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Patterns of District Performance in Student Achievement: Connecting Resources to Student Achievement

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I. INTRODUCTION

This presentation is the first sequence of a three-phase study using a mixed method sequential explanatory strategy (Creswell, 2003).

The study is research in-progress that investigates how resources can increase or diminish the value resources as they move through the education delivery system contributing in variations in its overall performance (Porter, 1985). The study is unique, because it combines, and is based on microeconomic and complex adaptive theories to examine resource utilization within school districts.

This first sequence has two analytical goals and steps: (1) to verify the significant correlation, but with patterns of variability for district performance measured by student achievement as the dependent variable and Socioeconomic Status (SES) indicators as the independent variable Gaudet, 2000; Walberg, 2006); and (2) to identify distinct patterns of district performance over multiple years that include sustained over-performance, stagnation, decline and possible turnarounds. This is a simple regression analysis that utilizes SES as a predictor variable for district performance. The patterns of district performance are measured by comparing a statistically-predicted performance value with actual performance.

Comment: Later you say second step. Be consistent

The variability of performance over multiple years will inform the second sequence that examines the nature and strength of patterns of resource decision-making and utilization compared outcomes among school districts along the spectrum of socioeconomics, demographics and scale. Gaudet's (2000)

explanation for the variance between actual and SES-predicted student achievement for outperforming districts supports the central tenet, which is that, “some school districts add value to the learning readiness of their students” (p.3).

Statement of the Problem

McDermott (1976) stated that the macroeconomics of “educational policymaking is now in a state of indeterminacy. No satisfactory criteria exists by which to make important decisions regarding school finance” (as cited in the National Research Council, 1999, P.161). The same publication National Research Council (1999) suggests the need for a qualitative model to supplement production function and resource allocation analyses to address this state of indeterminacy by suggesting that, “indeterminacy will always characterize educational production because of the impossibility of standardizing the characteristics and behavior of key factors of production in the education productivity equation: teachers and students” (p.162).

Reeder (1934) supports financial indeterminacy of schooling as a long-standing phenomenon for both the macro and microeconomics with the simple fact that “the financial problem with school has and always had two parts: *securing* the money …and *spending* the money (p.43). He predates National Research Council statements, and the central focus of this inquiry, which is that while decision-making about both financial and non-financial resources is highly contextual, some schools with minimum resources in lower socio-economic

strata sustain high performance compared with schools with more than adequate resources and in high socio-economic strata.

Monk (1981) provides a rationale for applying economic theory, which is that, even there is much research regarding about effective school concepts, “neglect of economic kinds of phenomenon… [exist] about the microeconomic operations of schools” (p.229). He continues to express the lack of economic theory to interpret the phenomena of decision-making about resource utilization within effective schools. Applying economic theory to the operation of schools is not intended to provide definitive answers, but to help conceptualize the processes.

These processes and outcomes within schools can be examined and within a range of outcomes using a framework of complex adaptive systems (CAS) theory. O’Day (2002) makes the distinction between biological CAS and organizational CAS based on behavioral adaptation between, and among all of the individuals that compose the unit of a school, which are difficult, if not impossible to predict, but have conceptual patterns.

In a CAS context, O’Day (2002) identifies three inherent problems from the effect of accountability policies at the school-level organizational unit that are: (a) “The school is the unit of intervention, yet the individual [teacher] is the unit of action; (b) External control seeks to influence internal operations; and (c) Information is both problematic in schools and essential to school improvement” (pp.295-296). Each of these problems network, and interact between each other through the types interrelationships found in schools, that include teacher and student, teacher to teacher, and student to student. These interrelationships are

further complicated by other participants that are not directly involved with teaching and learning, such as administrators who manage the organizational functions, parents and school committees who have other influences on the education delivery system.

Background of Problem

In Massachusetts, standards-based reform began in 1993 and the School and District Accountability System began in 1999. During the 2001-2002 school year, high-stakes standardized testing, called the Massachusetts Comprehensive Assessment System (MCAS), established a baseline data of school and district student achievement levels. MCAS is implemented as the instrument for meeting the goal of Federal No Child left Behind (NCLB), which is that all students will achieve proficiency in English language arts (ELA) and mathematics by 2014. Massachusetts relies on accountability policies to improve the school and district's student achievement. Adequate Yearly Progress (AYP) is the accountability gauge to measure the progress between a baseline Composite Performance Index (CPI) and the NCLB goal.

Performance Measurement

A performance index representing the elements of AYP called the Composite Performance Index (CPI) rates the school and district's gain toward achieving the NCLB goal for each district, school and subgroup of students. This rating system is depicted in Table 1.

Table 1
Composite Performance Index rating system for Adequate Yearly Progress for schools and districts in Massachusetts

Performance Rating	CPI Range
Very High	90 - 100
High	80 - 89.9
Moderate	70 - 79.9
Low	60 - 69.9
Very Low	40 -59.9
Critically Low	0 - 39.9

Note. From "School Leaders Guide to the 2006 Cycle IV Accountability and Adequate Yearly Progress (AYP) Reports," By Massachusetts Department of Education. p. 3. (2006)

The data used to determine the CPI of a school district or subgroup of students is based on AYP, which is represented by the following equation:

$$A+ (B \text{ or } C) + D = AYP \qquad (1)$$

A represents the participation rate of students in MCAS for regular education or alternative assessment for special education students. *B* is the average school, district or subgroup CPI. *C* may be used as an alternative when the assessment cycle for a school year, improvement target is met. *D* is either a combination of 8th grade attendance rate above, a 1 percent improvement over the previous cycle or Competency Determination, graduation as measured by passing MCAS, greater than 70 percent. (Massachusetts Department of Education, 2006)

For this inquiry, CPI is the measure of the district's performance based in the organization's decision-making capabilities about resource utilization. The goal of the overall study is to utilize these five years of performance data along with complementary microeconomic and documentation that evaluates organizational dynamics compiled by the Educational Quality Assurance (EQA) Program to identify the conceptual patterns that can translate into sustainability, capability to change and capacity-building.

Significance of Problem

Economic theory is based on patterns of individual, organization and cumulative societal behaviors. Behavior at all of these levels, including schools, can be interpreted by, and sometimes even modeled complex adaptive systems theory. Previously, Monk (1981) identified the lack of empirical evidence about the understanding of the microeconomics of schools and classrooms. He also states the significance of the problem:

> [There is a need to understand] the economics of resource allocation…. since many of the reasons why administrators, teachers, students and parents respond as they do…may grow out of economic kinds of phenomena that operate at micro-levels…. Specifically, (a) substitution of inputs, (b) economies and diseconomies of scale, (c) jointness in the costs of resources as well as the production of outcomes, and (d) the allocation of non-purchased resources, such as student's time. (p. 230)

After Monk's (1981) observations, an additional phenomena has occurred in the economics of public education, which is the change in cost structure. Since the advent of education reform, Rothstein and Hawley Miles (1995) and Rothstein (1997) have identified economic structural changes in the overall cost structure of schools. Using data from nine districts, including Fall River,

Massachusetts, they tracked the shifts in cost structure from 1967, 1991 and 1996, which are depicted in Table 2.

