2014

Equity of Opportunity to Learn, Spending and Student Achievement

H. W. Meyers
University of Vermont

John D. Rogers
University of Vermont

EQUITY OF OPPORTUNITY TO LEARN, SPENDING AND STUDENT ACHIEVEMENT

A STATEWIDE ANALYSIS IN VERMONT

H. W. Meyers

University of Vermont

John D. Rogers

University of Vermont

APRIL 5, 2014

Paper presented at the Annual Meeting of the American Educational Research Association

Philadelphia, PA

Abstract

Equity of Opportunity to Learn, Spending and Student Achievement: A Statewide Analysis

A statewide study of the relationships among student level measures of opportunity to learn (OTL), state assessments in mathematics and reading, and the allocation of spending by schools for various educational programs was completed for a joint legislative committee workgroup of the House and Senate Education Committees of the Vermont Legislature. The results of the study showed a positive relationship among all three sets of variables when displayed on GIS maps and examined with multiple regression. When measures of poverty were included in the mapping it became evident that areas of the state that held high concentrations of poor families displayed significantly lower levels of opportunity to learn, lower levels of achievement in reading and mathematics and lower levels of investment in school programs. The state has implemented an equity funding system since a state Supreme Court decision forced a revision of the allocation formula. Despite the effort to equalize the tax burden, equity of opportunity to learn and outcomes of schooling at the student level related to the allocation of public resources remains elusive.

Introduction

In Vermont, student enrollment in K-12 public education has been declining for the past twelve years at the rate of about one percent per year. At the same time, costs for public education as reflected in property taxes have been increasing at about three percent per year. The result of this perceived discrepancy between the need to provide adequate funding for public education and pressure it exerts on taxpayers has been increasing tension between schools and their communities. Seniors on fixed incomes, legislators and politicians attempting to be responsive to citizen concerns, advocates for privatization, school choice and home schooling add voice to the overall concern that the value obtained for the high cost of public education is insufficient. There seems a growing consensus that Vermont's system of funding public education, despite a positive review from Picus, et al, (2012) is simply not sustainable.

Vermont, like many other states, addressed the funding equity questions raised by Serrano v Priest. The problem, which may have been created by a concern for tax equity, was forecasted by Fishel (1998):

> *There is strong evidence from California that the consequence of a highly egalitarian system ordered by the Serrano court has made poor children worse off, and there is some circumstantial evidence that court decisions or the threat of such decisions in other states have induced taxpayer revolts that have undermined education for all. At its worst, school finance litigation has engendered dog-in-a-manger equality of low-quality education. At its best, it seems to have done little more than shift tax burdens and property values in ways that offer no systematic benefit to the poor.* (p. 43).

The resulting Brigham decision (Brigham v. Vermont, 1997) of the Vermont Supreme Court set the stage for a sequence of state laws aimed at achieving the equity of tax burden and effort. With each attempt to evaluate the effects of each in the series of laws beginning with ACT 60 (1997) and most recently with ACT 185 (2006), one element of equity defined as a consequence of the laws was generally missing from the discussion of effects. That missing element is the generally unexplored territory of the distribution of Opportunities to Learn (OTL)[1] for all children enrolled in public education. At a forum held in January of 2014 that focused on the Vermont finance system none of the reported discussion on the finance system included the topics of equity of the outcomes of education or opportunities to learn for all children as related in any way to the system of finance that drives investment (Remsen, 2014).

Purpose

The purpose of the paper is to report findings from a statewide study of opportunity to learn, student achievement and school spending for 59 Vermont Supervisory Unions (SU), representing 23,527 students from 303 schools at grades 4, 8 and 10 during 2004. The study used multiple-source data to identify student achievement in reading and mathematics and opportunity to learn, and examine those variables from student and school perspectives. The aggregated data were provided by the Vermont Agency of Education (AOE) census and assessment, which are based on student-level data. Data were aggregated at the SU level because of inconsistency of financial accounting across individual schools and supervisory unions, and to ensure expedited data

