

Student Achievement and *Passport to Teaching* Certification in Mathematics

Purpose

ABCTE recently examined the validity of the exams necessary for candidates in the *Passport to Teaching* mathematics certification program. The study investigated the relationship between exam proficiency and student achievement by assessing currently certified mathematics teachers.

Study Methodology

ABCTE conducted the Mathematics Certification Study in Tennessee during the spring of 2006, following methodology similar to that of the ABCTE Elementary Education Validation Study. Tennessee was chosen as the study site because the state provides value-added student achievement reports to teachers. The TVAAS (Tennessee Value-Added Assessment System), designed by William Sanders, matches students to teachers and measures the actual progress of a teacher's students in terms of their projected learning growth.

Description of Teacher Sample

A sample of 78 mathematics teachers, specializing in grades 5 through 8, participated in the study by completing the two ABCTE certification examinations needed for *Passport to Teaching* mathematics certification: the Professional Teaching Knowledge exam and the Mathematics exam. Of the 78 participants in the study, 65 teachers have their professional license in secondary mathematics and 13 teachers have either an apprentice or interim license. The average participant's teaching experience in the field of mathematics totaled 10.4 years. The participants taught in seven of the larger and more urban Tennessee districts. The participants agreed to submit their TVAAS student achievement reports with the understanding that the results would remain confidential.

To encourage substantial effort on the exam, participants were compensated at a base level and then provided with an additional sum based on how their exam performance compared to the study mean. The participants were given access to an ABCTE online refresher course in mathematics five days prior to completing the exam. The pass rate for study participants on the mathematics exam (5.1%) was less than the pass rate for *Passport to Teaching* candidates (36.1%). However, the pass rate on the teaching knowledge exam (66.6%) was very similar to the pass rate for actual *Passport to Teaching* candidates (71.0%). The examination results indicate the approximate knowledge base of a teacher at the time of instruction.

Student Achievement Calculations

The value-added student achievement scores were obtained from the Tennessee Value-Added Assessment System based on the mixed-methods model developed by William Sanders. They are expressed as normal curve equivalent scores (NCE). Teachers receive average student learning gain scores by subject area and year.

An NCE score of zero means that the average student gained one year's growth in achievement during a school year. A positive score indicates that the teacher's students achieved above-average growth, compared with students in the rest of the state. In other words, they gained more than a normal year's achievement while taught by a particular teacher. A negative NCE score means the teacher's students attained less than one year's growth in achievement. Student NCE average scores for math typically range two or three NCE points from "exceptional" to "deficient" (see *Appendix B*).

Middle-Level Mathematics Teachers and Secondary Mathematics Certification

In Tennessee, middle-school mathematics teachers (grades 5-8) who hold a secondary mathematics license are permitted to teach at the middle- and high-school levels. The grade range for which value-added student achievement data are available (grades 4-8) limits the sample of teachers used for the secondary mathematics validation study. Ideally, the sample would include a range of teachers throughout the secondary level.

The study's sample includes only those who teach through grade 8, the last year in which TVAAS calculates student learning gains and provides a report to teachers. Since these teachers hold a secondary mathematics certificate, it is still appropriate for them to take the ABCTE mathematics exam that states currently use to certify secondary teachers.

Content of Professional Teaching Knowledge and Mathematics Exams

The content tested on each licensure exam is listed below by domain.

Professional Teaching Knowledge:

Domain 1 – Instructional Design

Domain 2 – Effective Instructional Delivery

Domain 3 – Classroom Management and Organization

Domain 4 – Assessment

Mathematics:

