

# Differences between Charter and Traditional Public School Teachers' Instructional Practices and Curricular Alignment to the Mathematics Standards and State Assessment in Indiana

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## Abstract

Many researchers and policymakers talk about the importance of instructional differences in charter and traditional public schools, but to date, no one has systematically addressed this important issue. In the state of Indiana, we examine the enacted mathematics curriculum of charter and traditional public school teachers—examining differences in the breadth and depth of instruction, the cognitive complexity of instruction, and alignment of instruction to standards and assessments (Porter, 2002). Using a quasi-experimental design relying on propensity score analysis, we find that both charter and traditional public school teachers' mathematics instruction is aligned to the Indiana state assessment, but charter school teachers are more aligned with mathematics standards. Moreover, charter schools teachers' mathematics instruction goes into more depth than breadth compared with traditional public school teachers. Moreover, charter school teachers use more instructional practices that utilize memorization, demonstrations of understanding, proving and solving, and applying and making connections strategies more often than traditional public school teachers. We end the paper by discussing the implications of these findings within the context of school governance and test-based accountability.

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**CHARTER PUBLIC SCHOOLS AND MATHEMATICS INSTRUCTION:  
HOW ALIGNED ARE CHARTERS TO STATE STANDARDS AND ASSESSMENTS?**

Charter public schools (CPS) are one of the fastest growing areas of school choice (Berends, Springer, & Walberg, 2008; Lake, 2007). There are now nearly 4,000 serving over a million students within the United States. Although in existence since 1991, many CPS are relatively new. Moreover, the evidence about their effectiveness is mixed, and little is known about the conditions within charter schools that make them effective or not (Berends et al., 2008; Gill et al., 2007; Hill et al. 2007).

Most studies that examine charter school effects lack information about the organization of schools and classrooms, whether charter or traditional public. Although they shed some light on the main effects of charter schools in different locales, existing charter school studies provide limited information about the schools as organizations and the conditions within them that may promote or hinder student achievement gains. Organizational practices remain a black box, particularly the curriculum and instruction that is most likely to affect student learning. For this reason, many school choice researchers and policymakers advocate looking inside the black box of schools to better understand the conditions under which schools of choice have (or do not have) positive effects on achievement (Betts & Loveless, 2005; Hess & Loveless, 2005; Loveless, 2003; Zimmer et al., 2003). As Gill et al. (2007) write, “The newest and best studies on achievement in charter schools...do little to explain the sources of any differences in school performance...The next step should be to assess why some charters do well (and others do not)” (p. 221).

The policy argument for CPS is that increased levels of autonomy, flexibility, and market-like competition among schools should propel schools to operate more effectively

(Walberg, 2007; Walberg & Bast, 2003). CPS advocates anticipate that schools of choice are in a better position to develop in-school structures and processes that are characteristic of effective schools. Research evidence to date, however, reveals that contention to be an open question.

Studies of school effectiveness point to important aspects of schools and classrooms that need to be examined when opening up the black box of CPS (see Goldring & Cravens, 2008; Hallinan et al. 2003). For example, effective schools research suggests that principals and teachers in effective schools are not only dedicated to high standards and expectations, but they spend considerable effort on aligning curriculum content with standards and assessments. Moreover, they reflect critically on their pedagogy and rely on instructional strategies identified in respectable research as effective. In addition, when adopting school and classroom interventions and strategies, staffs in effective schools seek to make the efforts coherent and consistent across the school to support student learning (see Goldring & Berends, in press).

Establishing such coherence and consistency across pedagogy and content aligned to standards involves a continuous focus on how the school staff coordinates across and within grade levels. It also involves attention to how the school's common standards are coordinated across subject areas, departments, and the different types of students it serves (Bryk et al., 1993; Newmann et al., 1996; Newmann et al., 2001). Moreover, schools that aim to align instruction with challenging standards rely on flexible instructional grouping arrangements that provide opportunities for all types of students to be exposed to the standards, learn them, and achieve at higher levels (Gamoran, 2004; Oakes et al., 1992).

In spite of the variation in state standards and the overwhelming amounts of modern knowledge, teachers in effective schools are able to make decisions about what knowledge is substantively worth teaching, provide depth and specificity to the academic standards that guide

their instruction, and ensure that their decisions are grounded in respectable research and data-based decision making. Moreover, when teaching the content—involving facts, theories, concepts, algorithms, question and answer sessions, and discussions—teachers in effective schools focus on being accurate and precise. “They emphasize and celebrate ‘getting it right’” (Newmann, 2002, p. 30). But getting it right does not imply merely learning isolated fragments of facts. Rather, it moves beyond the facts toward analytic, creative thinking. So students not only reconstruct the knowledge taught in the classroom, they exhibit in-depth understanding by synthesizing and interpreting knowledge domains.

In this paper, for the purposes of comparing charter to traditional public schools, we analyze measures of curricular and instructional alignment based on research that has developed methods for judging the extent and nature of alignment of instruction to standards and assessments (e.g., Blank, Porter, & Smithson, 2001; Porter and Smithson, 2001a, 2001b; Porter et al., 1993; Schmidt, McKnight, & Raizen, 1997; Webb, 1999). Porter (2002) has developed measures of alignment among student achievement tests, content standards, curriculum materials, and instruction. Because Porter’s procedures have good measurement properties in terms of reliability and validity (Porter, 2002; Porter and Smithson, 2001) and are defined for both mathematics and reading, we rely on those tools for our analyses that follow.

