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Impact of National Board for the Professional Teaching Standards Certification on Student Achievement

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Abstract: A growing number of teachers have undertaken National Board for Professional Teaching Standards (NBPTS) certification training since its inception over twenty-five years ago. Previous empirical research on the impact of NBCTs on student performance has focused on state or district-level exams in individual states and found mixed results. This study examines the relationship between National Board Certified Teachers (NBCTs) and student achievement on the reading and math assessments of the National Assessment of Educational Progress (NAEP). We argue that achievement can be affected both directly by the certified teacher and indirectly as NBCTs provide mentoring to colleagues and assume school leadership positions. This study focuses on a nationally representative assessment to measure student achievement rather than state- or district-level assessment exams. We find that the percentage of National Board certified teachers in a state is positively related to scores on state-level NAEP Reading and Math assessments.
Keywords: Teacher Leadership; Academic Achievement; Teacher Qualifications

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Impacto de la Junta Nacional para la Certificación de Estándares de Enseñanza Profesional en el rendimiento estudiantil.
Resumen: Un número creciente de profesores han participado de la formación y de los exámenes de certificación de la Junta Nacional de Estándares de Enseñanza Profesional (NBCTs) desde su creación hace más de veinte y cinco años. Investigaciones empíricas anteriores sobre el impacto de NBCTs en el desempeño de los estudiantes se ha centrado en los exámenes estatales o de distrito en los estados y los resultados han sido mixtos. Este estudio examina la relación entre NBCTs y el rendimiento de los estudiantes en las evaluaciones de lectura y matemáticas de la Evaluación Nacional del Progreso Educativo (NAEP). Sostenemos que el logro puede verse afectado tanto directamente por docentes certificados e indirectamente por NBCTs cuando asisten a otros colegas y asumen posiciones de liderazgo escolar. Este estudio se centra en una evaluación representativa a nivel nacional para medir los logros de los estudiantes en lugar de los exámenes de evaluación de estado o de distrito. Encontramos con que el porcentaje de docentes certificados por NBCTs en un estado se relaciona positivamente con las evaluaciones de Lectura y Matemáticas de estado a nivel de NAEP.
Palabras clave: Liderazgo docente; logro académico; aptitudes docentes; NBCT.

Impacto do Conselho Nacional de Certificação de Padrões de Ensino Profissional no desempenho dos alunos.
Resumo: Um número crescente de professores participaram nos exames de formação e certificação do Conselho Nacional de Padrões Ensino Profissional (NBCTs) desde a sua criação mais de 25 anos. Investigações empíricas anteriores sobre o impacto dos NBCTs no desempenho dos alunos concentrou-se em testes por estados ou distrito e os resultados têm sido mistos. Este estudo analisa a relação entre NBCTs e desempenho dos alunos nas avaliações de leitura e matemática na Avaliação Nacional do Progresso Educacional (NAEP). Afirmamos que o desempenho dos estudantes pode ser afetado direta e indiretamente por professores certificados pelos NBCTs quando ajudam colegas e assumem posições de liderança. Este estudo centra-se em uma avaliação nacional representativa para medir o desempenho dos alunos em vez de os testes de avaliação estadual ou distrital. Nós achamos que o percentual de professores certificados pelos NBCTs num estado está positivamente relacionado com as avaliações de leitura e matemática de nível de Estado NAEP.
Palavras-chave: liderança educacional; conquista acadêmica; habilidades de ensino; NBCT.

Introduction

Since its inception in 1987, states have invested in providing experienced teachers with professional development by supporting their work toward certification through the National Board for Professional Teaching Standards (NBPTS) program. The main expectation of these teachers, and the stakeholders involved in P12 education, is that certification improves student achievement. There is also an expectation that certification will advance their careers as classroom teachers and as leaders in the school system. The previous research on the impact of teacher certification has primarily focused on the relationship between teacher training and student outcomes at state or district levels. A smaller body of research looks at activities in schools to determine the impact of certified teachers within the school organization as teaching mentors and school leaders. There are few national perspectives on the direct relationship between the National Board Certification (NBC) and student outcomes.

We expand the research base to focus on the impact of NBPTS certification on student outcomes using the Reading and Math assessments taken from the National Assessment of Educational Progress (NAEP) rather than individual state-level or district-level assessment exams. The use of a national assessment provides an opportunity to turn the focus away from the "high stakes" state exams, which may be targets of government pressures on teachers and school administrators to achieve high student assessment outcomes. The use of a national exam also allows for the possibility for generalization of effectiveness results beyond the few individual states where this work has been previously carried out.