Domain 1 – Number Sense

Domain 2 – Algebra and Functions

Domain 3 – Geometry and Spatial Reasoning

Domain 4 – Measurement

Domain 5 – Trigonometry

Domain 6 – Probability, Statistics, and Data Analysis

Domain 7 – Linear Algebra

Domain 8 – Calculus

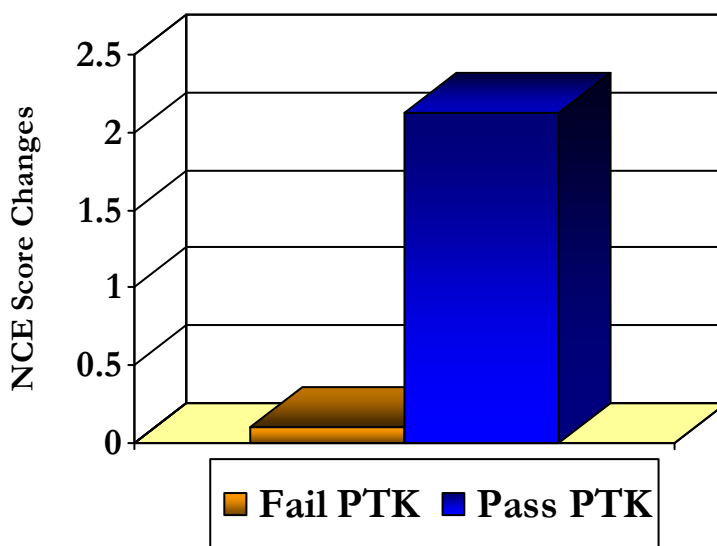
Study Findings

The study compares those who passed and failed the examinations with respect to their students' achievement. This comparison is of interest to policymakers who may be considering the *Passport to Teaching* credential as an indicator of teacher quality. An effective certification program identifies teachers with the necessary amount of subject area knowledge to positively affect student learning. By comparing the study participants' level of impact on student achievement with their performance on the ABCTE exams, the effectiveness of the ABCTE program can be determined. The study measured skill in mathematics as well as teaching knowledge through the ABCTE certification exams in these areas. Teacher effects on student achievement were measured by the Tennessee Value-Added Assessment System and reported as their students' increase in knowledge compared to their peers across the state. Overall, the study group had an average effect (1.46 NCE gain) that exceeded the state growth standard of 0.00 NCE.

Professional Teaching Knowledge

The participants, as a whole, performed well on the Professional Teaching Knowledge exam, with 52 teachers passing and 26 failing. Those teachers who were able to pass the teaching knowledge exam also showed higher student achievement, at statistically significant levels, than those who failed. These teachers also showed positive student learning gains in mathematics (2.13 NCE gain), while failing teachers showed significantly lower student learning gains (0.10 NCE). See *Figure 1* and *Table A* below.

Figure 1. Student Achievement and Professional Teaching Knowledge



The gap in student gains between those who passed the PTK exam and those who failed is further illustrated by the 2004 TVAAS report card (see *Appendix A* below). The TVAAS report card assigns typical classroom grades to levels of student learning gains. Teachers who demonstrated proficiency on the ABCTE exams tended to have A-level student learning gains that exceeded the state growth standard. Conversely those teachers who failed the exams yielded C-level student learning gains according to the Tennessee report card for student achievement.

Table A. Student Learning Gains of Teachers Based on PTK-Scaled Score

	n	Math-Scaled	PTK-Scaled	System-Adjusted NCE Gain	TVAAS Report Card Grade
Passing (Above 270)	52	218.3	289.1	2.13	A
Failing (Below 270)	26	206.5	245.5	0.10	C

The difference in student NCE gains is statistically significant at the $p=0.01$ level. (See *Appendix C*.)

Mathematics Subject Area Knowledge

The mathematics exam proved difficult for the middle-school mathematics teachers in the study. Only four teachers scored above the ABCTE-proficient cut score for mathematics. Teachers in the sample showed greater proficiency (average percentage of items correct) in the areas of number sense (48.4%), probability (48.2%), algebra (38.8%), and geometry (49.6%), and they showed less proficiency in the areas of trigonometry (22.7%), linear algebra (26.7%), and calculus (25.1%), topics generally beyond the scope of middle-school mathematics curricula. Teacher scores would likely increase if the exam reflected the sample population's current level of mathematics instruction. Since all of the teachers in the sample were middle-level math teachers, we chose to examine the relationship between their scores and their impact on student achievement, rather than just comparing their performance in relation to exam cut scores. This method of comparison shows whether there is a correlation between mathematics knowledge and student learning gains.