Using data on instructional practices in mathematics and alignment to standards and assessments, we investigate the following questions in teacher data from the state of Indiana:

- How do instructional practices differ between charter public school and traditional public school mathematics teachers?
- How does alignment of instructional practices to Indiana mathematics standards differ between teachers in charter and traditional public schools?

- How does alignment of instructional practices to Indiana State Mathematics Test (ISTEP) differ between charter and traditional public school mathematics teachers?

### **Measuring the Content of Instruction & Alignment**

Porter (2002) and colleagues research over the past 25 years has examined teachers' content decision making, resulting in the development of tools for measuring content and alignment, including: (1) surveys of teachers on the content of their instruction (Surveys of the Enacted Curriculum [SEC]), (2) content analyses of instructional materials, and (3) alignment indices describing the degree of overlap in content between, for example, standards and assessment.

A major focus behind these tools is the development of common languages of topics and categories of cognitive demand for describing content in different subject areas (e.g., mathematics, reading, and science). These uniform languages that make it possible to build useful indices of alignment.

The surveys ask a number of questions about a teacher's target class, such as how the class is organized, the description of the class, grade level, number of students, percentage female, percentage minority, the length of class, how many weeks it meets during the year, percentage LEP, achievement level, and what is considered in scheduling students into the class (questions 1-13 on the surveys; see <http://www.seconline.org>). Specifically, the survey asks teachers to report on the achievement level of the target class. Teachers can respond with "high achievement levels," "average achievement levels," "low achievement levels," and "mixed achievement levels." This indicator has been used in national surveys and analyzed by several researchers interested in ability grouping and tracking (see Rees, Argys, & Brewer, 1996; Gamoran, 1989; Gamoran & Berends, 1987; Oakes, Gamoran, & Page, 1992).

The content of instruction is described at the intersection between topics and cognitive demand based on data gathered from teacher surveys. Teachers are asked to indicate, for the past school year (a) the amount of time devoted to each topic (level of coverage) and then, for each topic, (b) the relative emphasis given to each student expectation (category of cognitive demand).<sup>1</sup> For example, the topic dimension lists some of the descriptors of mathematics topics: multiple-step equations; inequalities; linear equations; lines/slope and intercept; operations on polynomials; and quadratic equations. The cognitive demand dimension lists five descriptors of categories of cognitive demand: *Memorize*, *Perform Procedures*, *Communicate Understanding*, *Solve Problems*, and *Conjecture/Generalize/Prove*.

Teachers respond to both the time on the topic and the amount of emphasis for each cognitive demand category. The response options for time on topic include a four-point scale: *None/Not Covered*; *Slight Coverage* (less than one class or lesson); *Moderate Coverage* (one to five classes or lessons); *Sustained Coverage* (more than five classes or lessons). The response options for relative emphasis given to each category of cognitive demand are as follows: *No Emphasis*, *Slight Emphasis* (less than 25% of time spent on this topic); *Moderate Emphasis* (accounts for 25-33% of time spent on this topic); *Sustained Emphasis* (accounts for more than 33% of time spent on this topic). These basic data are then transformed into proportions of total instructional time spent on each cell in the two-dimensional matrix defined by the language. Across the cells in the content matrix, the proportions sum to one (Porter & Smithson, 2001a).

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<sup>1</sup> Through the development of these surveys, researchers have considered tailoring the surveys toward specific grade levels, such as elementary, middle and high school (Porter, personal communication, August 2006). The main reason for doing so was to reduce the length of the survey. However, because of the overlap in content across grade levels, WCER and CCSSO have begun to administer the surveys online in one K-12 survey for mathematics and one K-12 survey for English, Language Arts and reading. By including all the content on one survey, researchers ensure that they will not miss any possible content taught at a particular grade level. Moreover, because it does not take much time (5 minutes) for teachers to check off the content covered in the online version, the burden of including all the content does not pose a problem.

The two-dimensional language also can be used for content analyses of content standards and assessments.<sup>2</sup> Matrices of alignment can be used to compare and contrast (a) state content standards to each other and national professional standards, (b) state assessments to each other and NAEP, (c) the content of instruction to state assessment or state standards.

Quantifying the indicators for alignment is extremely useful for analytic purposes to understand the degree of alignment among instruction, assessment, and content standards. Specifically, consider the autonomy and flexibility that are provided to charter schools. Are teachers in charter schools able to cover content in different ways compared with traditional public school teachers and thus better able to align their instruction to content standards and assessments? In theory, the autonomy and flexibility provided to teachers in charter schools would predict that they would be able to cover content in different ways. For instance, charter school teachers may be able to go into some topics more in depth than others since they do not face the constraints of pacing guides and curricular frameworks like many public school teachers (e.g., see Hamilton et al., 2007). However, due to institutional constraints of all teachers—charter or traditional public—under the accountability requirements of the federal legislation of No Child Left Behind (NCLB), they may look more alike than different (Berends et al., 2007; Goldring & Cravens, 2008). That is, because charter school teachers face the accountability pressures to meet Adequate Yearly Progress just like traditional public school teachers, and because charter schools tend to serve more challenged populations, then it is likely that they are

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<sup>2</sup> The measure of alignment that we use is based on data that maps a school's standards and assessments along with a teacher's instruction to a "content grid" (see Council of Chief State School Officers [CCSSO], 2006 & 2002; see Porter, 2002). For examples of the Surveys of the Enacted (SEC) curriculum, see <http://www.seconline.org>. The content grid and alignment index have been used to predict student achievement gains (e.g., Gamoran et al., 1997) and to describe the consistency of state standards and assessments within and between states (e.g., CCSSO, 2006, 2002).

just as aligned to state assessments, if not more so. We address these hypotheses in the analyses that follow with data from the state of Indiana.