The following section of this paper, Section II, explains the structure of the NBPTS certification program and how certification is expected to affect student achievement. The efforts by states to recruit program participants are also described. The literature on the relationship between teacher certification and student achievement is explored in Section III. Section IV presents the data and the empirical models used to estimate the relationships between teacher certification and student assessments. The statistical results from several empirical models are reviewed in Section V. Overall, we find evidence that having a National Board Certified Teacher (NBCT) improves state average NAEP Math and Reading assessments, after controlling for other family and school factors. The implications of these results for state policies in support of the NBPTS certification program are presented in the concluding Section VI.

NBPTS and Spillover Effects

While the quality of the teacher is thought to have the greatest impact on student learning, generally weak statistical relationships have been estimated between common measures of teacher characteristics and student achievement (Hanushek & Rivkin, 2006). One of the stronger relationships is the positive impact of teacher experience on student achievement. A conclusion that could be reached from these findings is that the same amount of money (or even less) spent to improve and document teacher expertise in a different way is likely to enhance student performance. An example of this alternative expenditure is to establish teacher national certification programs that recognize the complex nature of teaching and strengthen the role of teachers on student learning.

The NBPTS began to offer certification to experienced teachers, in part to convey "the definitive standards and systems for certifying accomplished educators…" (NBPTS, 2013a) and to respond to recommendations and program criteria outlined in *A Nation Prepared: Teachers for the 21st Century* to professionalize the teaching profession. To be eligible for National Board Certification teachers must have at least a bachelor's degree, three years of teaching experience, and a valid teaching license. Relative to the general teacher population, the teachers who apply for NBC are younger, have slightly fewer years of teaching experience (even with the minimum of three years of experience required to enter the program), and are more likely to have Master's degrees. Candidates are assessed through three classroom-based portfolio entries, including sample videos and one portfolio entry to document "accomplishments outside of the classroom" (NBPTS, 2013b). In addition, candidates must complete six standardized, computer-based, exercises covering content knowledge in their specific licensure-areas (*e.g.*, Elementary Education or Secondary English Education). In all, program certification takes up to three years to complete and is valid for ten years.

The NBPTS program and its framework promotes a process of teacher professional development and teacher recognition centered around a core set of five propositions: "Teachers 1) are committed to students and their learning, 2) know the subjects they teach and how to teach those subjects to students, 3) are responsible for managing and monitoring student learning, 4) think

systematically about their practice and learn from experience, and 5) are members of learning communities" [NBPTS (2013a)]. These five core propositions "form the foundation and frame the rich amalgam of knowledge, skills, dispositions and beliefs that characterize" NBPTS certification (NBPTS, 2013a).

The first four propositions of the NBPTS have clear links to improving student learning and/or assessments. The fifth core proposition promotes the creation of learning communities (NBPTS, 2002), stating:

> Accomplished teachers contribute to the effectiveness of the school by working collaboratively with other professionals on instructional policy, curriculum development, and staff development. They can evaluate school progress and the allocation of school resources in light of their understanding of state and local educational objectives. They are knowledgeable about specialized school and community resources that can be engaged for their students' benefit, and are skilled at employing such resources as needed and they find ways to work collaboratively and creatively with parents, engaging them productively in the work of the school (p. 4).

Learning communities create opportunities for spillover effects as certified teachers are encouraged to participate in or even to lead collaborative teacher development activities with their colleagues, which should also improve student outcomes. These spillovers could benefit other National Board Certified Teachers (NBCTs) as well as non-certified teachers. Anagnostopoulous et al. (2010) survey teachers from forty-seven elementary schools in South Carolina and Ohio and find many teachers enter the NBPTS process for the opportunity to provide professional development to their colleague or to prepare to take on school leadership roles. However, the basic economic problem is private actors will not generally consider these spillovers or only partially so they do not consider all the benefits when making a decision. As a consequence, too little of the activity will be produced than is socially optimal (Rosen & Gayer, 2014). In this context, if teachers primarily compare the potential private individual benefits (e.g., wage increases and/or professional advancements) with the costs associated with board certification (e.g., program fees and lost time) and do not consider or do not consider fully the spillover benefits (e.g., leadership opportunities, mentoring, and other professional community activities), then too few teachers will choose to become NBC. Ongoing support for continued investment in these incentives could be gained if there was more information about the benefits of NBC to both students and the greater school community.