TABLE 2
Change in Percentages of Total Per Pupil Spending for Each Program
Average of Nine Districts, 1967, 1991 and 1996

Program Area	1967	1991	1996
Regular Education	80.1%	58.5%	56.8%
Special Education	3.6%	17.8%	19.0%
Food Services	1.9%	3.3%	4.8%
Compensatory Education	5.0%	4.2%	3.5%
Pupil Support	2.1%	3.5%	3.2%
Transportation	3.6%	3.3%	3.1%
Vocational Education	1.4%	2.8%	2.7%
Bilingual Education	0.3%	1.9%	2.5%
Desgregation	0.0%	1.9%	1.5%
Regular Health and Psychological Services	1.4%	1.0%	1.1%
After School Athletics	0.4%	0.7%	0.6%
At Risk and Alternative Education	0.1%	0.6%	0.6%
Security	0.1%	0.5%	0.6%
Total	100.0%	100.0%	100.0%
Overhead			
General Administration	9.8%	9.8%	10.1%
Operations and Maintenance	15.8%	14.5%	15.9%
Compensation as a percent of expenditures	77.9%	78.1%	76.1%
Benefits	9.4%	23.6%	27.5%
Benefits as a percent of compensation	8.5%	18.8%	21.3%

Note. From “Where’s the Money Going?” by S. Rothstein, 1997, *Economic Policy Institute*, p. 10. Reprinted with permission from The Economic Policy Institute

Even though the results depicted in Table 2 are for nine districts in different states, the structural shifts are representative of Massachusetts. These represent

major shifts which have been, to a large degree mandated by legislated changes and uncontrollable increases in the rate of health care costs rather than decision-making within individual districts. Based in a comparison of data presented in the first study by Rothstein and Hawley Miles (1995) and the second, Rothstein (1997) there is an implication of continuation in the shifts in cost structure trends.

The current policy in Massachusetts, and for most of the nation, is to measure student learning based on scores for standards-based assessment. This inquiry focuses on this outcome-metric, while fully acknowledging that learning and schooling have many dimensions and desirable outcomes beyond student performance on standardized tests. The rationale is that it is an opportunity to examine the effect and processes of resource decision-making on outcomes at the district-level and with a singular and quantitative metric.

Justification of Problem

Relationship between Accountability and Performance

In Massachusetts performance improvement has been dominated by accountability-based policies. Researchers including, Elmore and Fuhrman (2001), Hanushek, Raymond and Rivkin (2004), O'Day (2002), Walberg (2006), Elmore (2005), and Fullan (2005) have investigated the effect of accountability systems on student achievement and school performance, and a common observation from these researchers suggest that the initial effect of accountability is improved performance of schools. Fullan (2005) suggests the practice of accountability to improve teacher motivation and to drive improvement through

raised expectations is flawed, and that “many schools only improved on the surface” (p. 175). Even though Hanushek, Raymond and Rivkin (2004) provide empirical evidence that accountability improved student achievement in the 1990s, they state that, “accountability by itself is insufficient to close the gap in learning…. [and the] findings, taken together, underscore the fact that there is no single answer that will lead to all of the improvements that we desire” (p. 32). O’Day (2002) suggests that,

> Accountability systems will foster improvement to the extent that they generate and focus attention on information relevant to teaching and learning… [but] that policies that take the school as the unit of accountability must contend with a number of inherent problems if they are to effect organizational change. (p. 295)

Accountability versus Capacity Building

When considering the relationship between resource decision-making and the performance of schools, Childress, Elmore and Grossman (2005) simplify the relationship between decision-making and performance by suggesting that, “Most administrators have nothing in their background to prepare them for this task…. Few, if any school districts have a coherent human resource investment strategy, or even know what it means to have one” (p. 4).

Elmore (2005) and Fullan (2005) both advocate that performance-based accountability is an important element of reform, but that the critical component to school improvement is to the build capacity to improve. Elmore and Fuhrman (2001) states, that “Most state measures designed to assist low-performing schools, while well intentioned, are relatively weak ways to actually increase the instructional capacity of schools” (p. 68). Fullan (2005) elaborates that “Capacity building consists of developments that increase the collective power in the school

in terms of new knowledge and competencies, increased motivation to engage in improvement actions, and additional resources" (p. 175).

Brown and Saks (1981) make a connection to an aspect of capacity-building and economics when they state:

> Schooling like manufacturing, is regarded here as a process in which student time and teacher time are combined with other resources to produce an output called learning. Psychologists call such relationship the learning curve…. Educational psychologists try to understand and improve the learning curve. Economists take such curves as given and ask how such curves relate to optimal private and social decision-making and resource allocation. (p.219)

This analogy does not suggest that economic theory of learning curves is capacity building. Economic-based learning curve theory is a conceptualization of an organizational process that can include capacity-building, is subject to many other variables that can be further conceptualized by CAS theory.

Fullan (2005) assessed the role of strong interventions with capacity building components for underperforming schools in England that started in 1993. He states that, "Overall, the results have been positive in that a turnaround has happened in the majority of cases, and increasingly the timelines for turnaround has been reduced as the interventions have become more refined" (p. 174). In economics terms, successful intervention implies an organization is doing something different with its available resources, which suggests a change in decision-making about resource utilization.

Statement of Purpose

The purpose of this inquiry is to investigate resource utilization patterns that can enable capacity building within an education delivery system. The inquiry applies various micro-economic theories to resource decision-making in the context that these decisions can be generalized within the construct of Complex Adaptive System Theory (CAS). This claim is based on a fundamental tenet of CAS theory, which proposes that a range of behaviors, and subsequent outcomes can be predicted by the nature and strength of response patterns (Levin,2002), Pan, Rudo, Schneider and Smith-Hanson's (2003) investigation supports that these decision-making patterns about resource allocation and utilization can improve student achievement on standardized assessment. An effect of the economic concept of marginal rates of substitution in business is that resources can increase or diminish in value as they move through an organization's delivery system resulting in variations in its overall performance (Porter, 1985), which is a conceptualization of resources as they relate to capacity-building.

Research Questions and Study Design

This study is a mixed method sequential approach that has two quantitative analyses, which provide data, build assumptions and support the processes studied in the qualitative analysis. This presentation investigates the first sequence of the overall study.

The primary research question is:

What is the impact of resource allocation decision-making at the district-level on student achievement?

a. How can knowledge of the processes that create value during resource allocation, reallocation and utilization within the education delivery system inform decisions to build the capacity needed to improve student achievement?

The research questions for the first quantitative analysis are:

2. What is the range of variability of the dependent variable of district performance between the actual performance and statistically-predicted performance based on non-school demographic correlates?
    a. Has district performance changed over time?

Since Gaudet's (2000), study there has not been a similar statistical analysis of district performance in Massachusetts that compares actual performance with a statistically-predicted performance. Guadet (2000) developed a composite independent variable that he labeled the "community effects factors" (p. 24), which was used to estimate a predicted score for a community, which he labeled as the "Effectiveness Index" (p.24). The intent of this portion of the inquiry is to replicate Gaudet's (2000) analysis, but provide longitudinal data for five years from 2001-2006.

