



The Vocational Teacher Pipeline:

**How academically well-prepared is the
next generation of vocational teachers?**

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Kevin Cramer

U.S. Department of Education
Office of the Deputy Secretary
Policy and Program Studies Service

In the end, the judgments expressed in this report are those of the author. While the author was an employee of PPSS in the Office of the Deputy Secretary, this analysis is an independent study, as called for by law, and does not necessarily represent the positions or policies of the Department of Education. No official endorsement by the U.S. Department of Education is intended or should be inferred.

I. Introduction

The Carl D. Perkins Vocational and Technical Education Act of 1998, known as Perkins III, attempted to guide secondary vocational programs in new directions by strengthening the emphasis on academics in vocational education and incorporating the attainment of state academic standards as a performance measure for vocational programs. The policy objectives of Perkins III potentially require new roles and skills for vocational teachers, both those seeking entry into the profession and those already employed.

The purpose of this paper is to examine how well-prepared vocational educators are to teach courses and programs that reflect the emphasis on academic skills in the Perkins III legislation. The paper examines the academic skills and pedagogical knowledge of elementary, secondary and secondary vocational candidates to assess how well-prepared vocational candidates are to support and reinforce students' acquisition of academic skills. The study includes an analysis of 1) the demographic and academic characteristics of teacher candidates; and 2) the academic skills and professional knowledge of teacher candidates as measured by reading, writing, mathematics and pedagogical knowledge test scores on the Praxis assessments.

II. Research Methods and Data

The data reported in this study are from more than 200,000 elementary, secondary and secondary vocational teacher candidates who completed the Praxis Series assessments for teacher certification between 1994 and 1999. The Praxis test takers are primarily college students actively seeking entrance to a college of education. This group is a reasonable proxy for prospective teachers, more so than measures used in other studies such as high school students intending to major in education.

The Praxis Series is a national Educational Testing Service (ETS) program that provides tests for states to use as part of their teacher certification process and for colleges and universities to qualify individuals for entry into teacher education programs.¹ This analysis primarily uses data from two of the Praxis Series assessments. The Praxis I Academic Skills Assessment measures the basic reading, writing and mathematical skills of prospective teachers, and was available in either a paper-based or computer-adaptive format during the period of this study. The Principles of Learning and Teaching (PLT 7-12) assessment, which is part of the Praxis II Subject Assessment, uses a case study approach to measure general pedagogical knowledge for teaching grades 7 to 12². Test

¹ The Educational Testing Service is one of two testing organizations that offer teacher assessments for state teacher certification in the United States. As of fall 1998, 31 states and the District of Columbia require the passage of Praxis exams for state licensure. National Evaluation Systems, of Amherst, Mass., provides licensure testing to nine states and shares licensure testing with ETS in one state. An additional nine states do not require a test for teacher licensure (Educational Testing Service, 1998).

² The Principles of Learning and Teaching assessments use a case study approach to measure general pedagogical knowledge for teaching grades 7 to 12. The tests feature constructed-response and multiple-choice items.

takers were coded as elementary, secondary or secondary vocational candidates based on responses to the certification field on the Praxis application, which asks test takers to indicate the fields in which they are seeking certification³. The data in this analysis are unique in that they provide reasonable estimates of the academic skills and pedagogical knowledge of individuals seeking teacher certification; allow for participants to be identified as candidates for certification in elementary, secondary or vocational fields; and were made available for this analysis by the Educational Testing Service and are not otherwise available to the public⁴.

Like many similar studies, this study has limitations that can affect the interpretation of the data and generalization of the findings. First, there does not appear to be a consensus in the field about whether a vocational teacher's academic skills are good predictors of their effectiveness as a teacher or the achievement of their students. The majority of research linking teacher academic skills to student achievement involves teachers in academic fields. The importance of academic and pedagogical skills in vocational fields is unclear, and many practitioners in vocational education argue vocational teachers' technical skills may contribute more to the success of vocational students. Second, the study results are not representative of the entire pipeline of teachers because those who enter the field through alternative teacher certification programs may not take the Praxis exams. Vocational teachers are particularly likely to come into teaching from business and industry, so the Praxis results may not represent the full set of entering vocational teachers. Whether vocational teachers who bypass traditional teacher preparation programs and enter the field directly from business and industry have stronger or weaker academic skills is unclear.

III. The Number and Characteristics of Teacher Candidates

This section describes the demographic and academic characteristics of teacher candidates to provide a context for analyzing the reading, writing and mathematics abilities and pedagogical knowledge of the next generation of teachers. Information on the number of teacher candidates is available for elementary, secondary and vocational fields. Demographic and academic characteristics, including age, gender, educational attainment and grade-point averages, are available for secondary and vocational fields.⁵

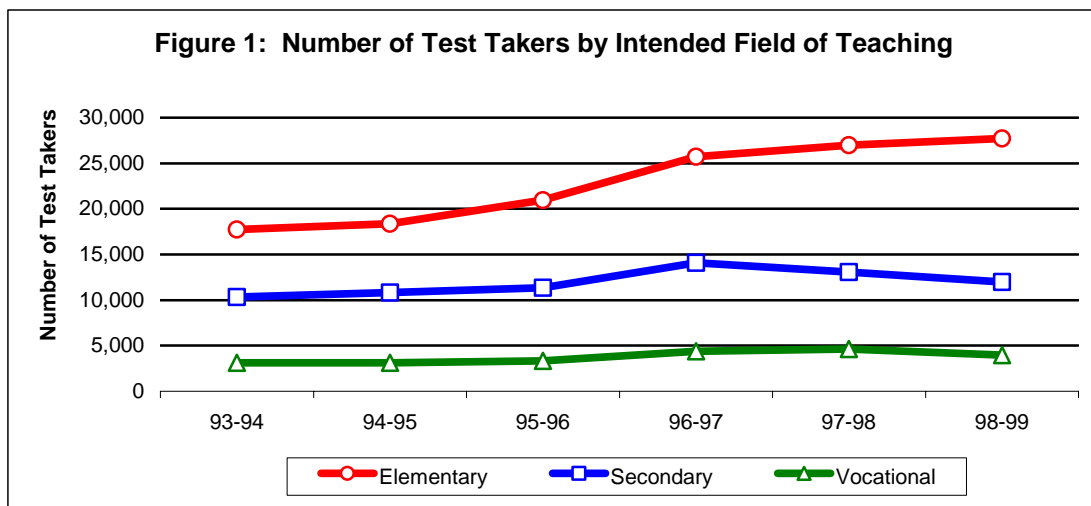
³ Teacher candidates were identified based on responses to the certification field – item #14 – on the Praxis application, which asks test takers to indicate the fields in which they are seeking certification. Vocational fields are 101 (agriculture), 104 (business), 105 (cooperative education), 107 (environmental education), 108 (health education), 109 (home economics), 110 (industrial arts), 112 (marketing), 115 (office technology), 120 (secretarial), 404 (computer and information sciences) and 407 (engineering technologies). Secondary teachers were defined as all prospective teachers indicating they were seeking certification to teach at the secondary level, not including the vocational certification fields noted above. Elementary teachers were defined as all prospective teachers indicating they were seeking certification to teach at the elementary level, not including the vocational certification fields noted above.