### **Sample & Data**

All charter public schools (CPS) in our data are located within an urban area we refer to as “Crossroads.” Our initial plan was to administer Surveys of the Enacted Curriculum in mathematics to all charter and traditional public schools (TPS) within that district. However, the district leadership was unwilling to allow us TPS access. Thus, we administered the SEC in two other Indiana urban public school districts—“Bentley” and “Riverdale”— to provide a reasonable comparison set of TPS teachers. Although the demographics of the three areas are not exactly the same, we wanted to analyze information from teachers who are teaching in diverse, urban areas with the same state with similar test-based accountability requirements.

A description of some demographic characteristics of these three areas appears in Table 1. Compared with Crossroads, Bentley and Riverdale have smaller total populations and district enrollments. In addition, the percentage of African Americans in Crossroads (59 percent) is greater than both Bentley (38 percent) and Riverdale (28 percent). The percentage of Latinos is comparable in Crossroads (12 percent) and Bentley (14 percent), but both these areas have less Latinos than Riverdale (37 percent). Crossroads also has lower median family income and a greater percentage of the population living below the poverty level compared with the other two urban areas.

We administered SEC surveys in mathematics to a total of 786 K-12<sup>th</sup> grade regular classroom teachers in the CPS and TPS in the three urban areas. Table 2 provides a breakdown of the teachers by grade level. Because there are only 24 CPS teachers in middle and high

schools, we focus our analyses on teachers who teach kindergarten through fifth grade, resulting in a total of 554 regular classroom teachers for whom we have SEC data (87 CPS, 467 TPS).

Although these CPS and TPS teachers are teaching within the same state, with the same state standards, assessments, and accountability requirements, we are concerned about simply comparing the entire group of TPS teachers with the group of CPS teachers. It is plausible that these two groups differ in systematic ways that may or may not be observed. To the extent that these differences are related to teachers' instructional choices, approaches, and programs, then we would be concerned that a failure to account for possible systematic differences would likely result in biased or unreliable estimates of differences between CPS and TPS teachers. Therefore, we employed a method of matching CPS to TPS teachers that accounts for these possible differences such that we have a sample of comparable teachers, except for the fact that some have a propensity to teach in a charter school, and some do not. We discuss these methods further below, but first describe the measures used in our analyses.

### **Measures**

The *Survey of Instructional Content* portion of the SEC requests of teachers information regarding topic coverage and their expectations for students in the target mathematics class for the most recent school year. Teachers are presented with a content matrix that contains lists of discrete topics associated with mathematics instruction. These topics are arranged around 16 content areas ranging from number sense, properties and relationships to instructional technology. Teachers are first asked review the entire list of content topic areas and then to indicate any content areas or topics that are not covered in their class. Next teachers are asked to rate the amount of time spent on each topic covered in their class as either: *slight* (less than one

class/lesson), *moderate* (one to five classes/lessons), or *sustained* (more than five classes/lessons).

Besides indicating the amount of time spent on each topic area, teachers are also asked to provide information about the relative amount of instructional time spent on work designed to help students reach certain expectations in mathematics (ranging from 0 = no emphasis to 3 = sustained emphasis accounting for more than 33% of the time spent on this topic) within each topic. There are five categories cognitive demand within which teachers rate the relative emphasis of their instruction and expectations: 1) *memorize*; 2) *perform procedures*; 3) *communicate understanding*; 4) *solve nonroutine problems*; and 5) *conjecture/generalize/prove*. Figure 1 provides more detail of each of these categories of cognitive demand.

Taken together, the two dimensions of content topics and cognitive demand can be thought of as a two-dimensional language for describing content (e.g. Porter, 2002; Porter, et al., 2006), whereby the intersection between each topic and cognitive demand can be reduced to a proportion that when summed over rows and columns equals 1.0. What is being measured is not just time spent on mathematics instruction, but within that time, the relative emphasis of particular types of content represented by the intersection of topics and categories of cognitive demand (Porter et al., 2007).

This language can be used to describe not only teachers' instruction, but standards documents and assessments as well. By comparing the content matrix created by expert reviews of standards documents and assessments to the matrix of an individual teacher, it is possible to create an index of alignment that captures the degree to which that teacher's instruction is aligned to the standards or assessment (see Porter, 2002).

## Outcome Measures

### *Topics Covered*

From the responses described above it is possible to create three variables that capture the topical coverage for each teacher.

