry programs and therefore are not included in the program completion figure reported above.

Many of the state's IHEs provided information for this report about programs they sponsor to attract, retain, and support candidates for math and science licensure. **Appendix C** contains a summary of those programs and also notes which programs are present at each IHE.

2 Retention

Most math and science teachers are hired to replace teachers who leave the profession, the classroom, or the state - not to meet the demand of increasing student enrollment.

Finding: The state supports a wide variety of general recruitment and retention programs, many of which are described in **Appendix C**. Of particular note for math and science teacher recruitment and retention are one current policy and one new pilot program. The state has long had in place a policy of granting non-teaching work experience credit for work deemed relevant to a teacher's content area, and this credit (in the form of years of experience granted, which increases teacher pay) is of particular importance to recruiting and retaining potential teachers who work in math- and science-related fields. More directly related to math and science teachers, the state is sponsoring a pilot program for the 2006-2007 school year that provides a $15,000 signing bonus for math and science teachers who take jobs in schools designated by the State Board.[19]

Finding: Math and science teachers leave the classroom at a very high rate during their first two years of teaching, and they continue to leave at a lower but steady rate in successive years.

> If we take 2004-2005 and 2005-2006 teacher numbers as fair representations of trends, math and science teachers leave the classroom rapidly after the first two years of teaching. A steady but less drastic proportion of each cohort of teachers continues to leave the classroom over the next twelve years of their careers. In 2005-2006, teachers with no experience or one year of experience made up 7.4% and 6.4% of the secondary classroom teaching workforce, respectively; the proportion of teachers with more years of experience was never higher than 4.9% per cohort and averaged about 2.2%. *(See Appendix A, Graph 1.)*

Finding: For every 10 math and science teachers hired, over 7 are hired to fill vacancies and only a little more than 2 are hired to meet growth in the student population.

> It is difficult to estimate the total annual number of hires of math and science teachers who are new to the profession or new to the state, but we can begin to make approximations based on teachers hired with no experience, the relative differences between the number of teachers employed at each subsequent experience level, and the growth in the middle

and high school student population from year to year. Taking all of these indicators into consideration yields a conservative estimate of about 1,200 new hires in 2005-2006; the actual number probably would be higher if we could account accurately for the hiring of early-career and mid-career teachers with experience who were new to the state in 2005-2006.

The secondary student population has grown by only about 2.5% per year over the past ten years, which, given the current teacher-student ratio, equates to just under 300 new teacher positions of our estimated 1,200 vacancies last year. Even if we only consider zero-experience hires for 2005-2006 and ignore all hires of more experienced teachers new to the state, we can see that the majority of these zero-experience teachers were hired to replace departing experienced teachers, not to meet demand created by growth in the student population. There always will - and should - be vacancies due to turnover; the question for the state is whether the current rate of turnover is acceptable.

Finding: The retention problem is a result not just of the state losing teachers due to retirement, career changes, and moves out of state, but also of schools having to deal with teacher movement among LEAs in-state.

Estimates for this report suggest that the statewide annual state-leaving or profession-leaving rate for math and science teachers is probably around 7%, but in a 2005 study, the Department of Public Instruction reported an average annual teacher leaving rate for all disciplines of about 12% per LEA. One reason why the statewide estimate is lower than the average reported LEA leaving rate is because it does not include teachers who stay in-state and in-profession but who move between LEAs. In 2004-2005, nearly 20% of all teachers who left their positions did so to take jobs in another LEA[20]. In other words, individual LEAs must contend with a high rate of turnover for reasons other than out-of-state moves, retirement, or career changes; many LEAs constantly face the challenge of losing math and science teachers to other North Carolina LEAs.

3 Quality

Many school districts employ a high proportion of early career math and science teachers.

Finding: Most of the state's licensed math and science teachers (around 90%) are designated as highly-qualified; however, middle school science license holders lag behind other math and science teachers in earning the highly-qualified designation.

> Though a definite pattern is not discernable, it is interesting to note that, of the 16 largest LEAs (LEAs with more than 10,000 students), 10 employed a higher-than-average number of early career math and science teachers (led by Guilford County at over 33%). Of the 14 smallest LEAs (LEAs with less than 1,000 students), only 4 employed a higher-than-average number of early career math and science teachers (in fact, Camden and Gates Counties employed no math and science teachers with less than 4 years of experience). The teaching workforces of three LEAs - Hoke, Jones, and Vance Counties - were composed of at least 40% early career teachers. *(See Supplemental Table F.)*

Finding: In forty LEAs about one out of every four math and/or science teachers is an early career teacher (a teacher with 0 to 3 years of experience); in 11 of these LEAs, early career teachers make up one-third or more of their licensed math and science teacher populations.

> Over 88 percent of the licenses held by licensed math and science classroom teachers also were held by teachers who were designated "highly qualified"for those areas of licensure under the stipulations of the federal No Child Left Behind Act. The rate was highest for high school math and science teachers (about 94%). However, over 1,000 (nearly 22%) of the 3,700 middle school science license holders were not designated "highly qualified." *(See Supplemental Table H.)*

4 Presence

Teachers trained in-state in traditional licensure programs are not present in equal proportions across all LEAs.

As explained in the **Data and Methodology Appendix (Appendix D)**, because most of the state's licensure programs do not track licensure candidate placement, it is impossible to determine with a high degree of accuracy the distribution of teachers across the state based on the IHEs at which they completed their licensure programs. However, the state does record information about the institution from which a licensee earned a degree. Since a licensee can earn a degree from one institution and eligibility for licensure from another institution (as is often the case with lateral entry teachers, for example), we cannot completely substitute a count of degree-granting institutions for licensure-eligibility-granting institutions.