⁴ For confidentiality, the data are aggregated by elementary, secondary and vocational classifications based on the responses to the certification field – item #14 – on the Praxis application.

⁵ Information on the characteristics of teacher candidates is self-reported by examinees at the time of taking the Praxis assessments.

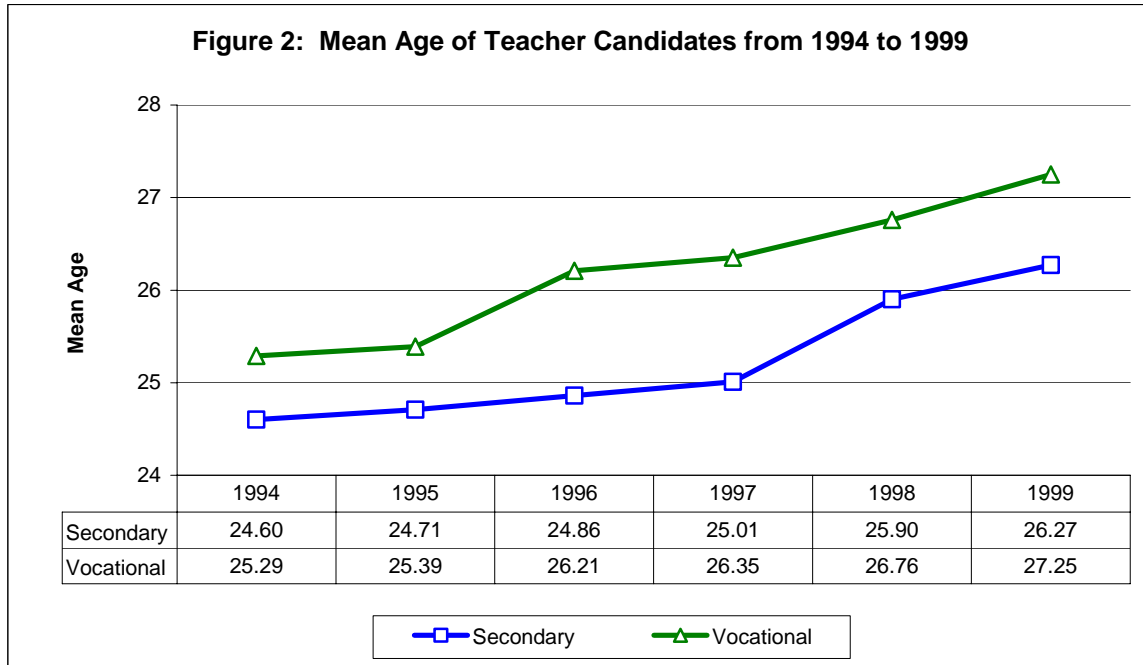
Over the past decade, there has been a dramatic increase in the number of teacher candidates. In 1994, just over 30,000 prospective teachers took the Praxis exam for teacher candidacy. By 1999, the number of teacher candidates had risen to almost 44,000, an increase of nearly 50 percent. The increases are likely due to a combination of factors, including increases in the student population (National Evaluation Systems, 1998b) and efforts to reduce class size and student-teacher ratios in elementary education. From 1997 to 1999, the number of teacher candidates remained fairly constant at about 44,000 candidates taking the Praxis each year.

Despite the large increases in the number of teacher candidates overall, the number of vocational candidates has remained fairly constant. Vocational candidates represent a small and declining share of candidates, although the actual number of vocational entrants may be higher due to alternative routes to certification. In contrast, elementary candidates have consistently increased both in number and as a percent of all teacher candidates, and secondary candidates increased slightly during the same time period, though not in a consistent pattern as seen in Figure 1.



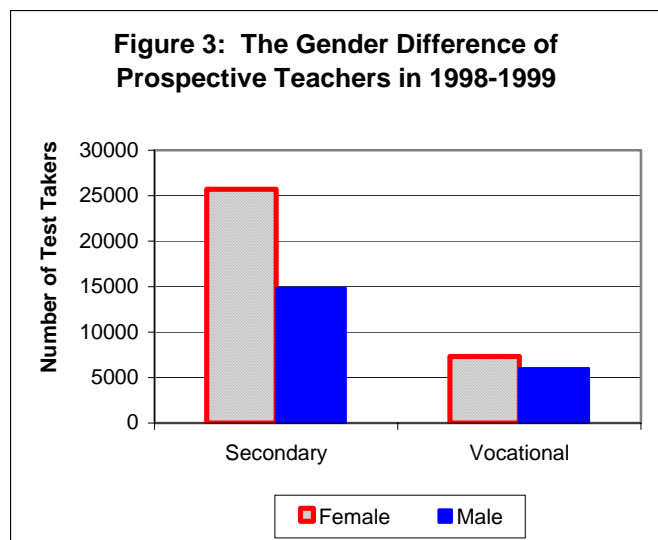
Age

On average, candidates for certification in vocational fields are slightly older than candidates in secondary fields. Vocational candidates are consistently between half a year and 1.5 years older than secondary candidates, and candidates in both fields have increased in age over time. Although the average age of vocational and secondary candidates appears to be similar, the distribution of ages varies considerably. Vocational candidates are more likely to be over the age of 30 – 27.8 percent to 23.3 percent – and are much less likely to be under the age of 20 – 6.3 percent to 11.3 percent. The mean age difference has potential implications for academic testing since, on average, vocational candidates may have been out of school longer than secondary candidates.