- *Number of Topics* is the total number of mathematics topics that the teacher has indicated that they have covered in their target classroom over the most recent school year. For our sample of teachers this variable ranged from a minimum value of 41 to a maximum value of 215.
- *Depth of Topic Coverage* is a measure of the extent to which the teacher goes into depth in her instruction for the topics that she covers over the course of the school year. This measure indexes the typical number of class periods during which a given topic is addressed, on average. For example, a teacher who rates highly on our measure of depth would have indicated a high level of *sustained* (more than five classes/lessons) time use on a majority of topics covered.
- *Breadth of Topic Coverage* is the percentage of the total possible topics that could be covered by a teacher that is actually covered by the teacher that ranges from zero to 1. For example, if there were 300 possible topics and a given teacher covered 225 of them, then the value of her breadth of topic coverage would be 0.75

### *Cognitive Demand*

From this extensive amount of information on teachers' topic coverage and the cognitive demand of instruction and expectations on their students we are able to construct five variables that capture the relative amount of instruction for each teacher that falls into each cognitive

demand category. The value for each of these variables (*Memorize, Perform Procedures, Communicate Understanding, Solve Nonroutine Problems* and *Conjecture/Generalize/Prove*) lies between 0.0 and 1.0. For example, a value of 0.50 for the memorize cognitive demand variable would indicate that 50% of the teacher’s instruction is on tasks and topics that emphasize memorization.

### *Alignment*

The alignment measures we use represent an indexes with a range of 0 to 1, with 1 representing perfect agreement between instruction and the relevant instructional “target,” (e.g., standards or assessment), and 0 representing perfect disagreement (see Porter, 2002; Porter & Smithson, 2001b). The alignment calculation we use is sensitive to teaching the right topic at the wrong level of cognitive demand, which counts against alignment (although it might be a quite reasonable pedagogical strategy for a given set of students at a given point in time). In addition, alignment would also decrease if teachers spent more time on a given standards-based topic than its relative emphasis in the standards. Hence, perfect agreement is not the goal, though higher alignment tends to lead to higher achievement gains (all else being equal) (see Gamoran et al., 1997; Porter & Smithson, 2001b).

We have three measures that gauge a teacher’s level of alignment with standards and assessments. First, *Alignment to Indiana State Standards* measures the degree of alignment between the teacher and the grade level state standards for mathematics for the grade in which she teaches.<sup>3</sup> *Alignment to NCTM Standards* measures the degree of alignment between the teacher’s instruction and the appropriate grade band standards as put forth by the National Council of Teachers of Mathematics. Finally, *Alignment to ISTEP* measures the degree to which

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<sup>3</sup> Indiana has content standards for grades 2, 4, 5, and 7. Therefore in cases where the teacher’s target class is of a grade not covered by Indiana state content standards (e.g. grade 3) the content standard of the next highest grade level was applied (e.g. grade 4).

a teacher's instruction is aligned with the Indiana Statewide Testing for Educational Progress mathematics assessment for the target class grade level.

### **Teacher Characteristics Measures**

*Temporary certificate* is an indicator variable that takes on the value of 1 if the teacher indicated that she held a state certification that was either “emergency, provisional or temporary,” and took the value of 0 for any other type of state certification (i.e. elementary/early childhood, middle school, secondary mathematics, etc).

An indicator variable, *minority teacher*, was created that took on the value of 1 if the teacher indicated their race/ethnicity other than “White” and took the value of zero if the teacher indicated their race/ethnicity as “White.”

Teachers were asked to indicate their level of experience as both the number of *years teaching mathematics* and the number of *years assigned to teach in current school* in one of 7 categories (less than 1 year, 1-2 years, 3-5 years, 6-8 years, 9-11 years, 12-15 years, More than 15 years).

Finally teachers were asked to indicate their highest attained post-secondary degree in one of 6 categories; Does not apply, BA or BS, MA or MS, Multiple MA or MS, Ph.D. or Ed.D and Other

### **Classroom Context Measures**

Teachers were asked to indicate their target *class size* within six categories ranging from “10 or fewer” to “31 or more.” Due to infrequency of response, these categories were collapsed into 3 final categories that were used in the analysis (“15 or less”, “16-25”, and “26 or more”).

Teachers were also asked to indicate the *percentage of females*, *percentage of English Language Learners* (ELL) and *percentage of minority students* enrolled in their target classroom, rounded

to the nearest 10% (10 categories, 0=less than 10% - 9 = 90+%). After checks of response frequencies the variables for percentage of minority students and the percentage of female students were recoded to reflect 3 categories (20% or less, 20%-70%, more than 70%). The percentage of ELL students was recoded into 2 categories that reflect the nature of classrooms to either have a large number of ELL students or very few (10% or less, 11-30%). As a final measure of the classroom context teachers were asked to rate the *achievement level* of most of the students in the target class, compared to national norms, as either “high achievement levels”, “average achievement levels”, “low achievement levels”, or “mixed achievement levels”.

### **Methods for Matching with Propensity Score Analysis**

When making comparisons between traditional public schools and charter schools, it is important to account for possible differences in the types of teachers who are employed by them and teach in them every day. To create a matched set of traditional public school teachers and charter school teachers we used a procedure of propensity score matching (Dehejia and Wahba, 2002; Luellen, Shadish, & Clark, 2005; Rosenbaum and Rubin, 1983). This procedure generates a propensity score for each teacher that is the probability that the teacher is a charter school teacher. Charter school teachers are then matched with traditional public school teachers on the basis of similar propensity scores. This same methodology has been used to create comparison groups of charter and traditional public school students in analyses of the effect of charter schools on student outcomes (see Zimmer and Buddin, 2005; Berends et al., 2007). Below we discuss the propensity score matching procedures in more detail, and then we describe the variables in our subsequent analyses.