Many states provide significant financial incentives to inspire teachers to become NBCTs. The size and nature of these benefits vary by state and include higher salaries, the possibility of being able to apply for a teaching license in other states, and hiring preferences (National Research Council, 2008). Elfers and Plecki (2014) find these financial incentives contributed to the growing number of teachers participating in the NBPTS in Washington State. In addition to incentives for achieving NBC, several states also provide full or significant partial subsidies to offset the NBPTS program entrance fee which is approximately $3,000. These generous fee subsidies and the salary and job incentives correspond to the increase in the number of NBCTs across the states since the beginning of the program. Between 1993-1994 and 2006-2007, 63,800 teachers successfully completed certification. By 2010-11 that number had increased to over 100,000 teachers. Table 1 lists the benefits given to participating teachers to complete this program in the states that provide incentives. The next to last column in Table 1 lists the percentage of eligible teachers in the state who successfully completed NBPTS between academic years 1993-1994 and 2009-2010, and illustrates the variation across states in NBPTS participation (National Conference of State Legislators, 2011). North Carolina and South Carolina have had more than 10% of their eligible

teachers apply for NBPTS Certification, while other states have had less than 1%. In addition, the relationship between the wage benefits and teacher participation percentages reflects the importance of these incentives. In 2010, the mean of the NBPTS completers as a percentage of eligible teachers in each state was 3.96% in states providing salary benefits for completers and it was 0.83% in those states without salary benefits.

Table 1

Maximum Financial Incentives and National Board Participation Rates by State, 2011

State	Fee Assistance	Salary Bonus	Bonus as % of Salary	Number of NBPTS Completers as % of Eligible Teachers	%NBPTS = NBPTS Teachers/Total Teachers Administering 8th Math & Reading NAEP
AL	$2,500	$4,450	9.3	4.20	4.29
AK			0.0	1.50	8.86
AZ			0.0	1.40	6.68
AR	$2,500	$5,000	10.8	4.50	7.42
CA		$5,000	7.3	1.60	11.47
CO	$750	$4,800	9.8	1.10	9.75
CT			0.0	0.30	14.07
DE			0.0	5.30	7.20
DC		$4,000	5.8	1.20	4.93
FL		$4,650	10.0	7.30	7.25
GA			0.0	2.20	9.50
HI	$1,500	$5,000	9.2	2.50	7.37
ID		$2,000	4.1	2.40	8.91
IL	$2,000	$3,000	5.2	3.50	11.33
IN			0.0	0.20	22.41
IA			0.0	1.80	7.20
KS	$2,000	$1,000	2.1	1.00	9.57
KY		$2,000	4.0	5.00	12.57
LA	$750	$5,000	10.0	3.40	9.26
ME			0.0	1.30	6.11
MD	$1,650	$3,000	4.7	3.40	9.96
MA			0.0	0.70	10.54
MI	$2,500		0.0	0.40	16.26
MN			0.0	0.70	15.78
MS	$2,500	$6,000	14.3	9.70	8.98
MO	$2,500	$5,000	10.8	1.00	10.61
MT		$3,000	6.3	0.90	11.15
NE			0.0	0.40	8.60
NV	$1,500	$2,727	5.0	2.20	5.32
NH			0.0	0.10	18.20
NJ			0.0	0.20	17.71
NM		$5,800	12.7	2.50	10.65
NY	$2,500	$10,000	13.6	0.50	16.18
NC	$2,500	$5,512	12.0	16.40	14.93

Table 1 con't

Maximum Financial Incentives and National Board Participation Rates by State, 2011

State	Fee Assistance	Salary Bonus	Bonus as % of Salary	Number of NBPTS Completers as % of Eligible Teachers	%NBPTS = NBPTS Teachers/Total Teachers Administering 8th Math & Reading NAEP
ND	50%	$1,000	2.2	0.40	21.79
OH			0.0	2.90	7.05
OK		$3,900	8.8	6.10	8.36
OR			0.0	0.80	12.60
PA			0.0	0.60	14.42
RI			0.0	3.70	10.83
SC	$1,250	$7,500	15.8	15.60	13.00
SD			0.0	0.80	8.97
TN			0.0	0.70	12.40
TX			0.0	0.20	22.61
UT			0.0	0.90	15.94
VT			0.0	1.40	8.38
VA		$7,500	15.6	3.10	7.02
WA	$2,000	$10,000	19.1	9.60	11.26
WV	$2,000	$3,500	7.7	2.90	6.53
WI	$2,000	$5,000	9.3	1.30	5.77
WY		$4,000	7.0	4.50	12.24
Min				0.40	4.29
Max				16.40	22.61
Mean				3.96	11.05

Previous Literature on the Outcomes of Board Certification

Previous studies of the impact of board certification on student achievement have generally focused on the relationship between NBCTs and student assessments from a particular state or school district. Three studies draw on the outcomes of a few individual teachers. Stone (2002) examines sixteen teachers in Tennessee. He connects individual students to NBCTs to analyze student scores on a small scale using a value-added analysis and finds that students in the classroom of this group of NBPTS certified teachers performed no better than expected. McColskey et al. (2005) look at twenty-five North Carolina teachers and find only slightly higher math and reading scores for children in NBCTs classrooms. Vandervoot, Amrein-Beadsley, and Berliner (2004) examine thirty-five elementary school teachers in Arizona. They make use of multiple measures of the teachers' effectiveness (including principal evaluation) and employ a measure of effect size to estimate the effect of having a NBCT on SAT-9 scores (the state measure at the time). They find statistically significant higher scores among the students with NBCTs. Vandevoort, Amrein-Beardsley, and Berliner use a more sensitive measure (gain scores) and may be a better way to evaluate teacher effectiveness, as compared to using other value added measures. A drawback of all three studies is that the student and teacher samples are too small to draw any general conclusions regarding the impact of NBCTs on student outcomes.