Gender

In general, females were more likely than males to take the Praxis exams for teacher certification. This is not surprising, considering a higher proportion of teachers tend to be female. Although the majority of candidates in vocational education were female at 55 percent, the gender gap was considerably smaller than for secondary fields, at 63 percent female. The absence of a significant gender gap in vocational education is likely due to the overrepresentation of men in many technical fields.



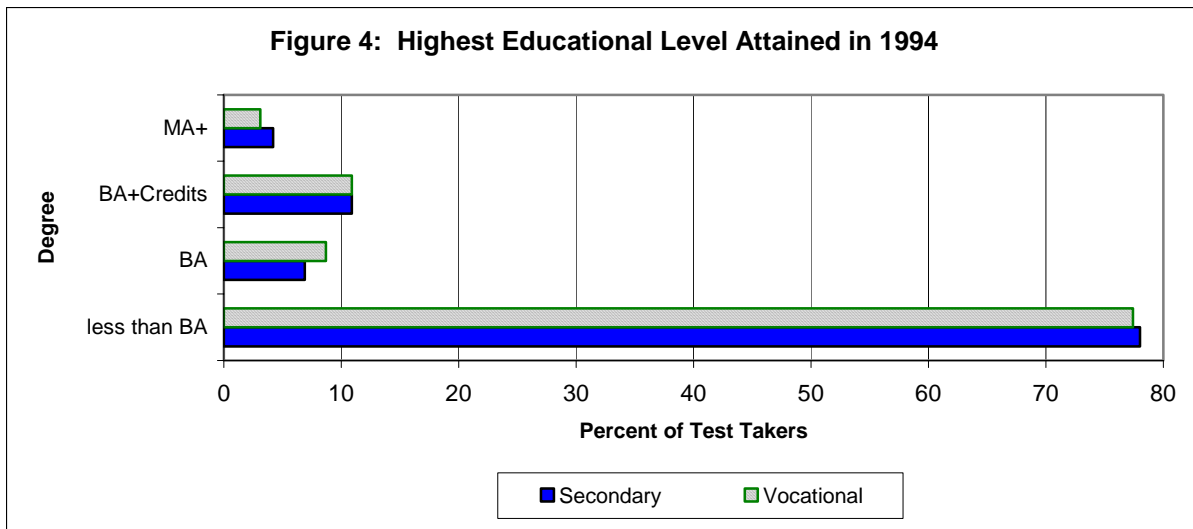
Educational Attainment

Teacher candidates were asked about the highest level of education they had attained and their grade-point average at the time of taking the Praxis assessments.⁶ A recent study by the Educational Testing Service suggests GPAs are meaningful predictors of success on

⁶ The Praxis data describes the educational attainment of individuals at the time they take the Praxis, which may not accurately reflect educational levels that candidates will achieve by the time they are certified and begin teaching.

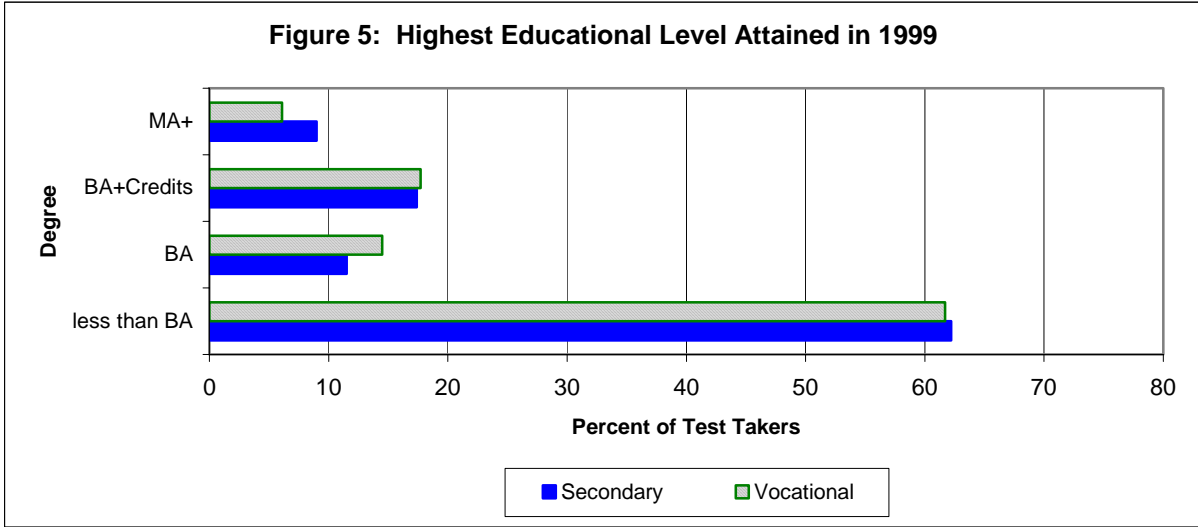
assessments of teacher certification, although the biases of self-reported data and the variation in policies for graduation and grading across institutions and academic departments may make GPAs a less reliable measure of academic ability and achievement.⁷ Still, the data suggest that although secondary and vocational candidates attained similar levels of education, secondary candidates performed better in their undergraduate programs than vocational candidates.