[1] Opportunities to Learn (OTL) for the purpose of this paper are defined in science, for example, "as the quality of the classroom instruction in science, the extent to which students have the opportunity to learn science in the way called for in the framework, and the extent to which schools have the resources needed to support learning (such as teacher qualification and subject area pedagogical knowledge, and time, space, and materials devoted to science instruction)." National Research Council (2013) p. 6-1. The measurement of OTL in this study was a twenty-four item questionnaire constructed by the Vermont Department of Education in 2004 to gather student self-report of the opportunities to learn that they experienced in their schools.

access. The study used a standard measure of opportunity to learn with a self-report questionnaire of twenty-four questions which were drawn from Effective Schools Research. The OTL questionnaire was attached to the annual student assessment, New Standards Reference Examination, which was also used to measure student achievement in mathematics. Per-pupil spending within SUs in 2004 was drawn from the Vermont Summary of the Annual Statistical Report on Schools (SASRS), based on data submitted by the Vermont Agency of Education to the National Center for Education Statistics.

The research questions posed by policy makers for this study included:

Does Vermont's current education system allocate financial and other resources in a way that promotes high quality, equitable opportunities for students throughout the state?

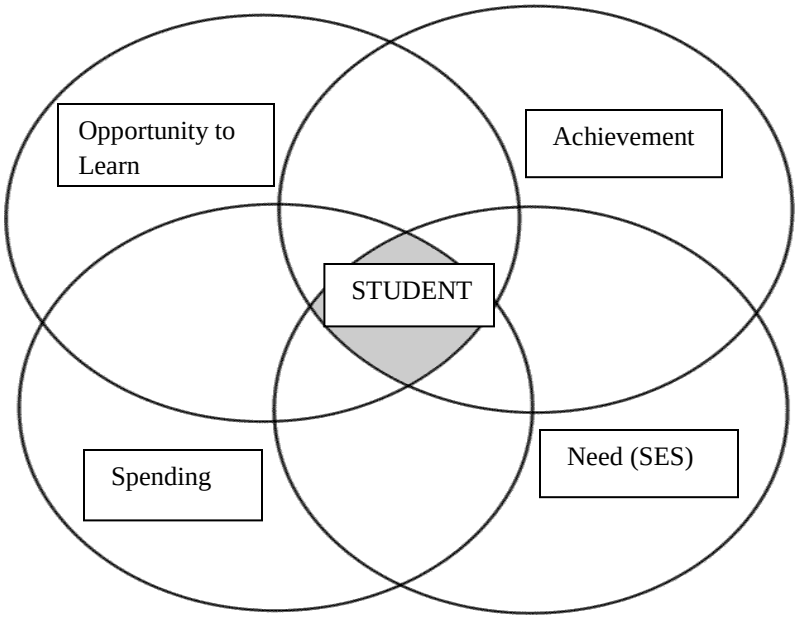
What is the relationship among opportunities that students have to learn, the spending of public funds on those opportunities and the outcomes of student achievement identified by the state?

Perspective

This paper combines perspectives on school finance reform (Rebel, 2002) with school spending and cost accounting (Hanushek, 2007) and the measurement of student performance as related to resource allocation (Odden, 2007; Hanushek, 1996; Greenwald, Hedges & Laine, 1996; Wenglinski, 1998). The intersection of the above perspectives provides part of the context of the examination of the relationship between spending and performance. The specific setting in Vermont is grounded in changes in spending that occurred coincident with changes in the Vermont statutes as a result of the Brigham decision in the Vermont Supreme Court (Brigham v. Vermont, 1997). These changes were documented in a general way in two Vermont State Department of Education reports (Barre, et al, 2002; Altemus, et al, 2008). The overall

analytical framework to include opportunity to learn, student achievement and spending as a complex system driven (or not) by need was identified by Killeen (2012) and Rogers and Meyers (2013). The figure below indicates the classes of variables and their interaction at the center of a learning system (individual student).

Figure 1. Dimensions of the Learning System



The question of how much spending is enough to equalize the effects of poverty on opportunities has been explored by Costrell (2007). But, the answer to this and other questions about the relationship of spending to performance has eluded researchers in the absence of a match of measures of opportunity to learn, taken at the student level, with both measures of achievement and spending. The second set of perspectives, then, makes use of Vermont's relatively unique opportunity to match student data on assessment driven measures of both achievement and opportunity to learn. This second set of perspectives is informed by research done on

opportunity to learn by Burstein et al. (1995); and by research on student mobility by Paik and Phillips (2002), Rumberger et al. (1999), Morgan (2005), and Meyers (2012).