To prepare the data for analysis, we constrained our dataset to only include teachers from three urban areas in Indiana. Next, we stratified our sample of teachers by the grade

classifications of their primary teaching assignment (K, 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup>, 5<sup>th</sup>). We stratified the sample in this way to ensure that teachers were matched to another teacher taught the same grade level and would thus face the same expectations for teaching in terms of state curriculum, testing, and standards.

This process created 6 ‘bins,’ to which each teacher was assigned. Within each stratification bin a propensity score for each teacher was generated by estimating a probit regression model conditional on teachers’ observed characteristics (teacher possesses a temporary teaching certificate, teacher is a minority, the total years that the teacher had taught math, the number of years the teacher had taught at her current school, and the level of their highest degree [from B.A. to Ph.D./Ed.D.]).

For example, we fit the following model for each bin:

$$\Pr(T_i) = \beta_0 + X_i\beta_1 + \varepsilon_i$$

where  $X$  is a vector of  $k$  observable characteristics of teacher  $i$  predicting the conditional probability of teacher  $i$  being a charter school teacher  $T_i$  (1=charter school teacher, 0=traditional public teacher). The predicted probability obtained from this estimation is then the propensity score  $p$  for each teacher in the data reflecting the conditional probability that the teacher is a charter school teacher.

A distance score ( $d_{ij} = |p_i - p_j|$ ) was then computed for each CPS teacher ( $i$ ) with every TPS teacher ( $j$ ). Each CPS teacher was matched to the TPS teacher who minimized  $d_{ij}$ . TPS teachers were allowed to match to multiple CPS teachers. This was done to ensure that we retained as many charter school teachers as possible in our matched sample. This form of

propensity score matching is known as nearest-neighbor matching with replacement. Matching was based on nearest neighbor ( $k=1$ ) with replacement, in which each CPS teacher was matched to only one TPS teacher who minimized  $d_{ij}$ . This form of matching results in a reduction in the bias remaining after matching, but is traded-off against a reduction in the matched sample size (TPS teachers are allowed to match to more than one CPS teacher based on the propensity score distance thereby allowing some TPS teachers to match to more than one CPS teacher) (Caliendo and Kopeinig, 2005).

These matching procedures resulted in an analysis sample of 45 TPS teachers matched to 84 CPS teachers for a total matched sample of 129 K-5 teachers. Table 4 provides the results of t-tests of the difference in group means between CPS and TPS teacher characteristics used in the matching equation for the whole sample as well as for our total matched sample. Despite a reduction in the difference between the mean number of years teaching math (row three Table 3) between TPS and CPS teachers of approximately two years, there still remains a marginal statistically significant difference between the group means after propensity score matching. To address this, the variable indicating the number of years teaching math was included in our subsequent analyses. None of the other teacher characteristics differ in the matched sample (temporary certificate, minority teacher, years at current schools, and highest degree).

### **Analytic Methods for Estimating Instructional Differences between CPS and TPS Teachers**

We applied an OLS modeling strategy that accounts for the nesting of students within schools by adjusting of estimated standard errors for clustering. Consider the following model with the dependent variable  $Y_i$  (the instructional practice score of interest for teacher  $i$ ) regressed on a charter school dummy, grade level, years teaching math, and classroom context measures

for class size, classroom composition (gender and minority), and ability group level reported by the teacher (high, low, and mixed compared with average).

$$Y_i = \beta_0 + \beta_1 (\text{Charter}) + \beta_2 (\text{Grade Level}) + \beta_3 (\text{Years Teaching Math}) + \beta_4 (\text{classroom context}) + \varepsilon_i$$

In all of our estimations we include a grade level fixed effect in the form of dummy variables to account for the stratification strategy we used in the process of generating our matched sample of traditional public and charter school teachers. Furthermore, we include a variable of years teaching math due to the statistically significant group difference between TPS and CPS teachers that remained after matching. Finally, we include classroom context measures, such as class size, classroom composition (gender and minority), and teacher reports of ability group level (high, low, and mixed compared with average group). The standard errors in the results that follow are robust standard errors that adjust the standard error estimate for clustering of teachers in schools (school  $n = 31$ ; TPS = 22, CPS = 9)

To address differences between CPS and TPS teachers in our matched sample, we estimate models for several dependent variables, including coverage of mathematics topics, cognitive demand of mathematics instruction, and alignment of instruction to standards and the math assessment in Indiana. The topics covered dependent measures include the total number of mathematics topics covered over the course of the school year, the depth of coverage when covering those topics, and the breadth of topics in math instruction. In addition, we examine differences between CPS and TPS teachers in the cognitive demand of mathematics instruction, with measures for memorization, procedures, demonstrating understanding, conjecture/problem solving, and apply/make connections. Finally, we examine alignment of CPS and TPS teachers'

mathematics instruction to the Indiana state math standards, NCTM standards, and the Indiana state test for mathematics (ISTEP).