Candidates seeking certification in secondary and vocational fields attained similar levels of education in both 1994 and 1999. Approximately similar proportions of secondary and vocational candidates possessed less than a bachelor's degree at the time of taking the Praxis exams in 1994 (78 percent and 77.3 percent) and in 1999 (61.6 percent and 62.2 percent), respectively⁸. Secondary vocational candidates were more likely to possess a bachelor's degree in 1994 (19.6 percent) and in 1999 (32.2 percent) than candidates seeking certification in secondary academic fields (17.8 percent in 1994 and 28.9 percent in 1999). However, secondary vocational candidates were less likely than secondary academic candidates to possess advanced degrees. In 1994, 3.1 percent of vocational candidates possessed an advanced degree, compared to 4.2 percent of secondary candidates. By 1999, the percentage of vocational candidates possessing an advanced degree increased to 6.1 percent. During the same period, the percentage of secondary candidates possessing an advanced degree increased to 9 percent.

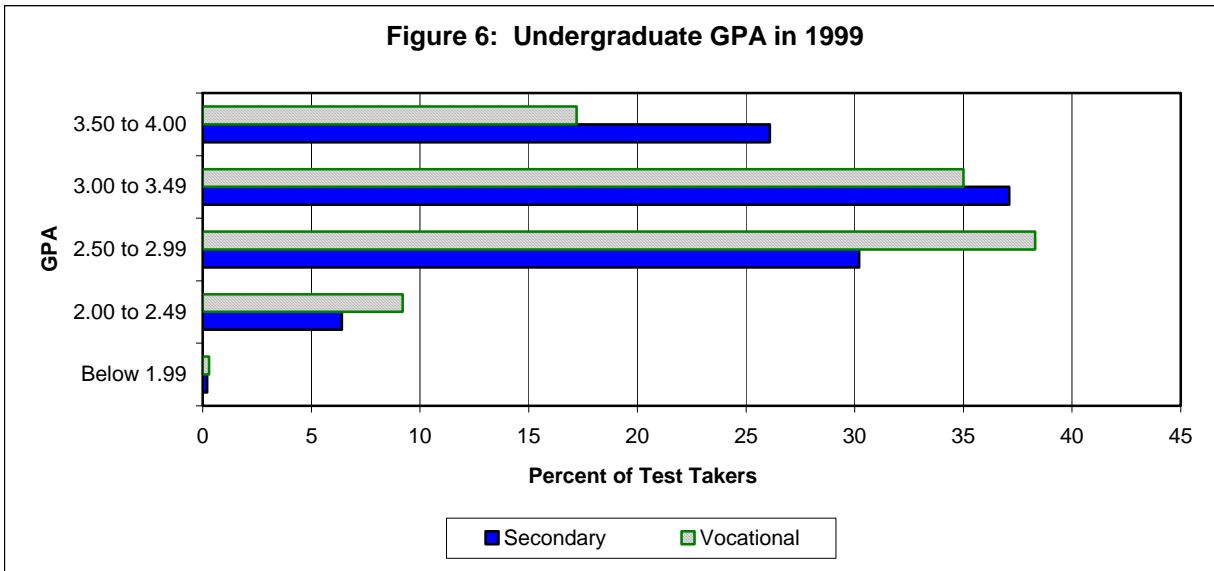


⁷ Gitomer, Latham and Ziomek (1999) examine the issue of whether undergraduate GPAs have any influence over success on assessments for teacher certification. They found a consistent relationship between GPA and passing rates, where the top quartile of students almost always pass the assessments, and as GPAs decrease, so do passing rates.

⁸ The number of test takers receiving less than a bachelor's degree at the time of taking the Praxis exams in 1994 and in 1999 reflects students still completing their postsecondary education programs and preparing to enter postgraduate teaching preparation programs or to go directly into teaching after earning their degree.



Overall, vocational candidates were more likely to have lower GPAs than secondary candidates, and were significantly less likely to be among students with the highest GPAs. In 1999, about half – 52 percent – of vocational candidates had GPAs above 3.0, which is a B average and above, compared to 63 percent of secondary candidates; the percentages of candidates with GPAs between 3.5 and 4.0, which is an A average, were 17 percent and 26 percent, respectively. Although candidates in vocational and secondary fields attained similar levels of education at the time of taking the Praxis exam, secondary candidates appear to have performed better in their educational programs.



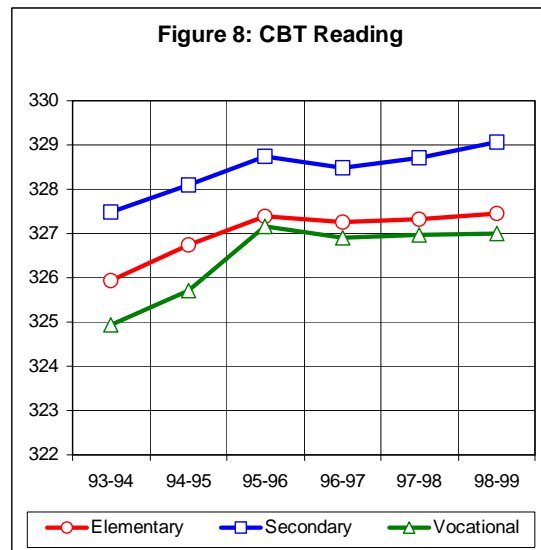
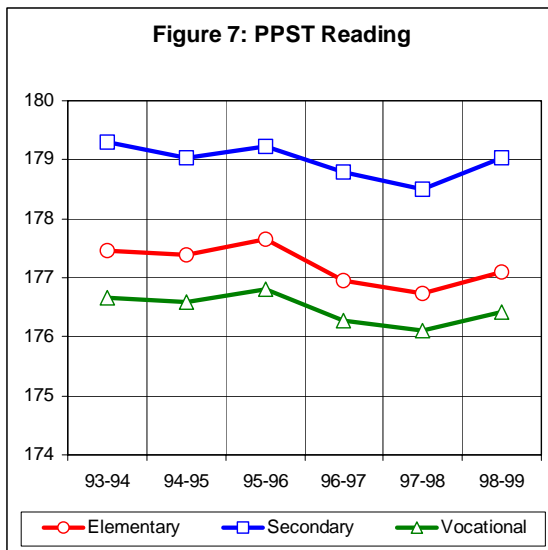
IV. The Academic Skills and Pedagogical Knowledge of Prospective Elementary, Secondary and Vocational Teachers

This section assesses the academic skills and pedagogical knowledge of elementary, secondary and vocational teacher candidates. Although the Praxis Series assessments are not designed to suggest an absolute score at which prospective teachers will either be effective or ineffective, the analysis of reading, writing, mathematics and pedagogical knowledge scores highlights the variation in the academic abilities of candidates for teacher certification in elementary, secondary and vocational fields.