Even with average participant scores registering below the ABCTE proficiency level, teachers with greater proficiency in math had a greater impact on student learning gains. The data were examined to determine whether there was a difference in student learning gains between those teachers who scored one standard deviation above the study mean and those who scored one standard deviation below the study mean. In fact, the data show a difference in the impact on student achievement between those who scored one standard deviation above the mean (2.51 NCE gain) and those teachers who scored one standard deviation below the mean (0.79 NCE gain). See *Figure 2* and *Table B* on the next page.

Figure 2. Mathematics Content Knowledge and Student Achievement

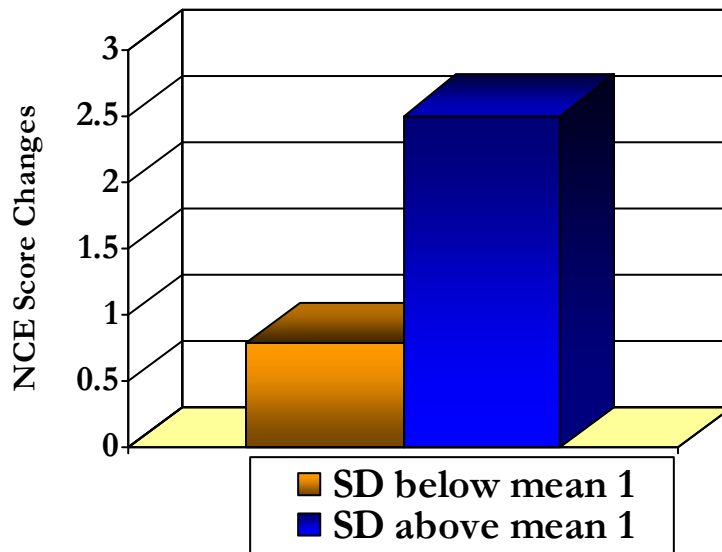


Table B. Student Learning Gains of Teachers Based on Mathematics-Scaled Score

	n	Math-Scaled	PTK-Scaled	System-Adjusted NCE Gain	TVAAS Report Card Grade
1 Std. Dev. Above Mean	15	263.7	283.3	2.51	A
1 Std. Dev. Below Mean	10	177.0	263.5	0.79	B

The difference in student NCE gains is statistically significant at the $p=0.14$ level. (See *Appendix C*.)

The difference in effect size between the highest- and lowest-performing teachers is again illustrated by the 2004 TVAAS report card. Teachers in the sample with higher mathematics content knowledge had A-level student learning gains, while those with the least content knowledge had B-level student learning gains.

Overall Conclusions

When teachers were given the opportunity to participate in the Mathematics Certification Study, they understood that they would need to present a copy of their 2004 TVAAS report. It is fair to say the study attracted a self-selecting group of teachers that showed higher levels of student achievement than average. The mean student learning gains of the sample population was 1.46 NCE, which is almost A-level student achievement according to the 2004 TVAAS Report Card. The nature of this high-achieving sample population makes finding significant differences in student learning gains more difficult.

Despite the limitations of the sample, the study found significant differences in student learning gains between those teachers who demonstrated greater knowledge in teaching and mathematics content and those proving to be less knowledgeable. Individuals that demonstrate proficiency on the ABCTE certification exams possess the knowledge necessary to positively and significantly affect student learning gains in the classroom.

Appendices

Appendix A. 2004 TVAAS Report Card

The 2004 TVAAS Report Card scale offers a way to compare the magnitude of the student NCE changes in mathematics. The report card expresses the scores as conventional academic grade points based on ranges of NCE changes. From these a grade point value was assigned, based on the typical 4.0-point scale, for each mathematics student learning gain level.

Grade	Status	Mean Gain Range
A	Exceptional	>1.5
B	Exceeds State Growth Standard	0.5 to 1.5
C	Maintains State Growth Standard	-0.5 to 0.4
D	Below State Growth Standard	-1.9 to -0.6
F	Deficient	<-1.9

Appendix B. Detailed Tables of ABCTE Certification Exams and Student Achievement

Scaled Score Statistics

	N	Mean	Std. Deviation	Std. Error Mean
PTK-Scaled Score	78	274.53	26.53	3.00
Math-Scaled Score	78	214.37	29.66	3.36