However, we can make approximations about the extent to which each IHE provides teachers for the entire state by counting degrees per institution. By comparing the proportion of in-state, traditional-route teachers with degrees from a certain IHE in each LEA versus the relative sizes of each LEA, we can begin to get a picture of the relative distribution of these teachers. Furthermore, by dividing the licensees into two groups - those with three or fewer years of experience and those with more than three years of experience – we can begin to make assertions about differences in patterns of distribution between relatively inexperienced and relatively experienced traditional-route teachers.

Finding: School systems of similar size employ sometimes widely different numbers of licensed math and science teachers.

> LEAs in North Carolina employed about 115 licensed math and science teachers per 5,400 middle and high school students (the size of the secondary student population in an average LEA) in 2005-2006, or about 21 teachers per 1,000 secondary students. Actual LEA hiring rates ranged from as few as 11 licensed teachers per 1,000 secondary students (Yadkin County) to as high as 35 licensed teachers per 1,000 secondary students (Hyde County)[21]. *(See Supplemental Table G.)*
>
> We cannot, however, deduce from these data the difference among LEAs in the number of licensed versus unlicensed or out-of-field teachers employed by each. For example, Yadkin County employs 20 fewer licensed math and science teachers than does similarly-sized Person County, but

we cannot conclude that Yadkin County therefore employs 20 more unlicensed teachers; other factors such as differences in class size would have to be accounted for first.

Finding: Many of our active and licensed math and science teachers (over 2,000, or roughly 13%) are not working in middle or high school classrooms.

Over 1,600 (about 11% of all) active teachers with middle or high school math and/or science licenses were teaching in elementary schools during the 2005-2006 school year. Nearly 400 more (about 2.5% of all licensed and active) were working in central administration offices. Therefore, one possible reason for a perceived math and science teacher shortage is because hundreds of eligible teachers are working in some other capacity *within our school systems*. To be sure, many of the elementary teachers likely hold elementary licenses as well as math and/or science licenses, but according to Department of Public Instruction research[22], math and science positions have been consistently much harder to fill than have been elementary positions. *(See Supplemental Table E.)*

Finding: Teachers trained in-state in traditional licensure programs are not employed at the same rate across all LEAs. This problem is more severe among early career teachers: in 2005-2006, there were 17 LEAs that employed no early career math or science teachers from the state's top-producing IHEs. (See *Map 1, Appendix A.*.)

In 2005-2006, fewer than 30% of all licensed math and science teachers in Polk County and Charlotte-Mecklenburg were trained in-state in traditional licensure programs. In Mitchell, Ashe, Wilkes, Graham, and Gates Counties and Elkin City, over 80% of all licensed math and science teachers were trained in-state in traditional programs. While each LEA employed at least one teacher from one of the ten top-producing IHEs, there were 17 LEAs without any traditionally-licensed early career teachers from the ten top-producing IHEs. Eight LEAs - Polk, Caswell, Halifax, Vance, Warren, and Hertford Counties and Weldon and Lexington Cities - ranked in the bottom 15 on both measures (proportion of all teachers and of early career teachers from top-producing traditional programs). One implication of these data may be that teachers are choosing not to apply for jobs in certain LEAs. *(See Supplemental Tables A & D.)*

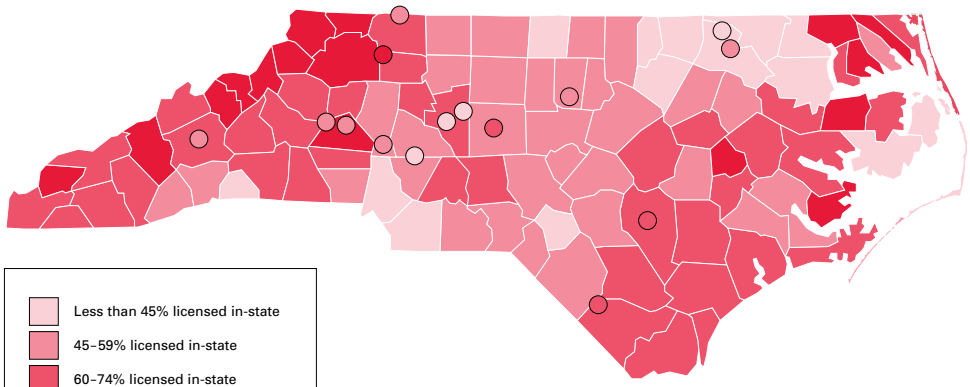
Finding: Many of these inequalities may be related to rurality, but the inequalities do not appear to be related to low or nonexistent local salary supplements.

The assumption that local salary supplements may have much to do with this disparity is not borne out by the data. All but three of the 17 LEAs that had no in-state, traditional-route early career teachers in 2005-2006 offered average local supplements above $750, and all of the other LEAs with a low overall proportion of in-state, traditional-path teachers offer average supplements above $750. Conversely, several of the LEAs with the highest proportion of in-state, traditional-route teachers offer low average supplements (less than $750) – like Yancey, Allegheny, and Ashe Counties - or they offer no supplement at all - like Clay, Cherokee, Graham, and Swain Counties. *(See Supplemental Table A.)*

On the other hand, all of the LEAs with low numbers of in-state, traditional-route early career teachers are relatively small districts (on average, they are about the size of a typical LEA) in more rural counties. Without direct information from the in-state, traditional-route teachers themselves, we can only speculate about the relative impacts of local supplements, district size, and rurality on their decisions to choose to work in certain LEAs (for instance, do teachers prefer to live in more populous communities?), but these data suggest that a closer inspection of the reasons why teachers - especially early career teachers - make these choices is both worthwhile and necessary.