Reading, writing and mathematics skills are assessed using the Praxis I Basic Skills assessments. The general pedagogical knowledge of vocational and secondary candidates for teaching grades 7 to 12 is evaluated using the Principles of Teaching and Learning assessment on the Praxis II. The reading, writing and mathematics assessments were available in either a paper-based (PPST) or computer-adaptive (CBT) format.

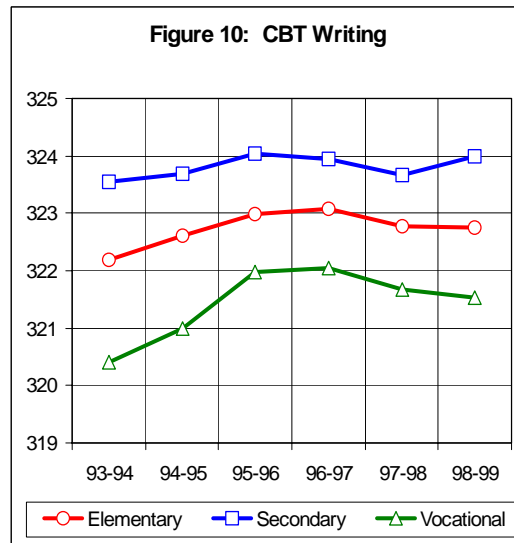
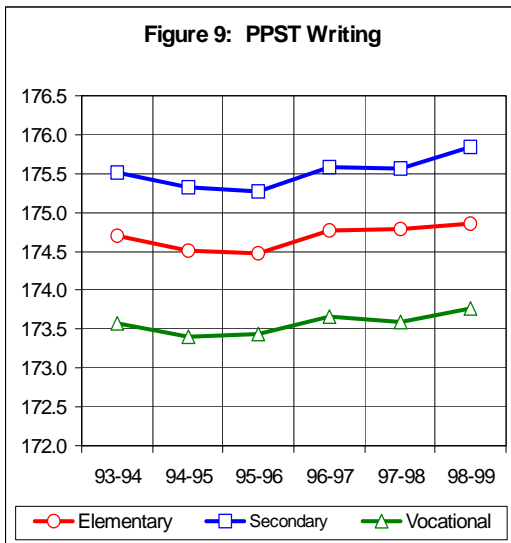
Reading

Vocational candidates consistently have the lowest reading scores in each year of the study and for the paper-based and computer-adaptive formats. The reading scores for vocational candidates were slightly below the scores for elementary candidates, and well below the scores for secondary candidates. The scores for all candidates appear to be remarkably stable from 1994 to 1999, with scores on the paper-based format varying less than one-half point each year and scores on the computer-adaptive format varying less than one point each year, on average. The scores also appear to all move together in a consistent pattern each year, either all increasing slightly or all decreasing slightly, but never moving in opposite directions. The stability of the reading scores over time suggests that the observed variation in the scores of elementary, secondary and vocational candidates is likely due to fluctuations in the difficulty of the test across years and appears to systematically affect candidates in the same ways.



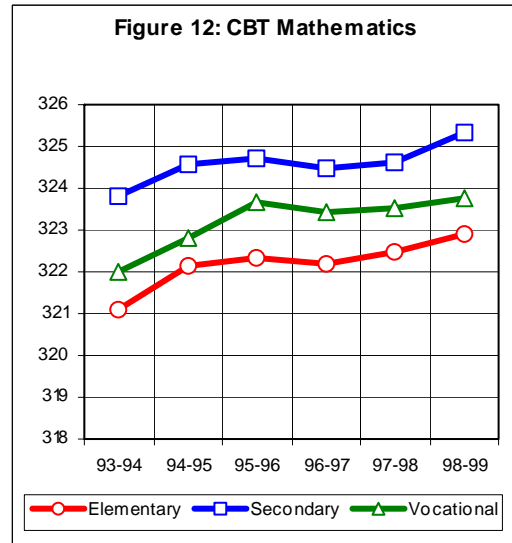
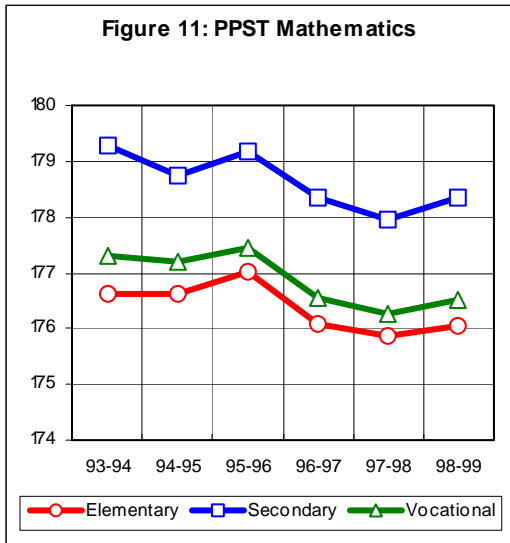
Writing

The scores from the writing assessment are very similar to the reading assessment, with vocational candidates consistently having the lowest writing scores in each year of the study and for the paper-based and computer-adaptive formats. Writing scores for elementary candidates appear to consistently be slightly above the scores of vocational candidates, and secondary candidates consistently have the highest scores. The writing scores for all three types of candidates appear to be as stable as the reading scores, with scores on the paper-based format varying less than one-half point each year and scores on the computer-adaptive format varying less than one point each year, on average.