Methods

The research combined both qualitative and quantitative methods in two phases. The first phase included a series of focus group meetings conducted by the working group, taking testimony from stakeholders in the education, business and governmental communities to assess the community views of the distribution of resources their effects. During the second phase of the research the work group conducted a correlational study examining the relationship between and among measures of student performance of students enrolled in the $4^{th,}$ 8^{th}, and 10^{th} grades in the spring of 2004. The methodology was guided by the conceptual framework of relationships between individual and organizational contexts and student achievement, which links the theoretical and empirical literature. The analytical methodologies used GIS mapping (Foote and Burke, 2000), summary statistics and multiple regression analysis.

Data Sources

The study population included Vermont public school students enrolled in 306 schools, grades 3 through 12, during school year 2004. Data aggregated by SU from student-level data sources included: (a) New Standards Reference Examination reading and mathematics performance data, grades 4, 8, and 10, from the AOE assessment files; and (b) Opportunity to Learn survey (twenty-four items), collected with the assessment data. Data from SU-level sources included (a) Per-pupil spending within SUs in 2004 as reported in the Vermont Summary of the Annual

Statistical Report on Schools (SASRS)[2], and (b) expenditures on teacher salaries reported on the website of the Vermont Agency of Education in the Teacher / Staff Full-Time Equivalency (FTE) and Salary Report.[3]

The OTL scale was defined as the average response of 24 survey questions (23 for middle and elementary school students). Students were asked to describe their experiences of different types of opportunities on a 4-point scale, with the options of "Not at all" (scored as 1), "A little bit" (2), "More than a little" (3), and "A lot" (4). Pre-aggregation reliabilities were high for all grade levels, ranging from $\alpha = .86$ among 4th graders, to $\alpha = .90$ among 8th graders and $\alpha = .91$ for students in the 10th grade. In addition to the mean ratings, the percentage of students responding at the highest and lowest levels was retained. Demographic measures available from the survey included the percent of children eligible for free and reduced lunches, gender (defined as percent male), and percent of students identifying their race or ethnicity as other than "White". Mathematics achievement was defined as the percent of students meeting the overall math standard in the 2004 NSRE examination.

Teacher salary expenditures included entries included entries for all Staff Category Descriptions referring to "teachers", including Guidance Counselors / Directors but not including Teachers' Aides. Expenditures, which include both salary and fringe, were aggregated by Supervisory Union, and the totals divided by the sum of FTE. The resulting figures are not exactly the same as what individual teachers receive, as not all teachers are employed on a 1.0 FTE basis.

[2] Data file retrieved from http://education.vermont.gov/data/annual-statistical-reports-of-schools.

[3] Data file retrieved from http://education.vermont.gov/new/html/data/teacher_FTE.html.

The aggregated and SU-level data were matched to base layer maps of 60 geographically defined SUs provided by the Vermont Center for Geographic Information (Waterbury, VT).

Results

Question 1: Does Vermont's current education system allocate financial and other resources in a way that promotes high quality, equitable opportunities for students throughout the state?

Available data from testimony to the 2012 Legislative Working Group on Opportunities to Learn, Per pupil spending data, teacher salary data, licensing and enrollment for early childhood learning programs, and a 2004 survey of students on Opportunities to Learn show that high quality opportunities to learn for students are not equitably distributed throughout the state.