Appendix A: Supplemental Maps and Tables

Map 1
Percentage of North Carolina Middle and High School Math and Science Teachers Licensed in "Traditional" In-State Programs



Note: Statewide proportion of middle and high school math and science teachers trained in traditional in-state programs is 55.8%; all other licensed teachers either trained out-of-state or via in-state alternate licensure programs. *Source: N.C. Department of Public Instruction*

Table 1
Total College and University "Touches," All Active Teachers Trained In-State in Traditional Licensure Programs

NORTH CAROLINA COLLEGES AND UNIVERSITIES WITH ACTIVE LICENSURE PROGRAMS

PUBLIC	TOTAL "TOUCHES"
Appalachian State University	1457
East Carolina University	1184
Elizabeth City State University	118
Fayetteville State University	295
N.C. A&T State University	168
N.C. Central University	159
N.C. State University	814
University of North Carolina - Asheville	90
University of North Carolina - Chapel Hill	597
University of North Carolina - Charlotte	605
University of North Carolina - Greensboro	531
University of North Carolina - Pembroke	389
University of North Carolina - Wilmington	424
Western Carolina University	620
Winston-Salem State University	60
Total Public "Touches"	7511

PRIVATE	TOTAL "TOUCHES"
Barton College	172
Bennett College	21
Campbell University	258
Catawba College	63
Duke University	57
Elon University	169
Gardner-Webb University	265
Greensboro College	40
High Point University	99
Johnson C. Smith University	9
Lenoir-Rhyne College	143
Livingstone College	17
Mars Hill College	130
Meredith College	150
Methodist College	46
North Carolina Wesleyan College	38
Pfeiffer University	71
Queens College	20
Salem College	13
Shaw University	18
Wake Forest University	110
Warren Wilson College	14
Wingate University	54
Total Private "Touches"	1977

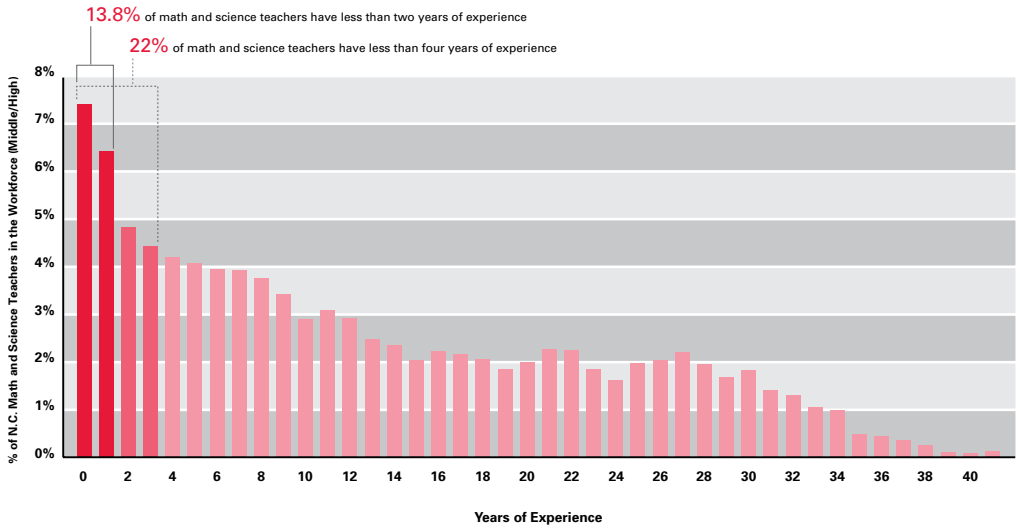
Total "Touches"	
Total Public	7511
Total Private	1977
In-state-trained teachers whose college and university connection is unknown	393
Total	9881

FINDINGS: ❶ The majority of in-state trained math and science teachers who completed traditional programs (c. 75–80%) also earned degrees in public universities. ❷ The impact of Regional Alternative Licensing Centers (RALC) licensure on math and science teacher totals is limited (21 RALC-only; another 41 in conjunction with an NC college or university).

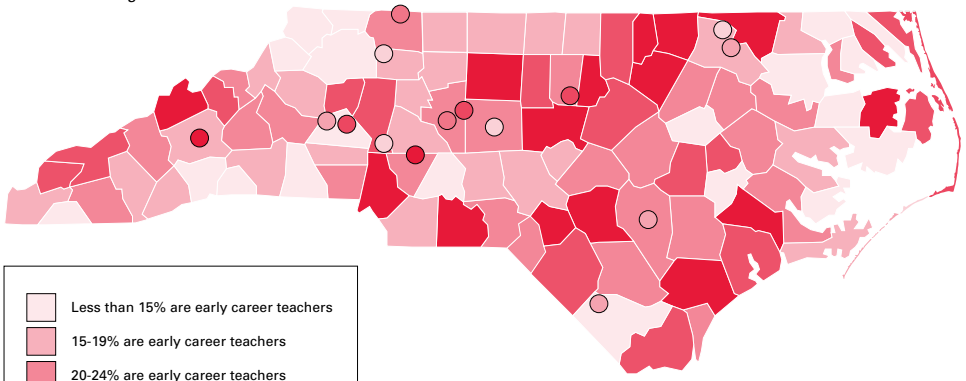
A NOTE ABOUT TOUCHES: The state currently tracks information about institutions from which license-holders have degrees, but it does not track information about institutions at which license-holders completed their licensure work. Thus, a teacher may have graduated from Fayetteville State University with a bachelor's degree in math and from Duke University with a master's degree in statistics but have earned his high school math licensure at the University of North Carolina-Greensboro. In the licensure database, only his degrees from FSU and Duke would be listed; there would be no indication of his work at UNC-G.