Larger studies draw on the experiences of a greater number of teachers and students. Cantrell et al. (2008) focus on the impact of certified elementary school teachers in Los Angeles Unified Public Schools on district reading and math assessments taken between 2003 and 2005. They did not find any statistically significant differences between classrooms with NBCTs and those with non-certified teachers, but did find statistical differences between the NBCTs and unsuccessful applicants for this NBPTS certification. Cavalluzzo (2004) considers student performance in ninth and tenth grade math in Miami-Dade County high schools and finds students of NBCTs had the greatest gains in scores relative to both non-certified teachers and unsuccessful applicants for NBPTS certification. Clotfelter, Ladd, and Vigdor (2006) use teacher and student data from North Carolina elementary schools between 1994 and 2004 to study the relationship between NBCTs and student performance on state reading and math exams. They also find NBCTs to be more effective than other non-certified teachers. The same authors (2007) carry out a similar study on North Carolina fifth graders who took exams between 1999 and 2000 and estimate a positive relationship between NBCTs and reading assessments but not in math. Goldhaber and Anthony (2007) examine teachers and students in North Carolina elementary schools between 1996 and 1999 and also find a positive impact of NBCTs on student performance in reading but not math. Harris and Sass (2009) focus on elementary and high school student performance on Florida high-stakes assessments between 1999 and 2004 and likewise estimate a positive relationship between NBCTs and student performance on reading but not math. Sanders, Ashton, and Wright (2005) consider teacher and student performance in two North Carolina school districts – Wake and Charlotte-Mecklenburg; this study did not find a strong positive relationship between NBCTs and student performance in fifth to eighth grade reading and math.

Another area of research looks to explain the impact of NBCTs within the school organization as mentors of colleagues and/or as school leaders. In the larger context of teacher certification, the NBPTS program's stated goal of the creation of a learning community in the school may be unique. As the only nationwide certification system, NBPTS distinguishes itself from other certification processes by requiring candidates to demonstrate how they work with their colleagues at the building level. State certification programs, such as those for principals and other school professionals, do not require the candidate to present similar information (Grissom & Loeb, 2011; Hale & Moorman, 2003).The learning community requirement within the NBPTS certification process creates opportunities for NBCTs to act as mentors to other teachers through casual interactions or formal instructional workshops and school leadership positions (Loeb, Elfers, & Plecki, 2010). Although there are specific eligibility requirements for teachers to enroll in the NBPTS program, not all entering teachers will have the same levels of experience and ability, and they will leave the program at different, albeit higher, levels. NBCTs will continue to benefit from interactions with other NBCTs, particularly those who have taken leadership positions. As a result, we expect that all teachers benefit with more NBCTs on staff.

Researchers have carried out basic indirect empirical tests and found mixed evidence for the possibility of spillovers as a result of NBPTS certification. For example, Sun et al. (2013) describe how teachers who are not directly receiving the professional development benefit as these practices are diffused throughout the school by the trained teachers. They suggest that the diffusion of tested teaching practices into classrooms of teachers mentored by master teachers may benefit a wider group of students. Harris and Sass (2009) include measures of the numbers of board certified teachers in the school to test for spillover effects created by NBCTs to non-certified teachers. They do not find a positive relationship between the numbers of board certified teachers and the effectiveness of the non-certified teachers and they estimate a small negative statistical relationship for the math teachers. In contrast, Frank et al. (2008) use survey information collected from certified

and non-certified teachers from forty-seven elementary schools in two states to examine whether teachers with NBPTS certification help more colleagues on instructional matters. When teachers were asked to nominate a teacher they found to be helpful with instruction, NBPTS teachers provided about 0.6 more teachers with instruction guidance, serving as "help providers," compared with comparable non-certified teachers, therefore transferring best practices techniques throughout the school. In their survey of teachers in Ohio and South Carolina, Anagnostopoulous et al. (2010) find NBCTs in some of schools are more likely to take on leadership roles, to be mentors to all other teachers and also to encourage the non-certified teachers to pursue NBPTS certification. Indeed, they suggest that schools with more NBCTs could engage them as important organizational resources to mentor all teachers. In a study of science teachers, Lustick and Sykes (2006) suggest that NBC may have broader benefits in the form of advanced study of scientific inquiry and assessment among teachers which establishes board certification as a vehicle for teacher learning and leadership.