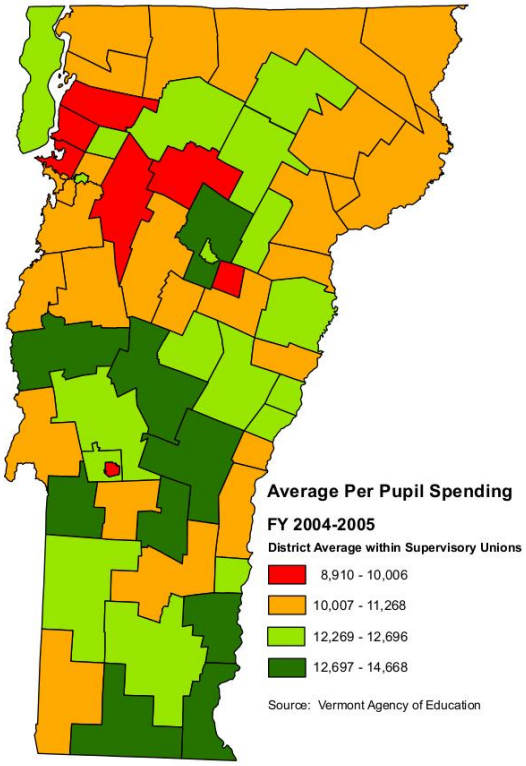
Per-pupil spending

Per-pupil spending dollar amounts are generally well documented by the Vermont Agency of Education and cited by most authors of reports concerning education finance without much variation. Average state-reported per-pupil spending in 2004 was $11,113. As previously noted, spending has increased considerably over time. Using NEA projections, Picus (2012) reported a 250% increase in per pupil spending, from $6,981 in 2000 to $17,447 in 2011. The state-reported figures are lower, but also show substantial increases. The 2013 SASRS reported per pupil spending of $16,773, an increase of 151% over 2004 spending.

In order to compare levels of spending across the state in the context of opportunities to learn and student achievement, we mapped the 2004-2005 spending by SU. The map below shows state reported per-pupil spending classified into four categories using the Natural Breaks method

to minimize within-class variance (Jenks, 1967). The range in spending across the districts is $5758, from a low of $8,910 to a high of $14,668.

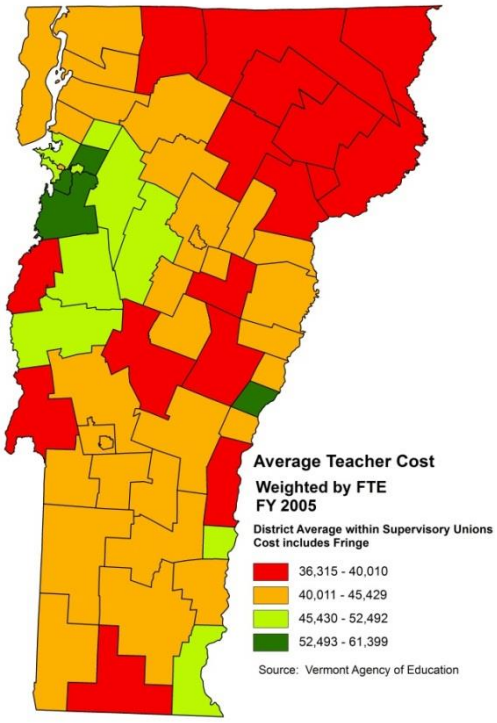
Map 1: Average Per Pupil Spending in Vermont 2004-2005



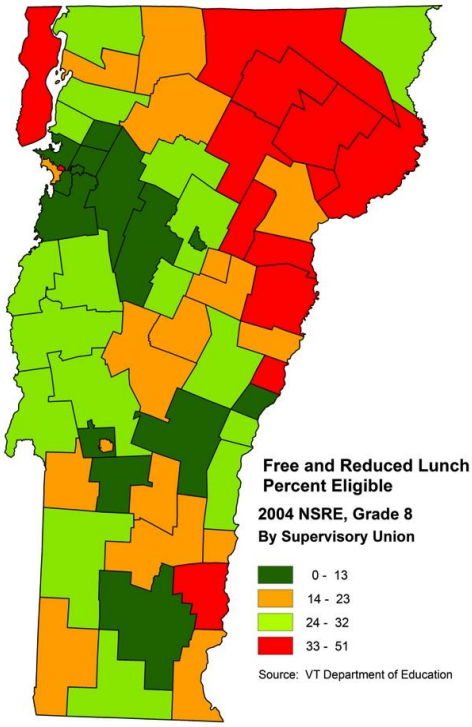
Mapping Teacher Costs, Poverty and Opportunity to Learn

To evaluate the extent to which salary expenditures vary by supervisory unions, and the implications of any variability, we mapped teacher salary and fringe benefit expenditures (teacher costs) by supervisory union. The following maps show the distribution of teacher salary expenditures, Opportunities to Learn and Free and Reduced Lunch Eligibility (poverty), again using the Natural Breaks method to classify each measure within four categories.