The data in this table and in some sections of the full report were generated by counting "touches." That is, every time a college with a math or science licensure program is mentioned in a teacher's record, that school is given credit for "touching" or potentially influencing a teacher and her or his decision to teach math or science. The resulting number is therefore not a true count of college and university production but instead only an approximation (and an over-estimate in almost all cases). Thus, when we report that 1,457 of the math and science teachers teaching in 2005-2006 were "touched" by Appalachian State University, we are saying that 1,457 math and science teachers have at least one degree from ASU. The actual proportion of those teachers who earned their licensure at ASU is smaller but unknown. While this solution to the problem is acceptable for the back-of-the-envelope estimates presented in this report, more accurate and meaningful assessments of college and university teacher production will require more accurate records.

Graph 1
Distribution of Teachers by Experience, 2005–2006



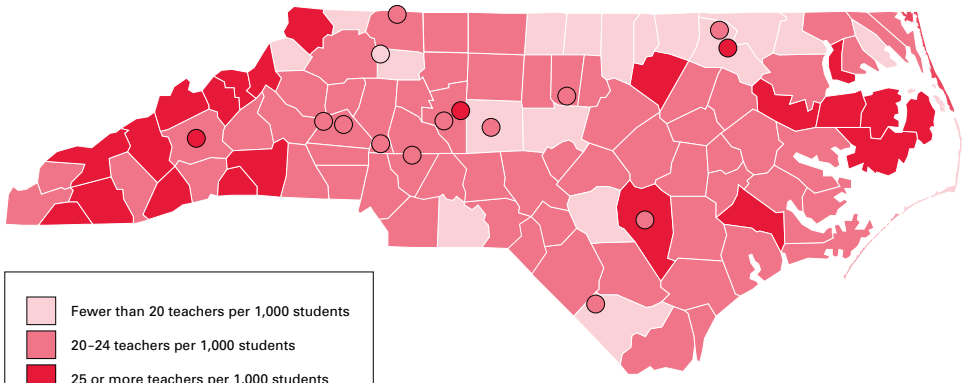
Map 2
Percentage of Early Career Licensed Math and Science Teachers Working in Each District



Note: Average Statewide early career license state for math and science teachers is 23.2%

Source: N.C. Department of Public Instruction

Map 3
Number of licensed math and science teachers per 1,000 students



Note: Not every school district in North Carolina has 1,000 middle and high school students. In the case of those districts, the number is an estimate based on the existing ration of math and science teachers to students. The average number of licensed math and science teachers per 1,000 students within the 115 school districts is 22.

Source: N.C. Department of Public Instruction

Table 2

Total Math and Science Licenses Held, by License Level, 2005–2006

Total # of Math and Science Licenses Held by NC Teachers		**20875**
Teachers Who Received At Least One License, of Any Level, from a Traditional In-State Program	57.3%	11958
Teachers Who Received Their Licenses from Out-of-State Institutions or Through Alternate Programs	42.7%	8917
Total # of Bachelor's-Level Licenses in Math and Science		**17837**
Teachers Who Received At Least One License, of Any Level, from a Traditional In-State Program	55.8%	9952
Teachers Who Received Their Licenses from Out-of-State Institutions or Through Alternate Programs	44.2%	7885
Total # of Master's-Level Licenses in Math and Science		**2944**
Teachers Who Received At Least One License, of Any Level, from a Traditional In-State Program	66.4%	1955
Teachers Who Received Their Licenses from Out-of-State Institutions or Through Alternate Programs	33.6%	989
Total # of 6th-Year-Level Licenses in Math and Science		**59**
Teachers Who Received At Least One License, of Any Level, from a Traditional In-State Program	67.8%	40
Teachers Who Received Their Licenses from Out-of-State Institutions or Through Alternate Programs	32.2%	19
Total # of Doctoral-Level Licenses in Math and Science		**35**
Teachers Who Received At Least One License, of Any Level, from a Traditional In-State Program	31.4%	11
Teachers Who Received Their Licenses from Out-of-State Institutions or Through Alternate Programs	68.6%	24

Note: Totals reflect all math and science licenses held by people currently employed by NC public schools; a teacher can hold more than one license.

Table 3

Where Active Math and Science Teachers Were Working in North Carolina, 2005–06

15,304	school employees held a math or science license for middle or high school
8,609	of these employees were licensed through traditional in-state licensure programs
1,340	of these employees were enrolled in lateral entry programs
5,355	of these employees were licensed through other licensure programs
13,276	licensees were teaching in middle or high schools (86.7%)
1,646	licensees were teaching in elementary schools (10.8%)
382	licensees were working in central offices (2.5%)

FINDING: There are a sizeable number of public school employees who are licensed to teach math or science but who are currently working in other capacities (e.g., elementary education or central office work).

Appendix B: Limitations of this Report

Retention

- How do math and/or science leavers compare to new math and/or science hires?

Quality

- How many unlicensed teachers are teaching math and/or science in North Carolina?