Description of Empirical Methods and Data

We use the standard educational production function model to estimate the relationships between the student performance "outputs" and the various student, school and teacher "inputs," including whether the teacher is NBPTS certified (Hanushek, 1986). The basic empirical structure of the model is:

Achievement = f[STUDENT,SCHOOL,TEACHER], where:

Achievement measures educational "output," or something resulting from the education process. Although several outcomes could be used, achievement is most easily measured by some examination or assessment score. The achievement output is a function (f) of:

STUDENT, which represents a vector of student and family background characteristics which usually includes measures of family income and parental education;

SCHOOL, which represents a vector of school characteristics, such as whether the school is classified as private/public and the student's class size;

TEACHER, which represents a vector of teacher characteristics. These characteristics include education level and years of teaching experience. The characteristic of specific interest to our research is the teacher's NBC status.

The regression coefficients are estimates of the partial effect of the variable on student achievement while holding constant the other determinants of achievement from the student, school, or teacher. While most of these "inputs" are not available to education leaders to adjust to affect student performance, changes to some of the school or teacher inputs may be possible for school administrators. For example, if shown to be effective, policies could be designed to increase teacher certification through programs like NBPTS.

Data

Our primary empirical analysis estimates the statistical impact of the various inputs of the educational production function at the state level using ordinary least squares. We use the state average assessment scores from the National Assessment of Education Progress (NAEP) for eighth grade Reading and Math taken over two years – 2009 and 2011 as our dependent variable or measure of student achievement. We obtained these scores from the U.S. Department of Education (2014). Administered by the US Department of Education's National Center for Education Statistics, NAEP is the only nationally representative assessment of student achievement. Linn and Dunbar (1990) describe NAEP as "the single best source of information about trends in educational achievement" in the U.S. Raymond and Hanushek (2003) argue NAEP "provides a neutral standard for assessing the effects of state policies," making it ideal for examining the outcomes of state teacher certification policies.

One of the primary differences between NAEP and the state and district-level assessments is that NAEP is not a "high stakes" exam and is, therefore, not subject to the potential for performance inflation found in those assessments (Koretz, 2008; Fuller, et al. 2006). Given the high stakes of the state-level assessments, there are strong incentives for classroom teachers to teach to tests, which is not an element of the NBPTS certification process. Fuller et al. (2006) find that state test results exaggerate the annual rate of academic improvement, when compared with the federal NAEP results. It might not be surprising to find a weaker relationship between teacher NBPTS certification and student performance on state assessments, where the curriculum is determined by the expected examination coverage. As a result, NAEP assessments may be more sensitive to effects on student achievement created by NBCTs.

Podgursky (2002) identifies potential limitations of the NAEP assessments for this type of study. He lists measurement errors associated with the self-reported or school-reported background variables as well as the large number of missing values in these answers. The most significant limitation is omission of a measure of prior achievement from our model. The current standard method employed by state education officials and researchers for measuring teacher effectiveness, including the research on the effectiveness of teacher certification reviewed in the previous section, is the value-added model. The basic empirical framework of these value added models requires a measure of prior achievement as an explanatory variable to control for the student's previous learning as a way to isolate the current individual teacher's value. Nonetheless, we believe these empirical relationships using the NAEP provide valuable insight into the effects of NBPTS certification given the national scope of the testing program.

Independent Variables

A standard set of explanatory variables is incorporated into the educational production function to control for family, teacher, and school effects. Two variables taken from the U.S. Census Bureau (2013) measure the family input into the education process. State-level real per capita (2005 dollars) income (PER CAP INCOME) represents the resources available in the state for education and is expected to have a positive effect on the average NAEP scores. The education level in the state, measured by the percentage of the population with at least a college BA degree (% COLLEGE GRAD) represents the state population's emphasis on education and is also expected to be positively related to the average NAEP assessment scores. A strong positive relationship between parents' education and student achievement is well established in the literature (Davis-Kean, 2005).

As student learning is cumulative, we use two standard teacher variables reflecting experience and education characteristics of the each state's teachers taken from the U.S. Department of Education (2014). The percentage of teachers in the state with ten years or more of teaching

experience (TEACHER EXP: 10+ YEARS) controls for the potential for experienced teachers to be in the classroom. The percentage of the state's teachers with a Master's degree or higher level of education (TEACHER EDUC: MA) controls for the impact of the teachers' education level on student achievement. Both variables are expected to be positively related to the student's NAEP assessments. One school variable, the average class size in the state (CLASS SIZE), is included as a measure of the school resources available to the students. Since smaller classes are thought to increase student learning, it is expected to have a negative relationship with the average NAEP scores.