Mathematics

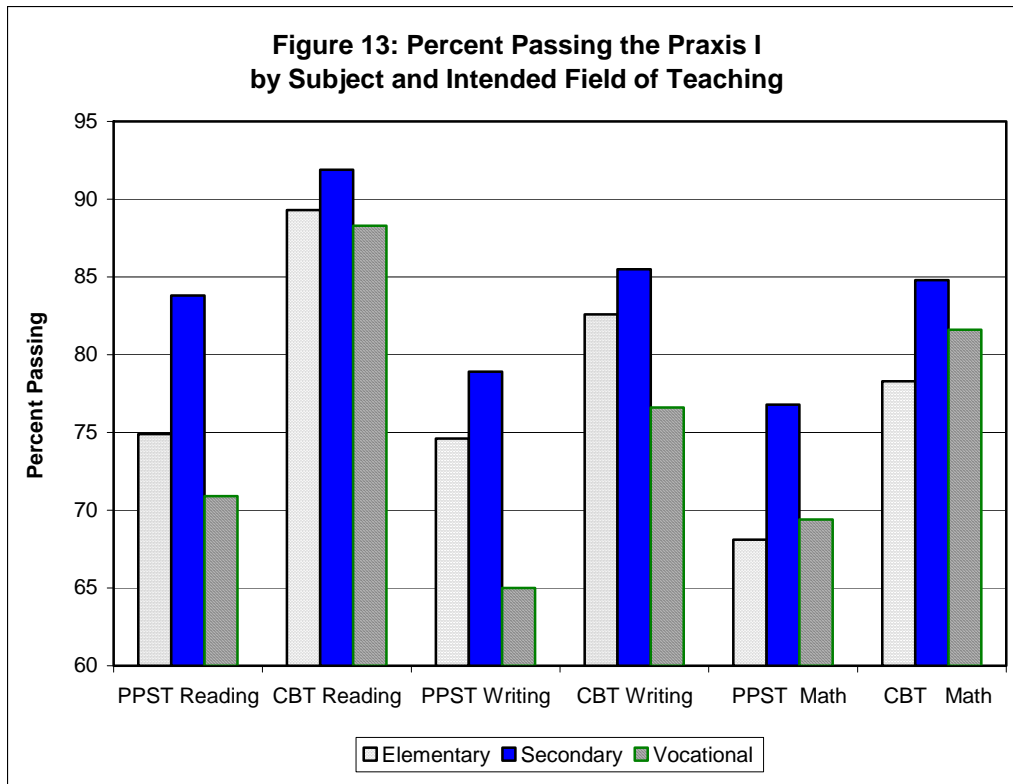
The scores from the mathematics assessment are similar to the scores on the reading and writing assessments, with one key difference. Although secondary candidates consistently had the highest scores, vocational candidates scored slightly higher than elementary candidates in each year and for each format of the assessment. Vocational candidates may score higher than elementary candidates due to the use of mathematics in many fields in vocational education, such as business, accounting, computer technology, agriculture, industrial arts and home economics. The mathematics scores for all three types of candidates are consistent over time and move together in a consistent pattern from year to year.



Pass Rates

Although there are clear differences in the average scores of elementary, secondary and vocational candidates, the importance of these differences is less clear. One way to assess relative score differences is to examine differences in pass rates, since a passing score indicates the designated state has certified that a candidate has acquired a level of knowledge that is adequate for a beginning teacher in that state.

States that use the Praxis assessments for teacher certification set qualifying scores – also referred to as passing scores – on each of the assessments based on the level of difficulty of each test over a given period of years. The passing score indicates the level at which a state will certify candidates as meeting minimum criteria. Each state determines qualifying scores based on the state’s judgment of the minimum required academic knowledge and skills for beginning teachers, factoring in the current supply and demand for teachers in the state. The qualifying scores for each assessment vary considerably among states, and even within states across a period of years. Therefore, it is difficult to compare pass rates across states fairly because of differences in state qualifying scores. Data on the pass rates for the reading, writing and mathematical assessments for elementary, secondary and vocational candidates was available for the 1998-1999 assessment year.



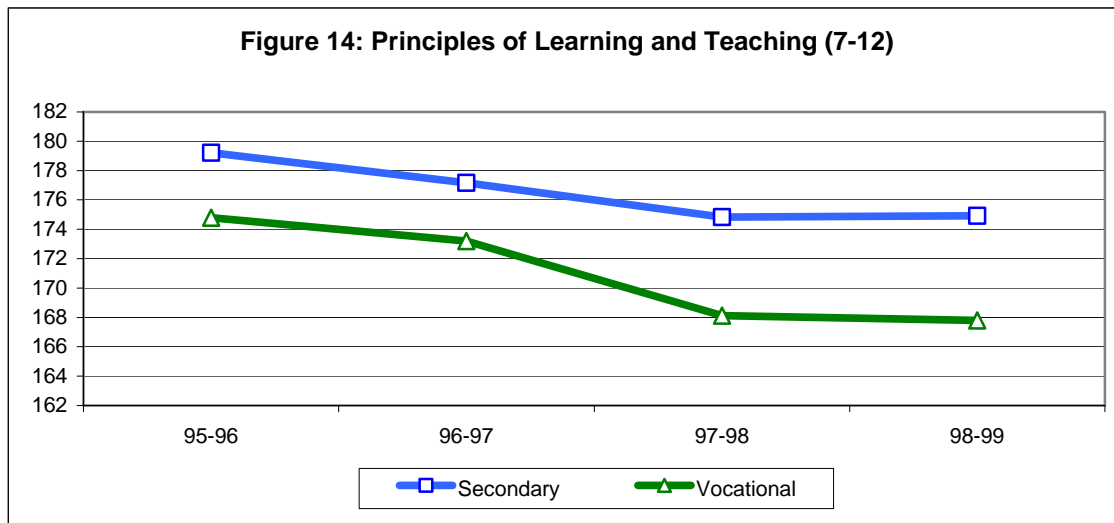
Vocational candidates consistently pass the assessments at lower rates than secondary candidates, and at lower rates than elementary candidates in reading and writing. The pattern of passing scores suggests that vocational candidates may be less likely than elementary and secondary candidates to have acquired a level of academic skills that is adequate for a beginning teacher.⁹