Presence

- What has been the demand for math and science teachers for the past several years, per local education agency (LEA)?

This report raises two new questions:

1. How does North Carolina's math/science teacher turnover rate compare to rates in other states?
2. At which IHEs did in-state-trained math and science teachers earn their licensure?

Appendix C: IHE Recruitment of and Support for Math and Science Teacher Candidates

Many of the state's colleges and universities support programs and initiatives that are designed to encourage potential math and science licensure candidates to enter licensure programs and to support them during their training and after they take their first teaching jobs. This appendix summarizes many of the efforts already in place or soon to be implemented across the state. It concludes with a statement from the University of North Carolina system general administration office about system-wide efforts in place or soon to be in place to support math and science teacher recruitment and retention efforts statewide.

Respondents: UNC System General Administration, ASU, ECU, NCCU, UNC-A, UNC-CH, UNC-C, UNC-G, WSSU, Barton, Bennett, Brevard, Campbell, Catawba, Duke, Elon, Gardner-Webb, Greensboro College, High Pint, Johnson C. Smith, Livingstone, Mars Hill, Meredith, Methodist, NC Wesleyan, Queens, Wake Forest, Warren Wilson

Non-respondents: ECSU, FSU, NC A&T, NCSU, UNC-P, UNC-W, WCU, Lenoir-Rhyne, Pfeiffer, Salem College, Shaw, Wingate

Recruitment of Math and Science Teacher Candidates

At the state level, there are several programs designed to aid in the recruitment of potential math and science teachers. The Future Teachers of North Carolina Scholarship Loan program, begun in 2005-2006, was established to support college juniors and seniors who are seeking certification in math, science, special education, or English as a Second Language and who are enrolled in North Carolina institutions. The program is open to students transferring from in-state community colleges to four-year institutions as well as those who are already enrolled in four-year institutions. The annual amount of the scholarship/loan is $6,500 for a maximum of two years, and 100 awards are funded each year. The state also offers North Carolina Millennium Teacher Scholarships to worthy and needy North Carolina resident high school seniors who attend Winston-Salem State University, Elizabeth City State University, or Fayetteville State University and who are interested in teaching in North Carolina public schools. In addition, the North Carolina Association of Educators sponsors the Teacher Cadets program, which encourages promising high school students to consider careers in teaching.

At the program level, several schools actively recruit high school students. High Point University makes presentations to Teacher Cadets in area high schools

on the need for math and science teachers. Livingstone College education faculty talk to students who attend Livingstone's math and science summer camp about becoming a teacher. UNC-Charlotte has implemented a National Science Foundation-funded project at a local high school that includes a component for recruiting potential math and science teacher candidates.

Many schools focus their recruitment efforts on older students, including new undergraduates and science and math majors. At Catawba, the Mathematics Education Coordinator communicates with all Mathematics majors to encourage them to consider opportunities in teacher education, and the college's faculty recently approved a new major in Environmental Education, with the hope that it will attract prospective Environmental Science teachers. Duke's MAT program sends letters to each math and science major at Duke and also sends letters to math and science department chairs at the top 50 liberal arts and research institutions in the nation. Because it is an area from which women have traditionally shied away, Meredith's mathematics and science faculty place special emphasis on recruitment of women. Warrant Wilson College works with the various math and science departments to help potential candidates understand the job market.

At Appalachian State University, special scholarships have been designated for middle grades and math and science candidates, and the departments and program areas recruit in multiple locations across the state as well as on campus. Additionally, candidates in math and science majors are provided services through major-specific organizations, such as the campus-based Teachers of Math Association. UNC-Asheville makes an effort to recruit math and science teachers through contacts with related academic departments, and UNC-Chapel Hill works with the Department of Mathematics and various science departments to develop collaborative courses which provide undergraduates tracks to licensure that are incorporated into their major. Warren Wilson's School of Education partners with the college's Environmental Leadership Center in an effort to encourage some of their students to pursue licensure.

Some schools are even recruiting to meet needs in specific locales. Through a grant entitled Leave No Educator Behind, North Carolina Central University recruits licensure-only and lateral entry candidates, especially in mathematics and science, for Vance County, Warren County, and Weldon City Schools. UNC-Greensboro recently opened new sections for middle school math and science teachers, and, with the support of Guilford County Schools, teachers admitted to this program have their tuition and fees paid.

Incentives Offered to Potential Math and Science Teacher Candidates

The state is beginning to benefit from a rise in the number of incentives being made available specifically for potential math and science teachers. Duke has received funding from the National Science Foundation's Noyce Scholarship program through 2009, which will provide funding for math and science candidates. Through Project ACT Plus, a Progress Energy gift, ECU supports candidates by repaying tuition for candidates who are changing careers and entering middle grades or high school math or science. NCCU provides scholarships, courses based on an individualized program of study, laptops, and a technology support program for math and science candidates, and at UNC-Charlotte, there are scholarships available for juniors and seniors in the middle grades and secondary math programs. Several UNC-A candidates have benefited from Progress Energy Scholarships, which support math and science students as they complete their licensure work. Catawba recently established the Academy for Teaching, which is supported by ten $13,000 scholarships; the award for in-state residents is $15,000. While not exclusively designed for math and science, the Academy does target prospective math and science teachers.