### **Analytic Results**

How do instructional practices differ between CPS and TPS mathematics teachers? How does mathematics instruction align with standards and assessments among these different groups of teachers? The results that inform these questions appear in Table 4. The dependent measures for topics covered, cognitive demand, and alignment appear in the rows of the table, and the results focusing on the charter estimates appear across the columns. All the estimates in the table control for grade level fixed effects, the number of years the teachers report teaching mathematics, and the classroom context measures.

Compared with a matched group of TPS teachers, CPS teachers report covering a significantly lower number of mathematics topics throughout the school year, and when CPS teachers cover the topics, they cover them much more in depth and with less breadth than TPS teachers. The CPS teacher estimate for the number of mathematics topics covered is -66.969, meaning that on average, CPS teachers cover about 67 less mathematics topics a year compared with TPS teachers. Controlling for other variables in the model, this coefficient is significant and the effect size (ES) for this estimate is -1.44, a rather large effect. In addition, the coefficient for depth (1.099, ES = 1.24) is positive and significant revealing that CPS teachers cover mathematics topics much more in depth than their TPS counterparts. CPS teachers also appear to sacrifice breadth for depth, as suggested by the coefficient for breadth of -0.311 (ES = -1.41).

Compared with TPS teachers, CPS teachers have higher levels across all aspects of cognitive demand—including memorizing, performing procedures, demonstrating

understanding, solving problems, and making connections. That is, not only is the effect of CPS positive and significant for lower levels of cognitive demand (memorization and procedures), but is also positive and significant for higher levels of cognitive demand (e.g., problem solving and making connections). The ES of CPS teachers across these cognitive demand measures range from .75 to .98. Specifically, the CPS coefficient for memorization is 0.068 (ES = .85), and for procedures it is .060 (ES = .75). For higher levels of cognitive demand, the ES of CPS teachers on demonstrate understanding is 0.98; for problem solving the CPS ES is 0.87; and for making connections, it is 0.88.

When examining alignment of teachers' mathematics instruction to standards and assessments, we find smaller, yet meaningful differences between CPS and TPS teachers. CPS teachers instruction seems to be more aligned to both the Indiana state standards and the NCTM standards compared with TPS teachers. The estimate for CPS teachers on Indiana state standards is 0.023 (ES = .55), and on NCTM standards, the coefficient is 0.27 (ES = .45). Thus, although the CPS ES are smaller when compared to the other instructional measures, they remain substantively and statistically meaningful.

When examining alignment of instruction to the state mathematics assessment, we find no significant difference between CPS and TPS teachers. In short, although elementary CPS teachers align their instruction more to content standards (whether state or more national) than TPS teachers, these groups of teachers do not differ when considering the alignment between mathematics instruction and the state test.

### **Discussion & Next Steps**

This paper addresses questions about how CPS and matched TPS teachers differ in their mathematics instruction, considering instructional aspects such as topic coverage, breadth, depth,

cognitive complexity, and alignment to the standards and assessment within the state of Indiana. When matched on observable characteristics, we find significant differences in mathematics instruction between the two types of teachers.

Because of the arguments about the importance of looking inside CPS and TPS to better understand how school structure and process differ in important ways (Betts & Loveless, 2005; Betts et al., 2006; Zimmer et al. 2003), we believe the SEC tools analyzed in this paper provide a powerful tool to understand the content of instruction (topics covered, breadth vs. depth), levels of cognitive complexity, and alignment to standards and assessments.

Charter schools are given the autonomy and flexibility to implement different instructional strategies or regimes (Cohen, Raudenbush, & Ball, 2003) and, as public schools, are thereby accountable to the requirements of NCLB. Thus, an important research agenda in this area includes systematic attention to instructional conditions inside schools. Does the increase in autonomy and flexibility lead CPS teachers to make different decisions about what and how they cover content? Or, do the accountability requirements of NCLB result in CPS and TPS teachers making similar decisions in the face of uncertainty (Berends et al. 2008; Goldring & Cravens, 2008; Meyer & Rowan, 1977)?

As stated, our findings show that CPS teachers do differ from their TPS counterparts in terms of covering less topics, going more into depth, and engaging students in higher levels of cognitive demand across the spectrum (i.e., from memorization to applications and making connections). In addition, the CPS teachers' mathematics instruction in Indiana is more aligned with both Indiana state mathematics standards and more national standards reflected in NCTM.

Yet, despite these instructional differences, CPS and TPS teachers do not differ in their alignment to the Indiana mathematics assessment. Thus, an important next step is to examine

student achievement differences and whether these instructional differences translate into greater gains for CPS students compared with their TPS contemporaries. Extending the analyses in this way is important because an aligned instructional system should produce better results on an aligned student achievement test (Newmann et al., 2001; Porter et al., 2006). For instance, prior research using the SEC reveals that the degree of alignment between a teacher's instruction and an assessment of student achievement in high schools explained a significant amount of the variation in student achievement across teachers (Gamoran et al., 1997).