We use information from the student level NAEP Reading and Math restricted data taken over the assessment years 2009 and 2011 to create two state-level measures of NBCTs to include in our empirical models. In addition to student assessment information, teachers are surveyed in the restricted NAEP data. One survey question relates to the teacher's NBPTS status and we use the answers to create the NBCT measures. The first variable is the percentage of teachers who were NBCTs in the state and who administered either the Math or Reading NAEP (%NBCT). The last column in Table 1 presents this measure across the states in 2011. We expect a positive relationship between this percentage and the NAEP assessments, after controlling for the other family and school factors. This positive relationship is expected as a result of the direct impact of teacher certification on achievement as well as the spillover impact created by certified teachers mentoring and leading their colleagues. Two other teacher questions drawn from the restricted NAEP data provide some information on the likelihood for these spillover effects to develop. The eighth grade reading teachers were asked two questions directly related to their work with colleagues. Teachers were asked about their participation in teacher collaborative or network activities. A second question asked the teachers about their participation in mentoring or peer observation activities. We correlated the answers to each of these two questions with their NBPTS status. Based on the estimated Spearman correlation coefficients, we found both correlations are positive and statistically significant at the 1% significance level, indicating a direct relationship between NBC status and the teacher's willingness to mentor and/or lead development activities in the school, as encouraged by the fifth NBPTS proposition.

The second variable created from the NAEP restricted data is a measure of how the NBCTs are distributed across the schools in each state. We adapt our variable based on the "Herfindahl Index," which is a commonly used measure of the size of firms (e.g. sales) in relation to the total market and is used to determine the degree of market competition. More concentration (a smaller number of firms accounting for a greater share of market sales) indicates less competition. The Herfindahl Index has also been previously used in education contexts to measure concentration. Borland, Howsen, and Trawick (2005) use the Herfindahl Index to measure the student enrollment shares for schools within Kentucky counties. In a seminal study, Hoxby (2000) uses the Herfindahl Index to determine the concentration of both school district land size and school district enrollment within a metropolitan area. To calculate this concentration index, we must first identify the Reading and Math NAEP classrooms for each school and count the number of classrooms with a NBCT. With that number we can then calculate each school's share of the total NBCTs in the state. The school-share is squared and all of the squared school measures in the state are summed: NBCT CONCENTRATION = $\Sigma_i^N (NBCT_i/NBCT)^2$, and for each of the N schools, i = 1….N.

NBCT CONCENTRATION ranges between 0 and 1, with larger numbers indicating a greater concentration (i.e., more NBCTs in fewer schools) and it reveals how well distributed the NBCTs are across the state schools. There is no a priori expectation of the direction of the statistical relationship between NBCT CONCENTRATION and the average state NAEP assessments, however if the NBCTs are not well distributed (relatively high measures of concentration), then the

benefits associated with NBC will not be felt throughout the state and the average state NAEP assessments may suffer as a result. The average NBCT CONCENTRATION is about 0.3, indicating a relatively low average concentration. Washington, DC, Delaware, and Hawaii have concentrations of NBCTs at more than twice the average state level.

Means and standard deviations of all of the independent variables used in all the estimated education production functions can be found in column [1] of Tables 2 and 3.

Table 2

NAEP (2009 & 2011) Reading Assessments

Independent Variables	Mean (SD)	OLS Regression Coefficients (t-statistics)		
	[1]	[2]	[3]	[4]
INTERCEPT		247.22 (30.87)	237.62 (27.03)	248.41 (31.69)
PER CAP INCOME	36213 (6290)	-0.0003* (1.94)	-0.0005*** (3.18)	-0.0003* (1.90)
% COLLEGE GRAD	27.47 (5.54)	0.674*** (4.02)	0.720*** (3.81)	0.676*** (4.05)
CLASS SIZE	23.83 (3.37)	-0.411** (2.56)	-0.285 (1.59)	-0.409** (2.56)
TEACHER EXP: 10+ YEARS EXP	56.37 (5.77)	0.328*** (3.70)	0.387*** (3.90)	0.320*** (3.63)
TEACHER EDUC: MA	45.00 (11.82)	0.105** (2.35)	0.122** (2.42)	0.105** (2.34)
%NBCT	11.05 (4.45)	0.083 (0.62)	0.497*** (4.09)	——
NBCT CONCENTRATION	0.030 (0.02)	-170.02*** (5.19)	——	-181.11*** (6.91)
R^2		0.512	0.372	0.508
Observations		102	102	102

Note. Statistically significant at *** 1%, ** 5%, *10%.