Special Programs and Outside Partnerships

Equally as encouraging are the number of special programs and partnership now in place across the state to encourage and support potential math and science teachers. In 2003, for example, Barton received a five-year grant from Merck Pharmaceuticals, Inc. for a total of $150,000 to create a facility for preparing pre-service teachers to teach mathematics and science in grades K-8. In addition to the Noyce scholarships, Duke has received approximately $500,000 from the National Science Foundation to attract math and science teachers who agree to teach in school districts that have at least one high-need school for two years after graduation. Additionally, Duke's President is providing full tuition and stipend support for 24 MAT students who agree to teach in Durham for two years upon graduation, and a significant portion of those funds is being targeted toward math and science teachers. Queens College has partnered with Duke Energy to provide financial support exclusively for math and science students.

Schools are also partnering with their local school districts to support potential science and math teachers. NC Wesleyan shares a math and science partnership grant with Nash/Rocky Mount and Franklin County schools to serve lateral entry middle grades math and science teachers. NCCU collaborates with Halifax County middle grades teachers on an NCQuest grant that helps them earn grad-

uate credit toward an advanced degree. UNC-Greensboro partners with Guilford County to offer tuition and fees for math and science middle school teachers, as well as on a plan to pay math teachers a more competitive salary and to pay for their tuition during the last year of their education Partnerships with other colleges across the state and the state's community college system are also on the rise. At ASU, the math department is currently developing a National Science Foundation proposal in partnership with Davidson County Community College to initiate a "2+2" program[23] specifically in math education. One of the goals is to support students in community college settings earning degrees in math and in teacher education. East Carolina University partners with Mt. Olive College to prepare some of their students to become middle grades and high school math and science teachers. These students receive a degree from Mt. Olive but licensure through ECU. In addition, through its provost's Council, ECU is marketing a three-year undergraduate degree for science majors that includes an MAT in the fourth year to attract non-teacher education undergraduate majors into science education.

With the proliferation of online access has also come innovation in math and science teacher education. East Carolina University has worked with Wachovia's Partnership East on a "2+2" collaborative to create a regional middle grades math and science cohort of teacher licensure candidates, and in summer 2007, the program will become completely on-line in an effort to draw applicants from community colleges across the state. Similarly, UNC-Chapel Hill's fully online program, Carolina Online Lateral Entry, supports lateral entry teachers statewide who are pursuing licensure in the areas of Math and Science.

Post-graduation Support Programs for New Math and Science Teachers

As indicated by some of the retention data analyzed in this report, recruitment and financial aid must be buttressed by comprehensive and thoughtful support for new teachers once they enter the classroom. Several campuses operate support programs for their first-year graduates. Gardner-Webb supports all completers via email communication and classroom visits, and faculty visit most completers during their first year in the classroom. Johnson C. Smith operates a Beginning Teacher Support program for graduates that includes scheduled follow-ups during the first year of teaching and ongoing support for all former candidates. Meredith offers first-year support for all former candidates, and both the mathematics program coordinator and the science program coordinator provide direct assistance to math and science initially-licensed teachers. ECU maintains a New Teacher Support Network, which is an online "ask an expert" question and an-

swer referral program for all new teachers. NCCU has an Induction Specialist who coordinates support programs for beginning teachers in its partnership districts. The specialist provides seminars and workshops and also arranges for appearances by guest speakers. Constructive Coaching courses, part of the UNC-Chapel Hill Carolina Online Lateral Entry program described above, provide lateral entry teachers ongoing mentoring, collaborative lesson study, structured reflection, and professional advisement. The coaches accompany teachers (online) through three semesters in the classroom. WSSU piloted a mentoring program during the 2005-2006 academic year, which included support for new middle grades math instructors.

There are also several examples of ongoing support for teachers beyond their first year in the classroom. At the statewide level, the state's North Carolina Partnership for Improving Mathematics and Science grant targets teachers in rural counties and, through graduate credit, works to enhance their skills and knowledge in teaching mathematics and science. Barton's teaching facility that was created with the grant from Merck Pharmaceuticals, Inc. (described above) is available for use by in-service elementary and middle school math and science teachers. At Catawba, the Center for the Environment offers a number of workshops each year for science teachers and their students. Duke's MAT program offers ongoing workshops and teacher support for graduates who remain in the Durham Public Schools following graduation, and North Carolina Wesleyan provides summer workshops for any math and science middle grades teachers in the surrounding districts. Elon University's Office of School Outreach Programs sponsors a series of staff development opportunities for local teachers through its Professional Development Academy. These programs are offered to all teachers, not just Elon graduates, and for all licensure areas, not just math and science.

ASU's summer *MELT* (Mathematics Education Leadership Training) program offers a nationally recognized set of workshops (with some support and stipends available) that are designed to enhance and strengthen in-service teachers' mathematical competence. Scholars receive tuition, room and board for the summer institutes along with eligibility for additional funds to support their graduate programs. In addition, ASU's weeklong Math Summer Institutes help mathematics teachers improve their teaching effectiveness through investigation of mathematics content and pedagogy while examining the appropriate use of technology. Program completers have access to other workshops and activities presented by the math department, the ASU Public School Partnership, and the ASU North Carolina Mathematics and Science Center. The Center offers special workshops, summer institutes, graduate courses, and other instructional programs. WSSU also offers professional development for middle school teachers through its SCI-

MAX 2006 Summer Institute with topics on statistics problem solving and ecological environments. The Center for Mathematics, Science, and Technology Education at WSSU also offers professional development in many math topics.