This analysis correlates the actual versus predicted variability and magnitude of student achievement from the demographic variable along a continuum of over-performance and under-performance districts. The longitudinal aspect of the

analysis provides information about the sustainability of high performance districts identified by Gaudet (2000) and trends towards decline and underperformance. This empirical evidence that school-based variables influence student achievement, but does not explain how.

The research questions for the second quantitative analysis are:

3. To what extent do resource allocation and utilization patterns within the education delivery system influence student performance?
    a. How do resource allocation decisions influence the quality of teacher correlate on student achievement?

Analysis for this question is based on another observation of Gaudet (2000) whish was that, “While spending clearly matters, merely increasing spending levels has a relatively weak impact on the results. Increasingly, many people are coming to the realization that how a community spends money is more important than how much money it spends” (p. 24).

Pan, et al. (2003) found evidence that different resource allocation patterns existed between high and low performing districts, both fiscal and human resources. Similar patterns of differences emerged between improvement and low performing districts. This inquiry builds on the resource allocation findings of Pan, et al. (2003) that suggest that resources allocated to different functions within the education delivery system or combination of functions, influence district performance in student achievement. This study extends and structures the ideas of Pan, et al. (2003) by predicting a range of outcomes with CAS theory

and measuring the marginal impact of different resource allocation decisions using economic theory conceptualizations.

Researchers including Evers and Clopton (2006), Burrup, Brimley and Garfield (1996), Reschovsky and Imazeki (2003), and Hanushek (1981) agree that there are great inefficiencies of resource utilization in education. Given the highly contextual nature of education, it is not the intent of this inquiry, nor is it feasible to provide the optimum resource allocation formula for schools and districts, but within each education delivery system efficiency is a factor, because it releases resources that could be targeted at building capacity.

The research question for the qualitative analysis is:

5. What are the system dynamics within an education delivery system that diminish, increase or leverage the value of resources?

Fullan (2005) identifies the complexity of trying to attribute a change in an activity to a change in performance by stating that, “Assessing the roles of strong intervention for failing schools is quite complicated, even in the narrow sense, because the combination of intended and unintended consequences is difficult to sort out” (p.174).

Education delivery systems, whether it is at the classroom, school or district level, are complex systems that are different from business (Childress, Elmore & Grossman, 2006, p.56), but they are still a composition of activities. To examine these processes, this study utilizes a modified version of Porter’s (1985) value-chain framework to investigate the dynamics that occur within and between the “collection of activities” (p.36) that compose the education delivery system.

To minimize this potential limitation of Porter's (1985) framework as a static view of an organization, it is modified to represent an education delivery system and systems thinking concepts (Senge, 1990) are utilized to analyze the dynamics of the resource value phenomena. The systems thinking approach is based in complex adaptive systems (CAS) concepts that O'Day (2002) began to adapt to school improvement processes. Axelrod and Cohen (1999) describe CAS as "a world in which many players are all adapting to each other and where the emerging future is very hard to predict" (p.xi, as cited in O'Day, 2002, p.297). Understanding system archetypes and the effect of decisions at leverage points (Flood, 1998; Senge 1990) are a critical component of the study design because they help to predict range of improvement behaviors and the nature and strength of these patterns (Levin,2002;O'Day, 2002). Elmore (2005) provides a pragmatic explanation of systems-thinking to analyze CAS within schools when he suggests, "pushing hard in a few strategic places in the system of relations surrounding the problem and then carefully observing the results" (p. 29).

II. LITERATURE REVIEW

Introduction

The literature review for the inquiry can be divided into four major knowledge domains, which are, (a) correlates of student achievement, (b) microeconomics of resource allocation and utilization, (c) characteristics of effective schools, (d) and education delivery systems. The literature for this presentation is limited to correlates of student achievement and an overview of the other domains.

The section on correlates of student achievement starts with production functions, which are quantitative measurement of correlations between the aggregate inputs and the output of student achievement. It establishes two classes of independent input variables that are non-school and school-based factors. This informs the second research question, which addresses the variability of student performance independent of a Socioeconomic (SES) variable (Gaudet, 2000;Walberg, 2006).

The second correlate of achievement in this knowledge domain is the quality of inputs and outputs. The primary quality correlate examined is teacher quality. Ozcan (1996) states the consensus among most researchers, which is, “One of the requirements to improve the quality of education is the improvement of the quality of teacher performance” (p. 5). Value-added modeling (VAM) is relatively new research strand even though the value-added concept is extant in Porter’s (1985) value-chain concept. Emerging VAM research attempts to estimate the impact of teachers on disaggregated student performance with longitudinal analyses. This literature strand examines estimates of, and methodologies to measure it, which according to Ballou (2002) “The latest innovations in Value-added Measurement (VAM) in measuring the performance of schools and teachers holds great promise, but the idea is still way ahead of our ability to execute it” (p.10)

The resource allocation research domain reviews the distribution of school-based inputs within an education delivery system. The purpose of this domain is to provide a baseline about patterns and effect of resource allocation within

education delivery systems. This informs the second quantitative analysis that is based on microeconomic theory including traditional production function concept, which measures inputs against outputs. Production function concepts are introduced as the baseline for the vast majority of existing research in this domain. This inquiry concentrates on microeconomic theory, which is dominated by the effects of marginal rates and costs of substitution; how marginal input yields marginal output, which is not usually a linear relationship. In addition**,** it examines the behavior of costs and values *within* the education delivery system, which is the stated purpose of Porter's (1985) value-chain framework. The goal of the review of this knowledge domain is to understand the current state of educational research and to provide a theoretical basis from economics to support marginal cost analysis at the microeconomic level of the education delivery system.

The goal of review of the effective school research strand is to simply identify specific characteristics that are found in effective schools. These characteristics are benchmarks that school improvement efforts strive to achieve. These characteristics are used to modify the static characteristic of Porter's (1985) value-chain concept into a representation of an education delivery system. The importance and connection to the other knowledge domains is argued by Marzano (2003), who presents evidence that effective schools can diminish, if not overcome SES limitations.

The literature review of education delivery systems draws from five of research strands that include, (a) Wenglinsky's (1997) hypothesized paths to

achievement, (b) Porter's (1985) generic value chain framework, (c) Complex adaptive systems, (d) Systems-thinking, learning organizations and capacity building. This knowledge domain is intended to provide a context of the complexity of the education delivery system as unique organizations that process inputs affecting the correlates of student achievement. The goal of the review is to provide the background about system dynamics that, when combined with the data, informs the synthesis of a model that begins to explain resource allocation patterns and leverage points that enhance student learning.

Complex Adaptive Systems (CAS) theory is presented as the theoretical basis for the organizational behavior of systems-thinking to develop learning organizations that are the platform for building capacity. The basic ideas that relate to this inquiry are that organizations are not unlike biological systems that act to survive, evolve to perpetuate and react to change. CAS whether they are biological or organizational consists of interrelated processes that determine outcomes of change, which can only be predicted across a range of behaviors.

Each of the four knowledge domains informs the central argument of this inquiry, which is the hypothesis that capacity building relies on an organization capable of increasing and leveraging the value of resources within the education delivery system.