Our current and future research aims to expand the work here in a number of ways. First, we are expanding our investigation to include ELA in addition to mathematics. This school year we are administering the SEC in English/Language Arts (ELA) to the same schools in the sample analyzed in this paper. Second, we plan to link the instructional measures to student mathematics and reading achievement in both the state tests and the interim assessments administered by Northwest Evaluation Association (NWEA). Third, we will expand the research in Indiana to a larger sample of charter and other choice schools during the 2008-2009 school year. For the schools that participate in the NWEA growth research database on student achievement, we will compare CPS and TPS instruction and achievement across different state and district contexts (e.g., Berends et al., 2008). By gathering measures of mathematics and reading instruction with the methods used in this paper, we hope to further understand what is going on inside schools and classrooms, whether choice schools or not.

**Figure 1. Instructional Expectations Measured on SEC in Mathematics**

## Expectations for Students in Mathematics

### **Memorize Facts/Definitions/ Formulas**

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Recite basic mathematics facts  
Recall mathematics terms and definitions  
Recall formulas and computational procedures

### **Perform Procedures**

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Use numbers to count, order, or denote  
Do computational procedures or algorithms  
Follow procedures or instructions  
Solve equations, formula, and routine word problems  
Organize or display data  
Read or produce graphs and tables  
Execute geometric constructions

### **Demonstrate Understanding of Mathematical Ideas**

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Communicate mathematical ideas  
Use representations to model mathematical ideas  
Explain findings and results from data analysis strategies  
Develop and explain relationships between concepts  
Show or explain relationships between models, diagrams, and/or other representations

### **Conjecture/Generalize/Prove**

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Determine the truth of a mathematical pattern or proposition  
Write formal or informal proofs  
Recognize, generate, or create patterns  
Find a mathematical rule to generate a pattern or number sequence  
Make and investigate mathematical conjectures  
Identify faulty arguments or misrepresentations of data  
Reason inductively or deductively

### **Solve Non-Routine Problems/ Make Connections**

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Apply and adapt a variety of appropriate strategies to solve non-routine problems  
Apply mathematics in contexts outside of mathematics  
Analyze data and recognize patterns  
Synthesize content and ideas from several sources

**Table 1. Demographic Comparisons of Urban Districts**

<b>District</b>	<b>Crossroads</b>	<b>Bentley</b>	<b>Riverdale</b>
<b>SEC Schools</b>	0	24	23
<b>Total Schools</b>	93	39	22
<b>Coverage</b>	0.00	0.62	1.05
<b>Urbanicity</b>	Large City	Mid-size City	Urban Fringe of Large City
<b>District PK-12 Enrollment</b>	38,142	21,973	14,628
<b>Percentage American Indian</b>	0.00	0.00	0.00
<b>Percentage Asian</b>	0.00	0.01	0.00
<b>Percentage African American</b>	0.59	0.38	0.28
<b>Percentage Hispanic</b>	0.12	0.14	0.37
<b>Percentage White</b>	0.29	0.47	0.34
<b>PER CAPITA INCOME (CENSUS) [2000]</b>	16,992	18,658	16,245
<b>MEDIAN FAMILY INCOME (CENSUS) [2000]</b>	36,204	45,910	42,196
<b>Total Population</b>	315,630	155,355	82,785
<b>Percentage of Population Below Poverty Level</b>	0.197	0.131	0.143

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**Table 2. Regular Classroom Teachers Who Took the SEC in Three Urban Districts by Grade Level**

<b>Grade</b>	<b>TPS</b>	<b>CPS</b>	<b>Total</b>
<b>K</b>	60	18	78
<b>1</b>	93	17	110
<b>2</b>	92	12	104
<b>3</b>	78	14	92
<b>4</b>	68	14	82
<b>5</b>	76	12	88
<b>6</b>	41	8	49
<b>7</b>	44	4	48
<b>8</b>	39	2	41
<b>9</b>	31	4	35
<b>19</b>	31	3	34
<b>11</b>	16	3	19
<b>12</b>	6	0	6
<b>Total</b>	675	111	786

Not for Distribution

**Table 3: Differences in Group Means between Traditional Public School Teachers and Charter Public School Teachers for Full and Matched Sample**

Characteristic	Sample	TPS	CPS	Difference TPS-CPS	
Temporary Certificate	<i>Full</i>	0.017 (0.006)	0.189 (0.041)	-0.172 (0.022)	***
	<i>Matched</i>	0.067 (0.038)	0.143 (0.038)	-0.076 (0.059)	
Minority Teacher	<i>Full</i>	0.141 (0.015)	0.311 (0.049)	-0.170 (0.042)	***
	<i>Matched</i>	0.178 (0.058)	0.262 (0.048)	-0.084 (0.078)	
Years Teaching Math	<i>Full</i>	4.208 (0.091)	1.611 (0.162)	2.597 (0.229)	***
	<i>Matched</i>	2.222 (0.300)	1.595 (0.169)	0.627 (0.318)	*
Years at Current School	<i>Full</i>	3.158 (0.089)	0.956 (0.099)	2.202 (0.217)	***
	<i>Matched</i>	0.978 (0.121)	0.917 (0.092)	0.061 (0.153)	
Teacher's Highest Degree	<i>Full</i>	1.615 (0.028)	1.278 (0.076)	0.337 (0.074)	***
	<i>Matched</i>	1.244 (0.065)	1.286 (0.080)	-0.041 (0.120)	
n	<i>Full</i>	519	90		
	<i>Matched</i>	45	84		