The UNC System Teacher Recruitment Initiative[24]

As noted above, the University of North Carolina system as a whole has also dedicated time and thought to issues of math and science teacher recruitment and retention. What follows is the most recent statement of the system-wide plan to address the issue of recruitment:

The University of North Carolina has initiated the development of a strategic plan to coordinate teacher recruitment efforts within the University. To accomplish this task we have partnered with Noel-Levitz, a leading authority in the US in optimizing enrollment management on higher education campuses. The purpose of the overarching UNC Teacher Recruitment Initiative is to consider perceptions of the teaching profession in developing a system-wide plan for teacher recruitment that is coordinated with the UNC Teacher Education Enrollment Growth Plan. The study has two primary components, an assessment phase designed to gain a better understanding of the current situation and a planning phase that will translate initial finding into actionable strategies and systems to meet North Carolina's teacher supply and demand needs. The research question addressed through the study is targeted directly at recruitment to the teaching profession: *What are the attitudes, motivations, and primary sources of influence of prospective teachers that are behind North Carolina's teacher supply and demand data and trends?*

Results from the study will be used to identify critical strategies for inclusion in a comprehensive plan for teacher recruitment. Each UNC institution will be required to prepare a campus-based plan that is aligned to the overarching system recruitment plan and also aligned to the enrollment growth targets for their respective campus. It is expected that the analysis of results from the market research, which will be based on reliable data, will provide greater insight into how the University can better coordinate and streamline teacher recruitment efforts across the University.

The research question is addressed in the assessment phase of the study through market research targeted at six specific population segments; college-bound high school juniors and seniors, bachelor's and advanced degreed adult populations in NC (i.e. mid-career professionals that could transition into the teaching profession), community college students, all undergraduate students on UNC cam-

puses, high school guidance counselors, and military personnel and their spouses. The assessment phase also includes focus sessions conducted with campus representatives from teacher education and enrollment/admissions offices, financial aid offices, K12 representatives (teachers, principals, and superintendents), and other educational representatives in North Carolina.

The planning phase of study requires the development of a strategic teacher recruitment plan for the University and campus-based plans for each institution. Development of the plans will be based on market research and the results from an institutional self-inquiry survey that asks the campuses reflect upon their current approaches to marketing and recruitment as it relates to teacher recruitment, including specific enrollment funnel data for each of the campus' market segments (e.g., high school, community college, and alternative entry). These data are being analyzed and compiled to assist in building a better understanding of the current approach to recruiting teachers at the campus level.

Coordinating UNC's teacher recruitment efforts will require the compilation and analysis of key data in order to develop an action plan that can meet the state's needs for teacher education graduates and licensure completers that are prepared to teach in the public schools of North Carolina. The UNC Teacher Recruitment Initiative will strategically enhance University's ability to respond to the state's teacher supply and demand needs. Working parallel to the UNC Teacher Education Enrollment Growth Plan, the recruitment plan(s) will help to ensure the enrollment pipeline in teacher education is sufficient to meet the campus-based targets which are measured on an annual basis and reported to the UNC Board of Governors and the North Carolina General Assembly.

Appendix D: Data and Methodology

Data Sources

Data were gathered from three primary sources: the North Carolina Department of Public Instruction's Licensure and Payroll Databases and survey responses from state Institutes of higher Education (IHEs) with at least one of the target teacher licensure programs (middle school math, middle school science, high school math, and/or any or all of the high school sciences).

The Human Resources Licensure and Payroll Databases

The state collects and updates an extensive amount of data about its teacher population, including information about degrees held and dates of graduation, years of experience for each area of licensure, and current and past schools of employment. Data from the 2005-2006 cohort of math and science teachers - over 15,000 teachers in all - were used for this study.

There is one important limitation of the data set provided for this report that directly impacted our ability to answer accurately some of the study's initial questions: the database contains information about institutions from which license-holders have *degrees*, but it does not contain information about institutions at which license-holders completed their *licensure work*. This is an important distinction. A teacher may have graduated from Fayetteville State University with a bachelor's degree in mathematics and from Duke University with a master's degree in statistics but have earned his high school math licensure at the University of North Carolina-Greensboro. In the licensure database, only his degrees from FSU and Duke would be listed; there would be no indication of his work at UNC-Greensboro. Another teacher may have earned her middle school science licensure and an undergraduate degree at Salem College and a master's degree in biology from UNC-Asheville, and both institutions would appear in the database, but there would be no way of knowing at which she completed her licensure work.

An additional problem arises with teachers who earned their full licensure via lateral entry programs. While still enrolled in a lateral entry program, these teachers are designated as lateral entry (and are thus identifiable as being trained in-state), but once they have completed the program, they are no longer listed as lateral entry teachers, nor are they recorded as having completed a traditional in-state program. Thus, of the 34% of math and science teachers who are not currently lateral entry teachers and who were not trained in traditional-route in-state programs, an unknown percentage still received training in-state via lateral entry.

Consequently, drawing firm conclusions from the data about the number of state-licensed teachers trained and educated at each IHE and thus the origin of each teacher's licensure is not possible. The effects of these missing data are twofold: first, it is difficult to assess accurately how many state-licensed teachers an IHE produces; and second, it reduces the state's ability to draw connections between teacher quality and teacher training.

To begin to address the problem, this report has followed a policy of counting IHE "touches"; that is, every time an IHE with a math or science licensure program is mentioned in a teacher's record, that IHE is given credit for "touching" or *potentially* influencing teacher's decision to teach math or science[25]. The resulting number is therefore not a true count of IHE production but instead only an approximation (and an over-estimate in almost all cases). Thus, when we report that 1,457 of the 2005-2006 math and science teachers were "touched" by Appalachian State University, we are saying that 1,457 math and science teachers have at least one degree from ASU. The actual proportion of those teachers who *earned their licensure* at ASU is probably smaller but unknown. *(See Supplemental Tables B C)*

While this solution to the problem is acceptable for the back-of-the-envelope estimates presented in this report, more accurate and meaningful assessments of IHE teacher production will require more accurate records.