Correlates of Student Achievement

Quantity Correlates

Production functions estimates the effect of the quantity of input correlates on the dependent output as measured by student achievement the aggregate. A simple example of a production function for education is provided by Hanushek, Raymond and Rivkin (2004):

$$A_{it}^{g} = \sum_{t-1}^{g} (f_{it} + s_{T_{ity}} + \gamma_i + \varepsilon_{it}) \quad (1)$$

A student's achievement (A) is determined by the cumulative effects of a student's non-school inputs (f) and school inputs in each grade (s), which are modified by the student's ability (Y) and a measurement error.

The study *Equality of Educational Opportunity*, (1996) known as the *Coleman Report* (Coleman, J.S. Campbell, E.Q. Hobson, C.J. McPartland, J. Mood, A.M. Weinfeld, F.D., & York, R.L.), is considered the starting-point for contemporary production function analysis. Part of its value is that it established the concept that there are two classes of correlates for student achievement, which are non-school factors characterized by demographics and school-based factors. In the *Coleman Report*, these two classes of variables consisted of five specific variables the student's "(a) home background experience, (b) the characteristics of his student-body peers, (c) the school's facilities, (d) curriculum, and (e) teacher's characteristics" (Smith M.S., 1972, as cited in Mosteller and Moynihan, 1972, p.234). The primary finding of the *Coleman Report* (1966) was that non-school factors were the dominant class of correlates for student achievement.

The *Coleman Report* (1966) sparked a debate for the past 40 years. Since its release, a large stream of research has emerged, including but not limited to Hanushek and Kain (1972), Smith (1972), and Orfield and Ashkinaze (1991) challenging its methodology; Jencks (1972) supporting its conclusions; Dyer (1972) outlining its implications for future research; Hanushek (1981, 1986, 1989) supporting the *Coleman Report*'s finding that school-based inputs have highly variable impact; Rivkin, Hanushek and Kain (2005) researching how school-based inputs do matter; Ferguson and Ladd (1995); Hanushek (1971), Murnane (1975) and several others presenting evidence that teacher quality can influence student achievement.

Gaudet (2000), in the second-year study of school district performance on the Massachusetts standardized student assessment called, the Massachusetts Comprehensive Assessment System (MCAS) suggested that 84 percent of the variation in the average MCAS score is explained by demographics. In another finding of the study, he conducts a narrower analysis of MCAS scores of eight grade students for 25 of the 140 demographically similar communities identified as Middle Massachusetts, there was a 39 scaled score point range of variation between the district's actual and demographically-predicted score. This range extended from 25 points above the expected score to 14 points under the expected score (p.16). Gaudet's (2000) explanation for this variance between actual and predicted student scores is that "[some] school districts add value to the learning readiness of their students as indicated by higher-than-predicted test scores" (p.3)

Other researchers, such as, Walberg (2006) have had similar findings. In Walberg's study, he acknowledges Hoxby's (2001) findings that indicated that 93 percent of the variance in twelfth-grade mathematics scores in a large national sample was attributed to "poverty and the related socioeconomic and demographic factors" (p.80). Walberg data of school districts in South Carolina had a coefficient of determination of 0.76 between the percentage of students in poverty and percentage of proficient students on the standardized state assessment. Despite Walberg's findings his focus was to examining "outlier high-performing districts" (p.80). Walberg's list of common practices among these high-performing districts is aligned with the effective school concepts described by Marsano (2003) and Blankstein (2004).

Conversely, but still consistent with Gaudet's (2000) and Walberg's (2006) findings, the study of low-performing, but high-spending districts by Evers and Clopton (2006) included the high socioeconomic districts of Cambridge, Massachusetts, and Sausalito, California, which had correlates of ineffective school characteristics described by Sammons, et. al.(1995).

To provide an indication of the complexity and to demonstrate the confounding influences of all of the possible variables in production function analysis, the *Coleman Report* included "119 school-based measures" in that class of variables alone (Jencks, C., S., 1972, as cited Mosteller and Moynihan, 1972, p. 71). To illustrate the magnitude of, and shortcomings of sole reliance on production function research the examines school-based factors, Hanushek (2000) conducted meta-analysis of these efforts and found that "377 separate

production function studies [of school-based factors] have been published in 90 publications before 1995, but only 27 percent of studies showed a positive and significant effect. In fact, 7 percent even suggested that adding resources would harm student achievement" (p. 4203). Among these studies per pupil expenditures analyses occurred most frequently, To demonstrate this inconsistency, in Walberg's (2006) findings, the district with the highest percent proficient in student achievement had approximately the mean of the sample in percent poverty, but the lowest per pupil expenditure. (p. 82)

In conclusion, Hanushek (1986), does provide evidence that once "measurement errors are corrected [in production functions and socioeconomic variables controlled], schools are seen to have important effects on student performance" (p.1159), but there is little reliable empirical evidence in existing research to support it.

Quality Correlates

The production function equation does not account for any differences in teacher quality except to imbed these differences in school-based correlates. One of the most commonly cited limitations of production function analyses, including in the *Coleman Report* (1966) is that variability in student achievement occurred *within* schools rather than between schools or districts Hanushek and Kain (1972), Mosteller and Moynihan (1972) and even Coleman (1972). This suggests that for production function analysis of school-based factors, there is a confounding variable within schools, which Hanushek proposes as teacher quality.

Hanushek (1971, 1986, 1994, 2003, 2004, 2005), Hanushek, Raymond and Rivkin (2004) and Rivkin, Hanushek and Kain (2005) repeatedly present the alternative argument to the quantity of inputs as the determinant of school-based student achievement, which is that the quality of resources has an equal, if not greater influence on student achievement. Quality refers to the teaching and learning process, and capabilities of the teachers to optimize student achievement. Even the first finding of the *Coleman Report* (1966) states that, "The quality of teachers shows a stronger relationship to pupil achievement [than other school-based variables]" (p. 21). The difficulty with understanding the influence teacher quality as it correlates to student achievement is that it is difficult to measure. (Hanushek, 2005; Rivkin, Hanushek, & Kain, 2005).

Hanushek (2004) estimates that, "the differences in annual achievement growth between an average and a good teacher are at least 0.11 standard deviations of student achievement" (p.14). To demonstrate the significance of this estimate, Hanushek (2004) suggests that,

> If a student had a good teacher as opposed to an average teacher for five years in a row, the increased learning would be sufficient to close entirely the average gap between a typical low income student and a student not on free and reduced lunch. (p. 14)

Even earlier Hanushek (1986) posed the concept that, "The fact that a school spends a lot on each student gives us little information on whether or not it does well in terms of value added to students" (p. 1166). Rivkin, Hanushek and Kain (2005) suggest an alternative approach to traditional production function measurements of student achievement when they propose that,

> focuses on the determinants of the rate of learning over specific time periods. The advantage of the growth formulation is that it eliminates a variety of confounding influences including prior, and often unobservable history of parental and school inputs. This formulation frequently referred to as a value-added model, explicitly controls for variations in initial conditions when looking at how schools influence performance. (p .422)