\*  $p < 0.10$ \*\*  $p < 0.05$ \*\*\*  $p < 0.01$

**Table 4. OLS Estimates of the Effects of Charter Schools on Teachers’ Instructional Practices †**

Dependent Variable	Charter Estimate	Robust S.E.	Significance Level	R <sup>2</sup>	Pooled Sample SD	Standardized Effect Size
<b>Topics Covered</b>						
Total Number	-66.969	5.946	***	0.699	46.60	-1.44
Depth	1.099	0.126	***	0.653	0.89	1.24
Breadth	-0.311	0.028	***	0.699	0.22	-1.41
<b>Cognitive Demand</b>						
Memorize	0.068	0.011	***	0.217	0.08	0.85
Perform Procedures	0.060	0.014	**	0.169	0.08	0.75
Demonstrate Understanding	0.049	0.008	***	0.360	0.05	0.98
Conjecture, Prove, Solve	0.052	0.011	***	0.354	0.06	0.87
Apply/Make Connections ‡	0.053	0.011	***	0.354	0.06	0.88
<b>Alignment</b>						
Indiana State Standards	0.023	0.010	*	0.615	0.07	0.55
ISTEP Mathematics	-0.005	0.007		0.894		
NCTM Standards	0.027	0.009	*	0.441	0.06	0.45

\* p < 0.10  
 \*\* p < 0.05  
 \*\*\* p < 0.01

† All models include controls for grade level, *Years Teaching Math*, class size, classroom composition (gender, race-ethnicity), and ability group.

‡ Statistically significant coefficient in *Years Teaching Math* (p < 0.10), but magnitude is of no practical significance (both = -0.005)

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**Appendix A. Descriptive Statistics for Measures in  
Total Analysis Sample and by School Type**

Variable		Total	CPS	TPS
Total Number	mean	113.52	90.80	155.93
	st. dev.	46.40	34.33	34.85
Depth	mean	1.90	2.21	1.30
	st. dev.	0.89	0.79	0.73
Breadth	mean	0.53	0.42	0.73
	st. dev.	0.22	0.16	0.16
Memorize	mean	0.22	0.24	0.18
	st. dev.	0.08	0.07	0.07
Perform Procedures	mean	0.22	0.23	0.18
	st. dev.	0.08	0.07	0.07
Demonstrate Understanding	mean	0.18	0.20	0.15
	st. dev.	0.05	0.04	0.05
Conjecture, Prove, Solve	mean	0.14	0.16	0.10
	st. dev.	0.06	0.05	0.06
Apply/Make Connections	mean	0.14	0.16	0.11
	st. dev.	0.06	0.05	0.07
Indiana State Standards	mean	0.23	0.23	0.22
	st. dev.	0.07	0.06	0.09
ISTEP	mean	0.17	0.16	0.18
	st. dev.	0.09	0.09	0.09
NCTM Standards	mean	0.25	0.25	0.23
	st. dev.	0.06	0.05	0.06

## Appendix A (cont.)

Variable		Total	CPS	TPS	
Percentage of Minority Students	20% or less	mean st. dev.	0.20 0.40	0.23 0.42	0.16 0.37
	21% to 70%	mean st. dev.	0.29 0.45	0.23 0.42	0.40 0.50
	More than 70%	mean st. dev.	0.51 0.50	0.55 0.50	0.44 0.50
Percentage ELL Students	10% or less	mean st. dev.	0.82 0.38	0.88 0.33	0.71 0.46
	11% to 30%	mean st. dev.	0.18 0.38	0.12 0.33	0.29 0.46
Percentage of Female Students	20% or less	mean st. dev.	0.16 0.36	0.17 0.37	0.13 0.34
	21% to 70%	mean st. dev.	0.82 0.38	0.80 0.40	0.87 0.34
	More than 70%	mean st. dev.	0.02 0.15	0.04 0.19	0.00 0.00
Class Size	15 or Less	mean st. dev.	0.02 0.12	0.02 0.15	0.00 0.00
	16 to 25	mean st. dev.	0.85 0.36	0.81 0.40	0.93 0.25
	More than 25	mean st. dev.	0.13 0.34	0.17 0.37	0.07 0.25
Teacher Rating of Classroom Average Achievement Level	Average	mean st. dev.	0.35 0.48	0.44 0.50	0.18 0.39
	High	mean st. dev.	0.07 0.26	0.07 0.26	0.07 0.25
	Low	mean st. dev.	0.16 0.36	0.07 0.26	0.31 0.47
	Mixed	mean st. dev.	0.43 0.50	0.42 0.50	0.44 0.50

**Appendix A (cont.)**

<b>Variable</b>		<b>Total</b>	<b>CPS</b>	<b>TPS</b>
Temporary Certification	mean	0.12	0.14	0.07
	st. dev.	0.32	0.35	0.25
Minority Teacher	mean	0.23	0.26	0.18
	st. dev.	0.42	0.44	0.39
Years Teaching Math	mean	1.81	1.60	2.22
	st. dev.	1.74	1.55	2.01
Years Teaching in Current School	mean	0.94	0.92	0.98
	st. dev.	0.83	0.84	0.81
Highest Degree	mean	1.27	1.29	1.24
	st. dev.	0.65	0.74	0.43

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