Pedagogical Knowledge

Pedagogy is the art and science of teaching children. Pedagogy refers to the professional skills teachers need to impart the specialized knowledge of their field to their students, and includes the methods and activities used by teachers in the learning process. The pedagogical knowledge for teaching grades 7 to 12 of prospective secondary and vocational teachers is examined through the Principles of Teaching and Learning assessment scores on the Praxis II from 1995 to 1999. The pedagogical knowledge score is a measure of a teacher’s understanding of how to incorporate theories of learning and development in practice and how to relate the process of teaching to the process of student learning. Higher pedagogy scores may suggest that candidates are more likely to use a range of teaching skills and techniques and are better able to adjust their

⁹ Although these results were consistent for both the paper-based and computer-adaptive formats, the passing rates did appear to vary slightly between testing formats. Since candidates could elect to take the assessments in either format, it is not clear whether differences in scores reflect differences in the relative difficulty of the exams or differences in the underlying characteristics of candidates that self-selected to take either the paper-based or computer-adaptive exam format.

professional practices to meet the academic and social needs of their students to create learning environments where students can succeed.



Vocational candidates consistently score lower than secondary candidates on the Principles of Teaching and Learning assessment of pedagogical knowledge. The scores for vocational and secondary candidates appear to be consistent over time and move together in a consistent pattern from year to year. The variation in pedagogical knowledge between secondary and vocational candidates may suggest that vocational candidates understand less about the theories of teaching and student learning and about how to incorporate the theories in their practice.

However, the importance of pedagogical skills in vocational fields is unclear, and many vocational practitioners argue vocational teachers' technical skills may contribute more to the success of vocational students than their academic skills or pedagogical knowledge.¹⁰

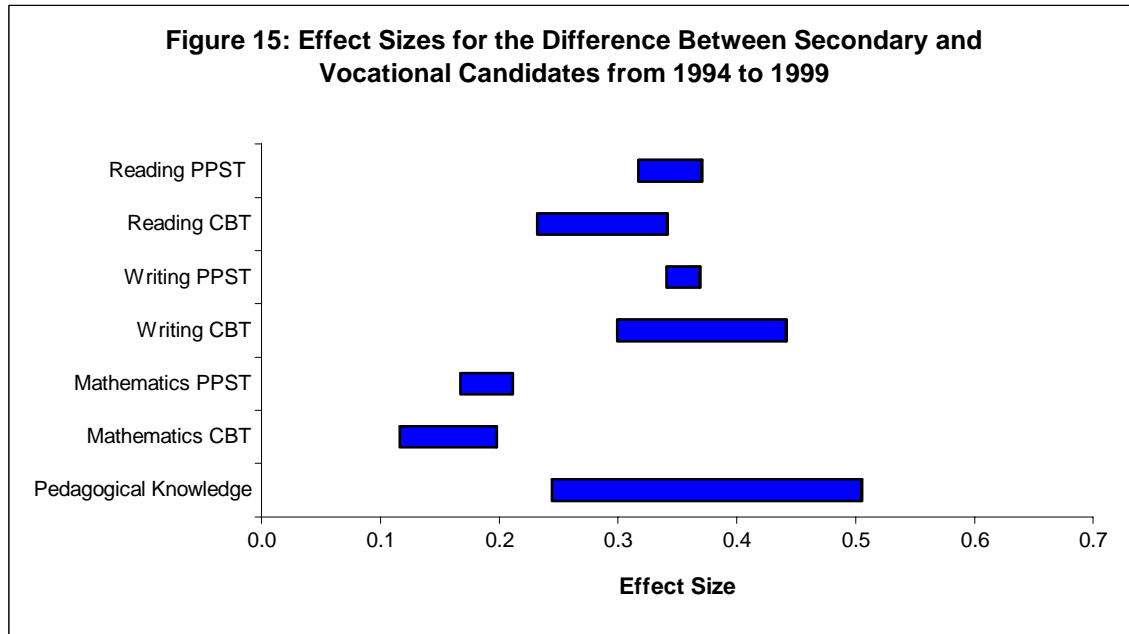
Probability Values and Effect Sizes

This section presents effect sizes to determine whether the differences in reading, writing, mathematics and pedagogical scores between secondary and vocational candidates are not only statistically significant, but also practically relevant. Simply stated, are the observed differences between secondary and vocational candidates large enough to matter in the real world?

Although the p-values in this analysis indicate there are statistically significant differences in the mean reading, writing, mathematics and pedagogy scores of secondary

¹⁰ Wenglinsky (2000) also notes that prospective teachers who pursue vocational education may not be a homogeneous group, as teachers who receive licenses may be professionals from other professions who have a high level of technical skills, or low performers who could not meet the requirements of a traditional license.

and vocational candidates, the real question of interest is whether the differences are also meaningful.¹¹ In studies with very large samples, such as this analysis, the probability of finding a statistically significant result is much higher than in studies with smaller samples simply because the p-values reflect the larger sample size. In this case, the effect sizes provide a much more meaningful indicator of the magnitude of the difference between groups, since they are calculated as the standardized difference between two means and are independent of sample size.¹²