Even though Rivkin, Hanushek and Kain (2005) propose a parametric equation that "attempts to define each variable in the education process, we begin by thinking in terms of the total systematic effect of students, families, and teachers, [we propose] a semi-parametric approach with inputs measured in achievement" (p. 424). They provide the following value-added equation:

$$\Delta A^{c}_{ijgs} = \gamma_i + \theta_j + \delta_s + v^{c}_{ijgs} \qquad (3)$$

> Test score gain in grade g is written as an additive function of student (γ), teacher (θ), and school (δ) fixed effects along with the random error (v) that is a composite of time-varying components. The fixed student component captures the myriad of family influences including parental education and permanent income that affect the rate of learning; the fixed school factor incorporates the effects of stable school characteristics including resources, peers, curriculum, etc. Finally the teacher component captures the average quality of teacher j over time. (Rivkin, et. al, 2005, p.424)

Dee and Keys (2004) examined the effect Tennessee Career ladder Evaluation System (CERA) on student attainment by analyzing data from Tennessee's Project STAR (Student Teacher Achievement Ratio) for the years 1985-1989. The data set included approximately 11,600 students tracked through grades 1-3. It measured scores on the Stanford Achievement Tests in mathematics and reading using a putatively random within-school paring of students with teachers who were at various levels on CERA. CERA combined monetary rewards with non-monetary rewards based on the teacher's progression along the ladder system. The career ladder system consists of a three year probationary period and three five years graduated levels. During the three year probation, new teachers are supervised by two tenured teachers from

their school. Progression from this apprentice stage and between the subsequent levels is based on state approved evaluation criteria. The financial rewards consisted of salary supplements of $1,000 for Level I, $2,000-$4,000 for Level II and up to $700 for Level III.

The econometric model presented by Dee and Keys (2004)

> relates Y_{isgc}, the grade and subject-specific percentile test rank for student I from school s, grade g and class c, to student, teacher, and classroom traits and fixed effects for the grade, entry wave (kindergarten, grades 1 through 3), and the school of entry. More specifically, this model takes the following basic form:
>
> $$Y_{isgc} = Z_{isgc}\Pi + X_{sgc}\beta + \alpha_g + \alpha_{sf} + \varepsilon_{isgc} \qquad (4)$$
>
> Where α_g represents grade fixed effects, α_{sf} represents fixed effects for school-of-entry and entry-wave interactions and ε_{isgc} is a mean-zero random error…. And since there is class-specific variation in class size and other unobserved determinants, class-specific heteroscedastity in ε_{isgc} is accommodated in this model through Huber-White standard errors. The matrix Z, includes the variables that vary at the individual level (i.e. race, gender, age, and free lunch status). The matrix X, includes class-specific variables, such as the teacher's career ladder status and assignment to a small class. (p.478)

The results of the Dee and Keys (2004) model indicate that, "indicate that students with career-ladder teachers had math scores that were nearly 3 percentile points higher than those students with other teachers." (p.480) The study provided some additional insight about comparing teacher quality with resource allocation substitutions by suggesting that estimated gains in student attainment for students with career-ladder teachers were equal to 40-50 percent of improvements from student participation in small class sizes.

III. METHODOLOGY

Research Design

The first sequence is ex-post facto analyses that use student achievement from the years 2001 to 2005.

SPSS 15.0 is used for statistical analysis. Microsoft Excel is used to present the data and graphical representations of SPSS data depicted in Tables 3 and 4, and Figures 1 through 7

Sampling Method

The data sources are from the Massachusetts Departments of Education and Department of Revenue. All of the data used in this study is public information, so there are no human consent requirements.

The sampling frame will consist of the 328 operating school districts in Massachusetts. The original sample will consist of 171 non-regional school districts with grades kindergarten through twelve. Some districts do not have secondary schools and their students are sent to a neighboring district. Both the sending and receiving district will not be used for this study, because the SES variables could confound the district performance results. Regional schools will not be used for this study, because it would be difficult allocate SES data among member communities of regional districts.

Boston, Worcester and Springfield are removed from the sample, because of the likelihood that district size has unique characteristics for cost analysis procedures. In addition, Weston was removed from the sample, because it has a 5.88 z-value for income per capita. Wellesley was also removed, because it has a z-value greater than 2.58 for all three income variables. The final sample size is 167 school districts.

Data Analysis Procedures

The first quantitative sequence begins with a series of correlation analyses to determine the correlation between independent variable of income and the dependent variable, the Composite Performance Index (CPI). The procedure is repeated to test longitudinal correlation for the years 2001-2005. The primary SES indicator used is 1999 per capita income, but triangulation of the correlations is conducted for household and family income. The dependent variable is district CPI performance on student achievement for the Massachusetts Comprehensive Assessment System (MCAS) in English Language Arts (ELA) and Mathematics.

The second step in this sequence is to conduct regression analysis to establish an adjusted predicted CPI, in both ELA and mathematics, for each district based on the SES indicator of income per capita. The adjusted value is a function of SPSS that is based on the predicted value, but minimizes the effect of outliers. This provides longitudinal data to examine changes in district performance on student achievement. The comparison between the district's actual CPI score and the statistically-estimated CPI value provides data for analysis of variance in performance.

The source of the SES data is from the Massachusetts Department of Revenue, Division of Local Services, Municipal Databank from the Local Aid Section. The title of the database is *Four Measures of Property and Income Wealth*, which was derived from data gathered from the U.S. Census Bureau.

Data for district performance came from results published by the Department of Education (DOE). It is a database of CPI results for years 2001 through 2005 published in 2006. Each district receives a separate CPI rating for English Language Arts (ELA) and Mathematics.

This first sequence is based on the assumption that Gaudet's (2000) observation about how a district spends money is more important than how much money it spends. The essence of this observation supports Hanushek's (2000) meta-analysis of production functions in which he concludes that the methodology has shortcomings, but later suggests (2005) production function are flawed because there are too many confounding variables that are led by the quality of resources. To verify the assumption of this first sequence, simple correlational analysis between per pupil spending and CPI is conducted in the form of scatterplots and accompanied by a correlation coefficient.

Data for all 167 districts in the sample is contained in Appendix B-1 for mathematics and B-2 for ELA.

IV. FINDINGS

Figures 1, 2 and 3 support the assumption that there no correlation between per pupil spending in Mathematics in the years 2001, 2002 and 2003 for the 167 districts used the study.