Table 3
NAEP (2009 & 2011) Math Assessments

Independent Variables	Mean (SD) [1]	OLS Regression Coefficients (t-statistics) [2]	[3]	[4]
INTERCEPT		264.76 (26.56)	252.74 (27.03)	266.93 (27.57)
PER CAP INCOME	36213 (6290)	-0.0004** (2.05)	-0.0007*** (3.28)	-0.0003* (1.90)
% COLLEGE GRAD	27.47 (5.54)	0.952*** (4.56)	1.010*** (4.28)	0.939*** (4.55)
CLASS SIZE	23.83 (3.37)	-0.477** (2.40)	-0.319 (1.43)	-0.478** (2.42)
TEACHER EXP: 10+ YEARS EXP	56.37 (5.77)	0.388*** (3.51)	0.462*** (3.73)	0.374*** (3.44)
TEACHER EDUC: MA	45.00 (11.82)	0.012 (0.33)	0.039 (0.63)	0.015 (0.27)
%NBCT	11.05 (4.45)	0.145 (0.87)	0.664*** (4.38)	——
NBCT CONCENTRATION	0.030 (0.02)	-212.76*** (5.22)	——	-236.13*** (7.29)
R^2		0.500	0.353	0.499
Observations		102	102	102

Note. Statistically significant at *** 1%, ** 5%, *10%.

Findings

The estimated coefficients for the independent variables used to explain the state average state NAEP Reading assessments are reported in columns [2]-[4] of Table 2 and the estimated coefficients used to explain the average state NAEP Math assessments are reported in columns [2]-[4] of Table 3. The associated t-statistics in parentheses below each of the coefficients summarize the statistically significance of each estimated regression coefficient. Statistically significant coefficients are marked by the level of significance in each table.

Most of the included family, teacher, and school explanatory variables have the expected statistical impact on student NAEP assessment. One unexpected result with the family variables is the negative and generally significant coefficient estimated on PER CAP INCOME, indicating an inverse relationship between state resources and student achievement. However, it should be noted that while the coefficient is negative and "statistically" significant, its size is not particularly meaningful, even when it is evaluated at the relatively large average level of state per capita income. Consistent with the extensive empirical literature, the family education (% COLLEGE GRAD) has a positive and relatively large effect on student performance in both Reading and Math NAEP assessments.

The two included teacher variables – TEACHER EXP: 10+ YEARS and TEACHER EDUC: MA – generally have the expected positive relationships. The estimated coefficient on

teacher experience is consistently statistically significant and positively related to student performance in both the Reading and Math assessments. The coefficient on TEACH MA is only statistically significant in the NAEP Reading assessments but has in those regressions a positive relationship with NAEP performance. Both characteristics have small estimated effects overall on the state average student performance on the Reading and Math NAEP assessments, which is consistent with the literature. In addition, teacher experience has a larger impact (defined by relative coefficient size and statistical significance) on student achievement relative to teacher education. The average state class size variable (CLASS SIZE) has the expected negative and significant relationship with the state average Reading and Math NAEP assessments.

Both %NBCT and NBCT CONCENTRATION are included in the models reported in column [2] in both Tables. When both are included, the coefficient on %NBCT is statistically insignificant and NBCT CONCENTRATION is negative and statistically significant in both tables. A potential statistical problem is that these variables are correlated. This correlation could increase the standard errors of the estimated coefficients and, therefore, reduce their t-statistics and statistical significance. A Pearson correlation statistic can help determine the degree of linear correlation between %NBPTS and NBCT CONCENTRATION. The statistic is equal to -0.512 and is statistically significant at the 1% level, indicating a strong negative linear relationship. To avoid the effects of this correlation, we estimate separate models, dropping NBCT CONCENTRATION in the model results reported in column [3] and %NBCT in the model results reported in column [4]. As a result, the coefficients estimated for %NBCT in column [3] in both Tables have the expected positive and statistically significant relationships for Reading and Math NAEP assessments. A larger percentage of NBCTs administering the Reading or the Math NAEP assessments leads to a higher state average scores on these NAEP exams. This result confirms the importance of this particular teacher certification on student outcomes. As described above, the impact of this certification comes directly from the teacher's training and indirectly through the collaboration and mentoring encouraged by the fifth NBPTS proposition. Negative and statistically significant coefficients continue to be estimated for NBCT CONCENTATION in column [4] in both Tables and confirms the negative relationship between the concentration of NBCTs in the state schools (most schools have no NBCTs) and the average state NAEP Math and Reading assessments. This finding indicates the potential importance of spreading the NBCTs as broadly as possible across the state, which benefits students both directly and indirectly with the spillover effects.