IHE Surveys

Each IHE with at least one of the target licensure programs was asked to complete a two-part survey. The first part (elements of which have been incorporated in to this report, and a summary of which appears in **Appendix C***) was a series of four questions about programs in place at each IHE to recruit, encourage, and support math and science licensure candidates before, during, and after their work in the program.*

The second part was a request for head-counts of program completers from each of the past five years (2001-2002 through 2005-2006), as well as a projection of the total number of candidates each IHE could accommodate, based on current program size and capacity. Data from this second part were not included in the final report due to difficulties in securing responses from some non-public IHEs, in verifying the accuracy of the counts that were submitted, and in clarifying what was meant by the term "capacity."

Nevertheless, establishing an accurate count of license-eligible candidates remains an important goal for several reasons. The number of license-eligible candidates

reported by each IHE does not equal the number of candidates from their programs who eventually hold NC licenses and will in most cases be an over-count: some candidates apply only for out-of-state licenses, and others decide during the program not to pursue any formal licensure at all, even though they have completed all requirements. With such data, we can begin to estimate how many license-eligible candidates the state loses before they even take their first jobs.

Methodology

With the exception of some projections about teacher turnover in math and science, none of the results in this report are the product of complex or problematic statistical analyses. More often than not, they are simply head-counts, from which tentative conclusions have been drawn. Therefore, we report provisional findings and not definitive assertions; in many cases, our findings raise more questions than they answer and may be important starting points for further investigation.

In some cases, raw numbers have been converted into ratios or percents so that totals from one IHE or Local Education Agency (LEA, or school district) can be compared more fairly with totals from another IHE or LEA. For instance, it would be valid but relatively uninformative to report that Charlotte-Mecklenburg employs ten times as many licensed math and science teachers as Randolph County. On the other hand, it is both valid and informative to report that the proportion of in-state-trained traditional-route math and science teachers in Randolph County is twice as large as the proportion in Charlotte-Meckenberg. Similarly, it is fair but uninformative to report that five times as many math and science teachers in Alamance-Burlington hold degrees from NCCU as hold degrees from Meredith College. It is both valid and informative to report that, relative to each IHE's total production of teachers, a greater proportion of NCCU's graduates teach in Alamance-Burlington.

Endnotes

[1]*The term "early career teacher" as used throughout this report refers to teachers with fewer than four years of experience. Though most research suggests that years of experience is one predictor of teacher effectiveness, such a designation in this report is not meant to imply that in all situations an experienced teacher might be preferred to an early career teacher.*

[2]*National Science Board. (2006). Science and engineering indicators 2006. Two volumes. Arlington, VA: National Science Foundation (volume 1, NSB 06-01; volume 2, NSB 06-01A).*

[3]*Ingersoll, R. M. (2003). Is there a shortage among mathematics and science teachers? Science Educator, 12(1), 1-9.*

[4]*Ingersoll (2003)*

[5]*NSB (2006)*

[6]*Ingersoll (2003)*

[7]*Berry, B., and James, T. (2006). A strategic resource for higher achievement in math and science: National Board certified teachers in North Carolina. 30 May, 2006. Citing Berry (2005).*

[8]*Ashby, C. M. (2006). Higher education: Science, technology, engineering, and mathematics trends and the role of federal programs. Testimony before the Committee on Education and the Workforce, House of Representatives. 3 May, 2006. GAO-06-702T.*

[9]*In the state's official Federal Title II reports (https://www.title2.org/default.asp), the percent of math and science teachers who are not fully certified was 7.7% for 2003-2004, 7.0% for 2004-2005, and 4.1% for 2005-2006, but in the Title II reports, "teachers not fully certified" does not include long-term substitutes or teachers who are teaching out-of-field.*

[10]*Office of Postsecondary Education. (2005). The Secretary's Fourth Annual Report on Teacher Quality: A Highly Qualified Teacher in Every Classroom, Washington, D.C.: U. S. Department of Education.*

[11] *NSB (2006)*

[12]*Ashby, C. M. (2006)*

[13]*Berry & James (2006)*

[14]*NSB (2006)*

[15]*Ashby (2006)*

[16]*cf. Berry & James (2006); Humphrey, D. C., Wechsler, M. E., and Hough, H. J. (forthcoming). Characteristics of effective alternative teacher certification programs. Teachers College Record, 110(4).*

[17]*Office of Postsecondary Education (2005)*

[18]*see fn. 1*

[19]*North Carolina Department of Public Instruction. (2006). North Carolina's revised state plan for highly qualified teachers. Raleigh, NC: Author.*

[20]*North Carolina Department of Public Instruction. (2005). System Level Teacher Turnover Report 2004-2005. Raleigh, NC: Author.*

[21]*Only a little over 300 secondary-aged students were enrolled in Hyde County in 2005-2006; the "per 1,000" figure is used for comparison only.*

[22]*NC DPI (2005)*

[23] *"2+2" programs help community college students transition to four-year institutions to complete their degrees.*

[24]*Text for this section prepared by UNC General Administration Division of Academic Planning and University-School Programs Fall 2006.*

[25]*Double-counts - that is, situations in which a teacher holds more than one degree from the same IHE - have been eliminated.*