Figure 1
Scatterplot and correlation coefficient of the relationship between per pupil spending and student performance in mathematics measured by CPI in 2001

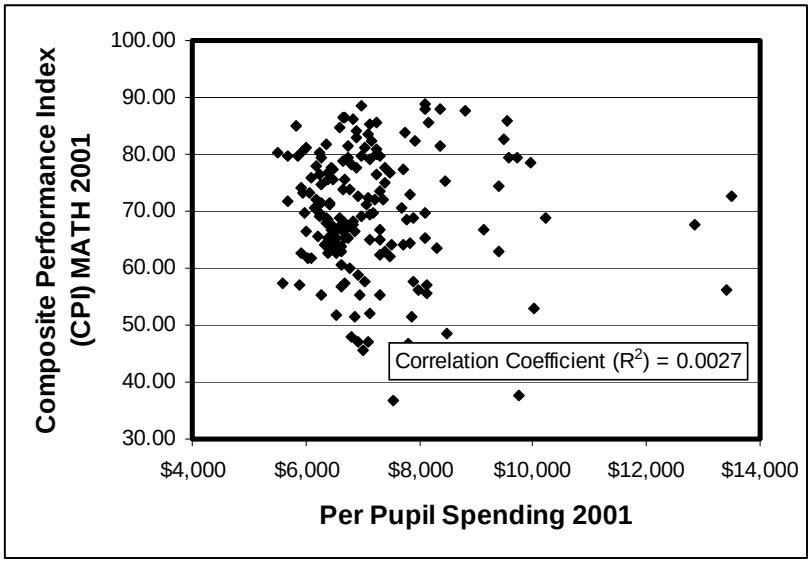


Figure 2
Scatterplot and correlation coefficient of the relationship between per pupil spending and student performance in mathematics measured by CPI in 2002

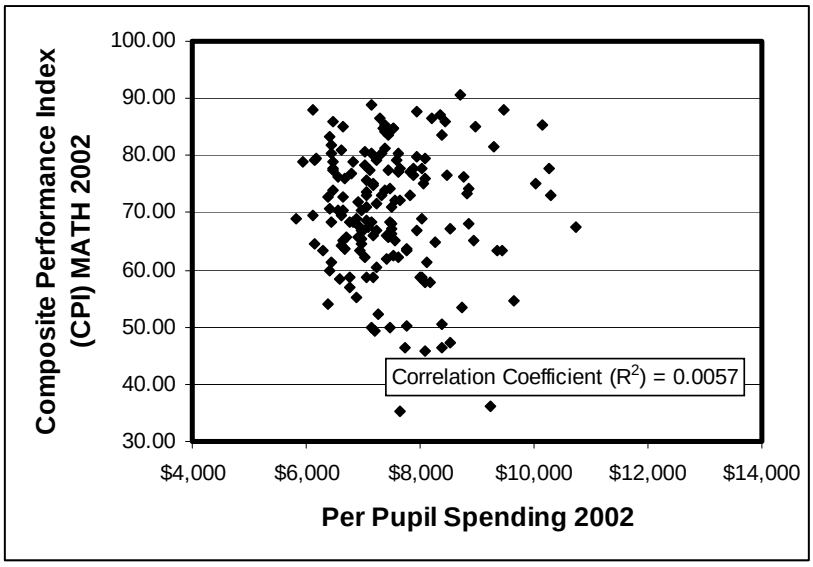
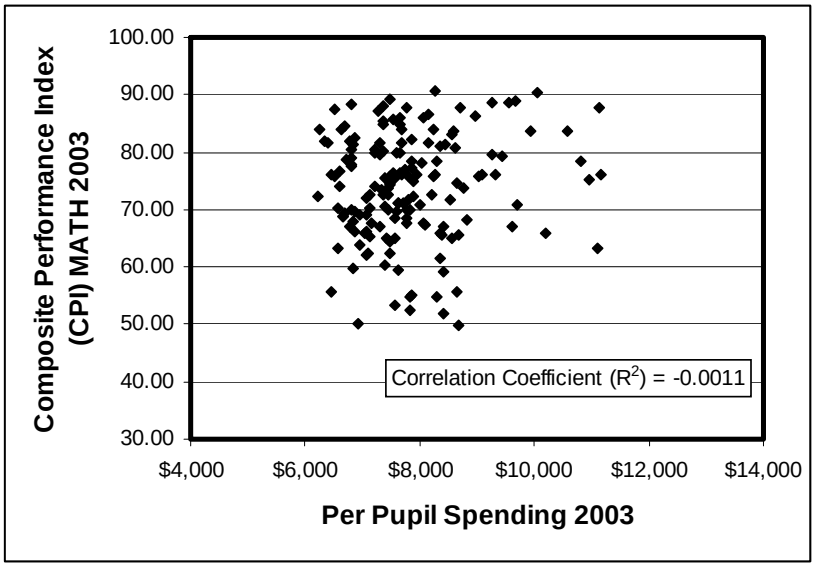


Figure 3
Scatterplot and correlation coefficient of the relationship between per pupil spending and student performance in mathematics measured by CPI in 2003



Similar correlation coefficients exists for the CPI in ELA and per pupil spending for 2001 through 2003. This confirms that the assumption that student performance does not correlate with per pupil spending at the aggregate-level.

The research questions for the first quantitative analysis are:

2. What is the range of variability of the dependent variable of district performance between the actual performance and statistically-predicted performance based on non-school demographic correlates?

    b. Has district performance changed over time?

Table 3 is a summary of the correlational relationship between the independent variable of income per capita and mathematics CPI for the years 2001-2005

Table 3
Correlation Coefficients for Districts in Mathematics 2001-2005

Coefficients	MATH01	MATH02	MATH03	MATH04	MATH05
Pearson's Correlation	0.786	0.780	0.776	0.795	0.783
Kendall's tau Correlation	0.633	0.617	0.614	0.626	0.626
Spearman's rho	0.801	0.791	0.793	0.803	0.802

Table 3 provides both parametric and non-parametric correlation indicators, because the sample data, could be interpreted as parametric, but may not meet all of the criteria indefensibly. Regardless, the correlations for all three methods are within a range that is determinant of a relationship. All of the correlations are significant at the 0.01 level as two-tailed test. These correlations are consistent with the findings of Gaudet (2000) and Walberg (2006), which indicates a strong correlation between SES indicators and student achievement.

Table 4 is a summary of the correlational relationship between the independent variable of income per capita and English Language Arts CPI for the years 2001-2005.

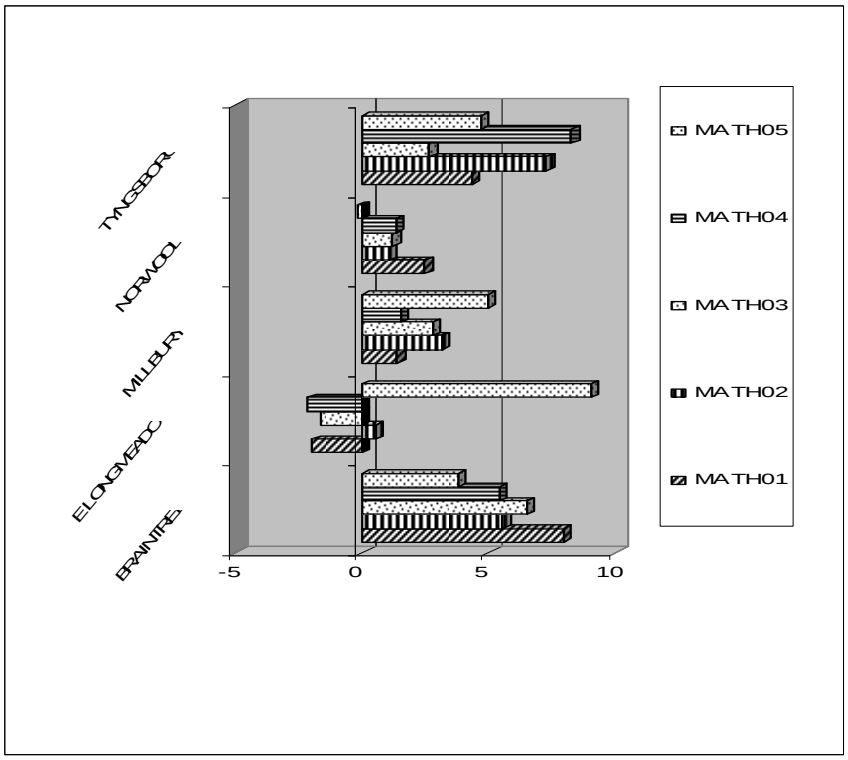
Table 4
Correlation Coefficients for District CPI in ELA 2001-2005