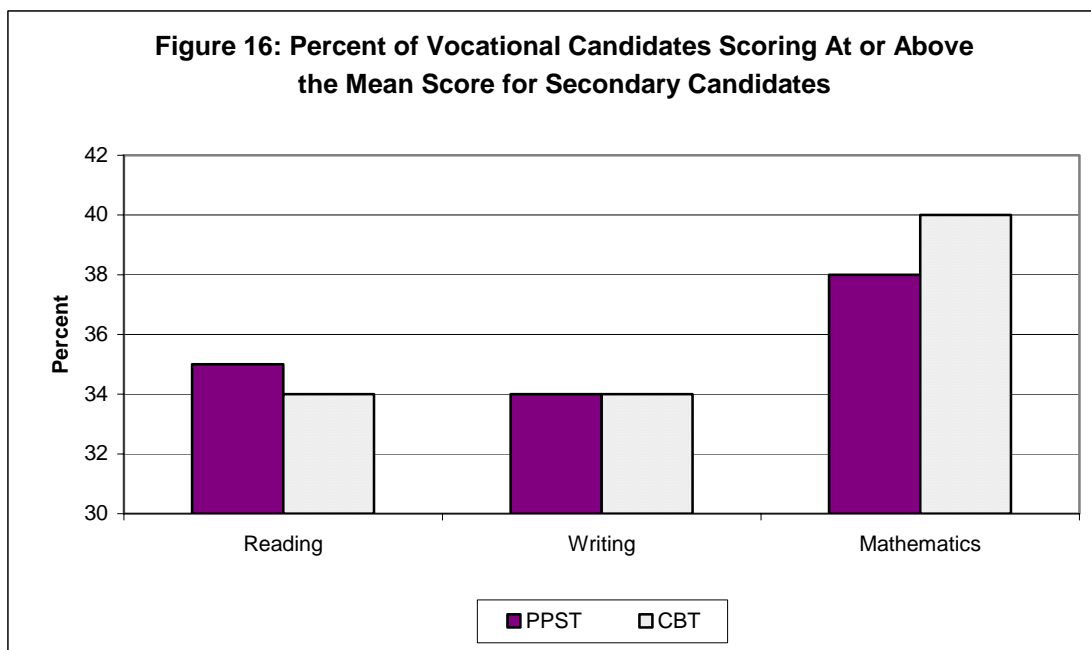


The effect sizes clearly indicate that there are meaningful differences between secondary and vocational teacher candidates. In reading, the effects sizes ranged between .23 and .37 between 1994 and 1999, which is a small to medium magnitude of difference. The effect sizes in writing were even larger, with effect sizes ranging from .29 to .43. Only small effects appeared in mathematics, ranging between .11 and .20. The most notable differences between secondary and vocational candidates were in pedagogical knowledge, with moderate effect sizes ranging between .24 and .50.

¹¹ Statistical significance is a way of examining the probability that an observed difference could have occurred by chance, and is expressed in terms of a probability-value – p-value. If the p-value is less than .05, then there is less than a 1 in 20 chance that the observed difference in sample means occurred by chance, which is generally considered to be statistically significant. The p-values for the analyses of reading, writing, mathematics and pedagogical scores are all less than .001.

¹² Although the effect size is used to calculate the magnitude, or practical significance, of an effect, interpreting the magnitude is often a matter of judgment. Convention in the field of research suggests that a small effect size is between .1 and .3, a medium effect size is between .4 and .6, and a large effect size is .7 and greater. In the social and behavioral sciences, the vast majority of effect sizes fall in the small to medium range, and effect sizes of .3 and greater are considered to reflect meaningful differences between groups. Therefore, it is important to interpret the magnitude of these findings as they relate to the magnitude of findings commonly found in the social and behavioral sciences.

Another way of understanding the differences between candidates for secondary and vocational teaching credentials is to examine the percent of one group scoring at or above the mean for the other group. If there were no differences between the two groups, then 50 percent of the students in each group would score at or above the mean score of the other group. Figure 20 shows the percent of vocational candidates scoring at or above the mean of secondary candidates. In reading and in writing, approximately 34 to 35 of vocational students scored at or above the mean for secondary students. More simply stated, nearly 7 out of 10 vocational candidates scored below the average score for secondary candidates. The group differences were much less notable in mathematics, where 38 to 40 percent of vocational candidates scored at or above the mean for secondary candidates.



From these analyses, we can conclude that the gap between vocational and secondary candidates in reading and writing are both statistically significant and of a size that are meaningful. On the other hand, differences in mathematical ability, while statistically significant, most likely do not reflect a large enough effect to warrant significant attention from practitioners or policymakers.

V. Conclusions and Implications

The purpose of this study was to examine how academically well-prepared candidates for teacher certification in vocational education are to teach courses and programs that reflect the principles in the Perkins III legislation. After examining the academic skills and pedagogical knowledge of elementary, secondary and vocational candidates, it is not

clear whether vocational candidates are prepared to support and reinforce students' acquisition of academic skills. Three key findings emerged from the analysis:

- Candidates for certification in vocational fields are not as academically or pedagogically prepared as are candidates for certification in secondary fields;
- Candidates for certification in vocational fields are not as academically prepared in reading and writing as candidates for certification in elementary education;
- A potential disconnect may exist between the academic and pedagogical skills of vocational candidates and the direction of federal policy, which has increasingly emphasized the importance of academic skills for vocational students.

There may be several factors that contribute to these differences, including:

- Vocational teachers' job requirements and teacher preparation programs may not currently emphasize this new direction of federal policy;
- Prospective vocational candidates tend to be older than other teacher candidates and may have been out of school for longer periods of time;
- Prospective vocational candidates tend to have lower grade-point averages in college than other prospective teachers, and they may have taken more courses that did not emphasize academics.

This analysis presented data on the reading, writing and mathematics skills and pedagogical knowledge of teacher candidates as a proxy for the abilities of prospective teachers. However, it is not clear how these abilities translate into effective teaching practices and student achievement, which is the real question of interest. As stated earlier, it is not entirely clear whether academic skills, pedagogical knowledge or technical expertise is the most important factor in effective teaching practices in vocational education. If a teacher's academic skills do exhibit some influence over the success of their students, then differences in the abilities of elementary, secondary and vocational teachers may lead to differences in the outcomes for students in academic and vocational courses of study. However, in order to accurately estimate the relative abilities of teacher candidates in different fields, we first need to understand the characteristics of effective teaching practices in elementary, secondary and vocational education.

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