Statistics Based on Performance Compared to Mean on Mathematics Exam

	N	Mathematics Score		PTK Score		Teacher Effect - NCE Gain	
		Mean	SD	Mean	SD	Mean	SD
1 Std. Dev. Above the Mean	15	263.7	15.6	283.3	20.2	2.51	2.47
Within 1 Std. Dev. of the Mean	53	207.5	14.5	274.1	26.4	1.28	3.33
1 Std. Dev. Below the Mean	10	177.0	6.3	263.5	33.2	0.79	3.14
Total	78	214.4	29.7	274.5	26.5	1.46	3.17

Statistics Based on Performance Compared to Cut Score on Professional Teaching Knowledge Exam

	N	PTK Score		Mathematics Score		Teacher Effect - NCE Gain	
		Mean	SD	Mean	SD	Mean	SD
Passed (270 and Above)	52	289.1	13.7	218.3	30.5	2.13	2.94
Failed (Below 270)	26	245.5	21.6	206.5	26.7	0.10	3.24
Total	78	274.5	26.5	214.4	29.7	1.46	3.17

Appendix C. Statistical Significance Tables

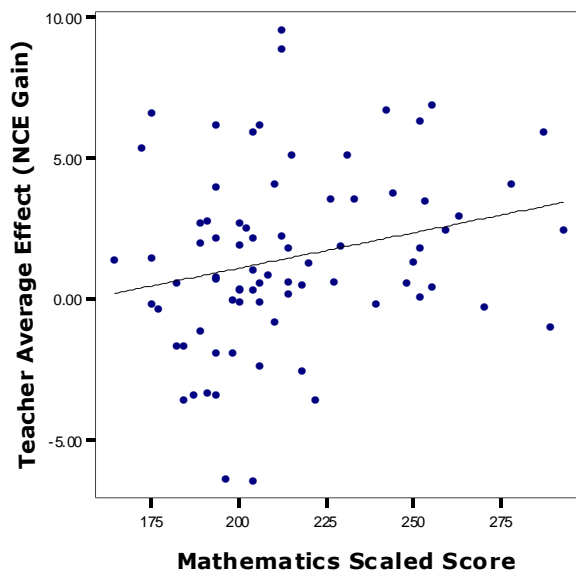
Independent Samples Test – Mathematics Exam (Between Scores 1 Standard Deviation Above and Below Mean)

	Sig. (2-Tailed)	Mean Difference	Std. Error Difference	90% Confidence Interval of the Difference	
Teacher Average Effect (NCE Gain)	0.14	1.72	1.12	-0.20	3.65

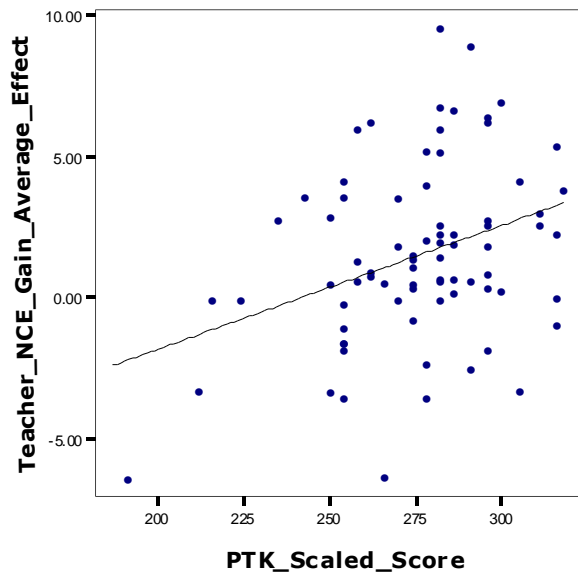
Independent Samples Test – PTK Exam (Between Passing and Failing Scores)

	Sig. (2-Tailed)	Mean Difference	Std. Error Difference	90% Confidence Interval of the Difference	
Teacher Average Effect (NCE Gain)	0.01	2.03	0.73	0.81	3.24

Appendix D. Regression Analysis of Certification Exams and Student Learning Gains



Teacher_NCE_Gain_Average_Effect = $-3.92 + 0.03 * \text{Math_Scaled_Score}$
R-Square = 0.05



Teacher_NCE_Gain_Average_Effect = $-10.62 + 0.04 * \text{PTK_Scaled_Score}$
 R-Square = 0.12