Coefficients	ELA01	ELA02	ELA03	ELA04	ELA05
Pearson's Correlation	0.703	0.680	0.725	0.734	0.725
Kendall's tau Correlation	0.606	0.585	0.625	0.628	0.624
Spearman's rho	0.778	0.757	0.800	0.803	0.796

Table 4 indicates similar correlational relationships as mathematics between SES and student achievement. A difference between both of these analtses and previous research cited in this inquiry is that it depicts longitudinal consistency in the relative strength of the correlations.

Figure 4 is a longitudinal representation of the districts that Gaudet (2000) identified as effective for the years 2001-2005. The data indicates the difference between the actual CPI on mathematics and the statistically-predicted CPI value. Appendix B contains the mathematics source data, predicted values and data for 167 districts in the sample data

Figure 4
Comparison of CPI for Mathematics 2001-2005 for Gaudet's effective districts
Difference between actual CPI versus predicted-value CPI

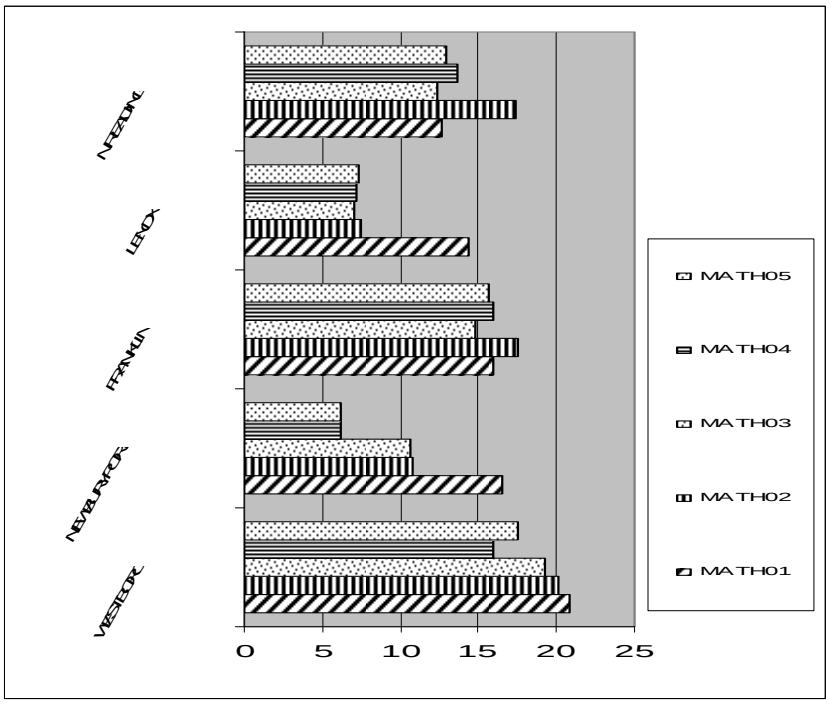


The data indicates that all of Gaudet's (2000) effective districts except for East Longmeadow maintained an actual CPI for 2001-2005, that is higher than their predicted CPI, except for Braintree, which ranked 16 in the sorting of outperforming districts, none sustained a consistent rate of student achievement that Gaudet (2000) thought when he suggested that these districts that had aligned its resources for student readiness to learn in 1999 would continue in subsequent years.

Figure 5 is a longitudinal representation of the top 6 outperforming districts that for the years 2001-2005. The data indicates the difference between the

actual CPI on mathematics and the statistically-predicted CPI value. Appendix B contains the mathematics source data, predicted values and data for 167 districts in the sample data.

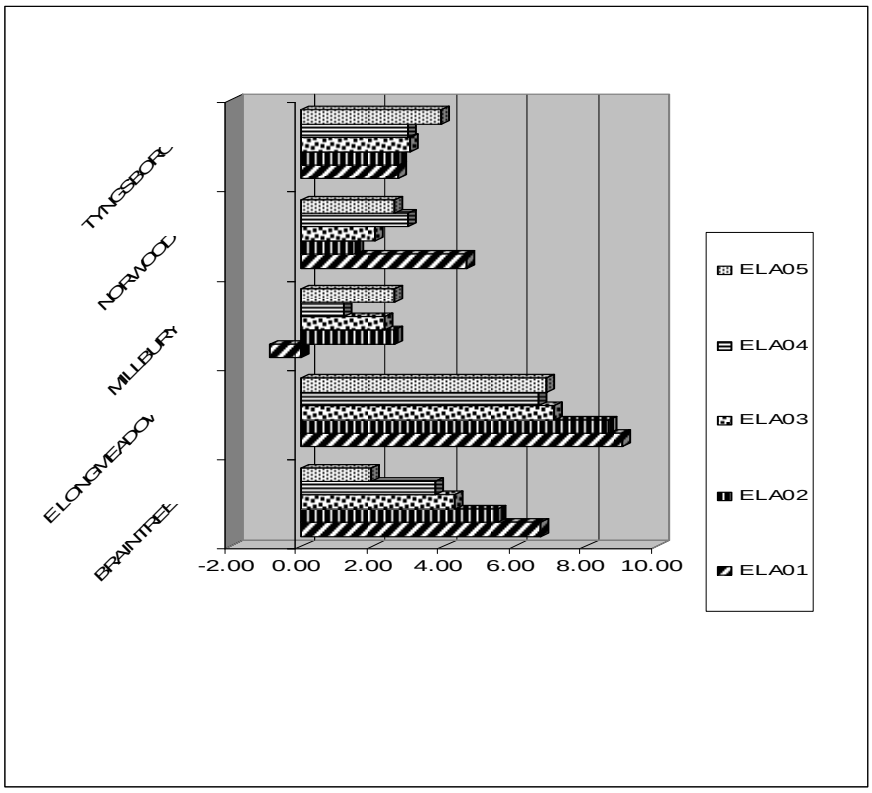
Figure 5
Comparison of CPI for mathematics 2001-2005 for outperforming districts
Difference between actual CPI versus predicted-value CPI



The state average for income per capita is $27,461. The per capita income for each of these districts is, (a) Westboro, $21,501, (b) Newburyport, $23,234 (c) Franklin, $21,420, (d) Lenox, $23,263, and (e) North Reading, $25,974,. Only North Reading was identified by Gaudet (2000) as a district that out performed above its SES. These districts sustained their performance indicating that they are aligned to excel in student achievement by the MCAS metric.

Figure 6 is a longitudinal representation of the districts that Gaudet (2000) identified as effective for the years 2001-2005. The data indicates the difference between the actual CPI English Language Arts (ELA) and the statistically-predicted CPI value.