Scholarly Significance of the Study

This study makes use of national student assessments from the NAEP Math and Reading exams to expand the existing research literature measuring the impact of the NBPTS program on student achievement. The national perspective allows a broader view of the impact at the state level of the National Board certification, rather than its impact on a few state or district high-stakes assessment exams, as presented in previous studies. This national perspective encourages an exploration of the ongoing investments states and teachers make in professional development from a broader perspective. We find a potential for differences in the impact on effectiveness of teacher certification measured by large variations across states in the percentages of teachers who successfully complete NBPTS training.

State school systems are constantly developing models to use for planning, implementation, and assessment so they can identify efficacious professional development programs for teachers that result in improved academic outcomes for students. As described by Koellner and Jacobs (2015), there is greater attention on professional development program outcomes that go beyond

developing teachers' content knowledge. These authors suggest that a more broad assessment of professional development programs is needed—beyond student test scores—in order to assess the value of the professional development program. In many states, the NBPTS process has established goals to support and compensate teachers based on continued career development and to ultimately ensure that children are able to learn and develop. Standards by which schools measure the effects of professional development and organizational structures to support teachers should result in a highly qualified teaching force and improved overall student achievement. By building professional development programs like NBPTS for master teachers, the intention of school systems is to ensure that teachers and schools understand and value ongoing professional development that results in positive outcomes for students. NBCTs can and should serve as leaders of professional development communities.

Clotfelter, Ladd and Vigdor (2007) suggest that it is important to examine the teacher characteristics that can be affected by state education policies. For example, financial and other professional enhancement incentives supporting the use of NBPTS certification as a means by which teachers can be deemed "highly qualified" exist in a majority of states, and have resulted in a growth in NBPTS applications. As states continue to attempt to improve the quality of teachers and measure student learning, the future of the NBC process as either an advanced professional development program or as a means to improve student achievement in schools where board certified teachers are employed needs to be monitored. Further, as suggested by Frank et al. (2008), NBCTs could be used to staff professional development programs, rather than hiring external consultants. This would be more economical while providing opportunities for ongoing engagement of school faculty. It might also be the case that low performing schools would benefit more from having NBCTs than schools with greater resources (Humphrey, Koppich & Hough, 2005).

The NBC process has gained status as a symbol by which schools and school systems present themselves to be superior. It is seen as a key element in the professional development of teachers, as well as an opportunity to enrich the school through mentoring and skilled school administration. As mentioned in Section II above, previous research has found that these spillover effects may improve overall teacher learning. Specific examples of the benefits of the NBC process have been identified within subsections of the profession. For example, in a study of school librarians, Smith (2014) found that alignment with the NBPTS could introduce librarians into leadership roles within the school community. Cornelius (2014) also suggests that special education teachers may benefit from the NBPTS core propositions as they work with general education teachers in co-teaching situations. She suggests that the perspective of "members of learning communities" fosters collaborative planning between general and special educators. As such, the impact of the NBC process on student achievement deserves continued evaluation and discussion. As described in the literature review, there is some evidence that NBCTs are more effective in the classroom than either those teachers who did not apply for certification, or who did apply but did not successfully complete certification. We suggest these outcomes might be distributed to other teachers in the school, given that NBCTs are more likely to have instructional leadership opportunities, supporting previous research (Anagnostopoulos et al., 2010; Cannata et al., 2010). Improved outcomes for students might be related to the NBPTS process if the approaches that the NBCTs presented in professional development sessions were ultimately responsible for student achievement.

This broader view of the potential for the process of NBPTS certification to have effects outside NBCT classrooms created by mentoring, peer observation, and other professional training activities is an important and often overlooked aspect of NBPTS certification. This view is similar to Tesconi's (2007) description of teacher professional authority. He finds teachers in schools found to

be comparatively successful with low-income and poor children possess and exercise a great deal of professional authority. They are fundamentally important in making their schools good places to be, and their importance is recognized and respected. Research reveals that teachers in successful schools are influential in shaping a school's education philosophy, and in establishing school-wide content and curricular goals. They are major contributors to school-wide, long range and strategic planning and development initiatives. They are partners in the development, selection and evaluation of school-wide and program instructional materials. They are participants in the evaluation of principals and in the appointment of teachers, and they are major designers of their collective professional development activities.

Further, we suggest that an outcomes driven model that solely focuses on achievement assessments like the NAEP may not be sufficient in describing high quality teaching. Highly effective teachers certainly have an effect on their colleagues; these effects can and should be measured. Continued research using more sensitive measures of student achievement, teacher effectiveness, and any cohort effects are needed to understand better the relationship between NBC and student learning on both the individual and school level. With the broader effects of NBC in mind, states might better be able to assess the value of this approach to improving teacher quality both economically and to the school community.

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