Figure 6
Comparison of CPI for ELA 2001-2005 for Gaudet's effective districts
Difference between actual CPI versus predicted-value CPI

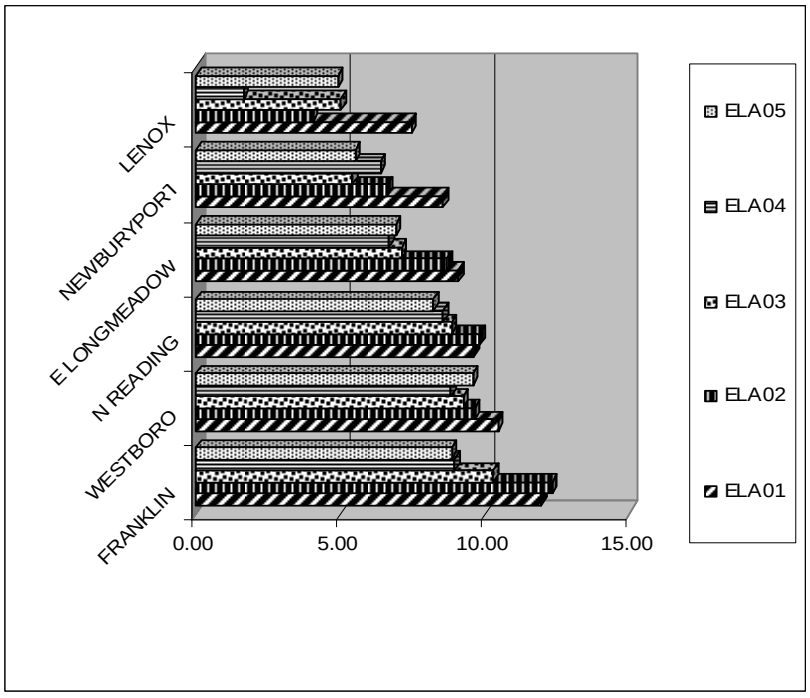


The data in Figure 5 indicates that all of Gaudet's (2000) effective districts maintained a robust improvement actual CPI fro 2001-2005, that is higher than their predicted CPI. Unlike the data for the same districts in mathematics all

sustained the rate of student achievement that Gaudet (2000) thought when he suggested that a district that had aligned its resources for student readiness to learn in 1999 would continue in subsequent years, but they do not represent the districts that substantially outperformed their SES.

Figure 7 is a longitudinal representation of the top 6 outperforming districts that for the years 2001-2005. The data indicates the difference between the actual CPI on English Language Arts and the statistically-predicted CPI value. Appendix C contains the mathematics source data, predicted values and data for 167 districts in the sample data

Figure 7
Comparison of CPI for ELA 2001-2005 for outperforming districts
Difference between actual CPI versus predicted-value CPI



A comparison of the top six districts that outperformed their community's SES in mathematics depicted in Figure 4 with those that outperformed in ELA depicted in Figure 6 is stunning evidence that these districts have aligned their resources with the expectations of the MCAS assessments, and they have sustained their performance. Based on the SES variable of per capita income, it is indisputable evidence that these districts have built capacity beyond their SES.

CONCLUSION

The data depicted in Tables 3 and 4, is empirical evidence that there is a strong correlation between per capita income as the independent variable and student achievement as measured by CPI in mathematics and English Language Arts.

The regression analysis depicted in the examples of Figures 3-6 and the complete databases found in Appendixes B-1 and B-2 provide empirical evidence that, even though the correlation exists, there is a variation along a continuum of performance between the actual and predicted CPI. This supports the hypothesis that some districts have built the capacity to mitigate their socioeconomic status.

It also begins to inform the second research question, which examines how districts have enhanced value of resources to varying degrees within their education delivery systems. The average per pupil expenditure (PPE) for the state in Fiscal Year 2001(FY01) was $7,562. The FY01 PPE for the districts that

outperformed in both mathematics and ELA from 2001-2005 was: (a) Westboro, $7735; (b) Newburyport, $8,357; (c) Franklin, $6,649; (d) $9,710; and (e) North Reading $5,945.

Even though the analysis for this inquiry only addresses the first research question, it does provide empirical evidence to support further investigation of questions 2 and 3. SES does account for the majority of student performance, but the variation of this relationship indicates that another independent variable is influencing CPI outcomes. The remainder of the study focuses on conceptualizing decision-making about, and organizational utilization of resource allocation within the education delivery system that produces outcomes based on a range of organizational behaviors. These behaviors represent the district's capability to design an education delivery system that focuses on student readiness for learning to perform on standardized assessments in Massachusetts.

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APPENDIXES

Appendix A

Definition of Terms

Capacity Building	Elmore (2005) states that," Capacity is defined by the degree of successful interaction of students and teachers around content" (p.118). Cohen, Raudenbusch and Ball (2002) developed a model for capacity that suggests that the education delivery system must be designed around the three portals of capacity, which are the student, teacher and content. (as cited in Elmore, 2005, p. 119). Senge addresses the means to build this capacity when he suggests that, "The bottom-line of systems thinking is leverage – seeing where actions and changes in structures [and behaviors] can lead to significant, enduring improvements" (p.114).
Complex Adaptive Systems	(CAS) "Self-organization of complex entities across scales of space, time and organizational complexity (Levin, 2002, p. 3) CAS theory is important to education delivery systems, because intervention will result in a range of patterns of outcomes, which can be used to evaluate the effect of an intervention on the organization.
Education Delivery System	The organizational structure that contains the distinct activities that provides instruction and learning. For this study, it is visually represented by Porter's (2000) generic value chain framework.
Production Function	[A process] characterized by the deterministic relationship between inputs and outputs (that is, a given set of inputs always produces exactly the same amount of outputs) Furthermore, it is assumed that all inputs can be substituted freely. (Hanushek, 1986, p.1149)

Resource Allocation	The ways in which fiscal and non-fiscal resources are divided between competing needs and expended for educational purposes (Pan, et. al., 2003, p.5)
Socioeconomic Status (SES)	A measure of a student's position along a continuum of wealth. In the Coleman Report (1966) It is was a position that was influenced by whether the student was a minority positioned at the lower end of the continuum. In contemporary terms, it is analogous to demographic. Its significance is that lower SES student " systematically achieve less than more advantaged students" (Rivkin, S., Hanushek, E. and Kain, J., 2005, p. 450)
Student Achievement	Student Achievement in this study is a measure of a district's performance on the Massachusetts Comprehensive Assessment System (MCAS). Performance is measured with a Composite Performance Index (CPI) for the district, which is based on the district's relative progress on its Adequate Yearly Progress (AYP) (Massachusetts Department of Education, 2006, p.3)
Systems Thinking	"A discipline for seeing wholes….a framework for seeing interrelationships rather than things, for seeing patterns of change rather than static snapshots" (Senge, 1990, p.68).
Value-added Models	Quantitative model that attempt to "isolate the contribution of teachers or schools [on] student achievement" McCaffrey, D. F., Lockwood, J.R., Koertz, D. & Hamilton, L. (2004).