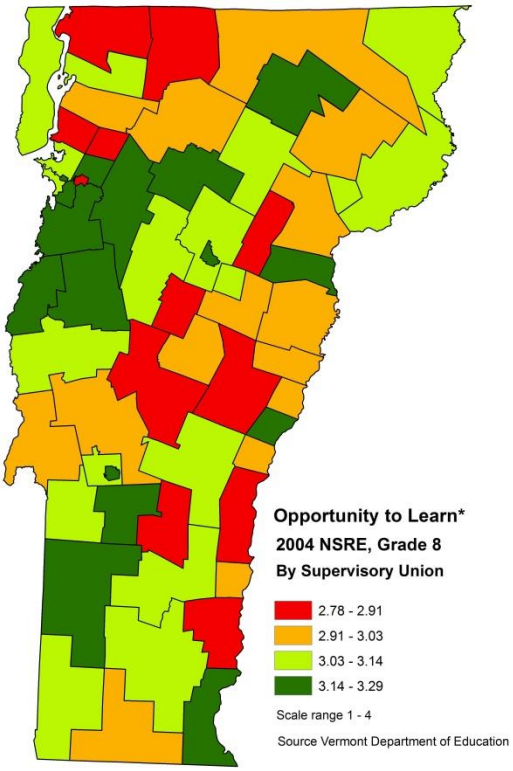
Map 2. Average Teacher Cost, 2004.



Map 3. Free and Reduced Lunch Eligibility, 2004

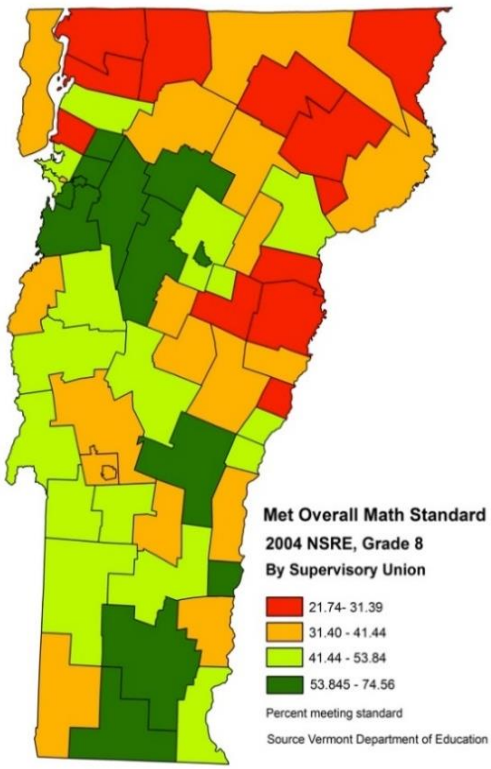


Map 4. Opportunities to Learn, 2004



*Composite scale is average of 23 questions from 2004 OTL survey (Alpha = .90)

Map 5. Met Overall Mathematics



All three maps suggest consistent relationships among teacher salaries, poverty and student perceptions of their opportunities to learn. We cannot make causal inferences, but the underlying theme suggests connections between poverty and opportunities to learn and then to student achievement, highlighting the links on which policy makers may need to focus changes in both methods of funding and spending and responses to needed school improvement. That is, if student perceptions of the lack of opportunities for them to learn occur most frequently in districts that pay teachers less and have higher proportions of low income students who are less likely to meet state standards, then it suggests that the focus of reform might be on the quality of education that all students actually receive.

Are Opportunities to Learn Equitably Distributed?

The maps on the preceding page show the considerable variation of mean OTL scores by supervisory union, followed by mathematics performance as measured by percent meeting overall standard. In both cases these are shown for 8th grade students. Supervisory unions are color-coded to provide a high-level view of variability, with low scores shown in red and high scores shown in green. OTL appears to be highest in the most populous areas. The pattern for mathematics performance is more complex, ranging from a low of 21.7% in a town located in a rural county to a high of 74.6% in a city located in a relatively urban county.

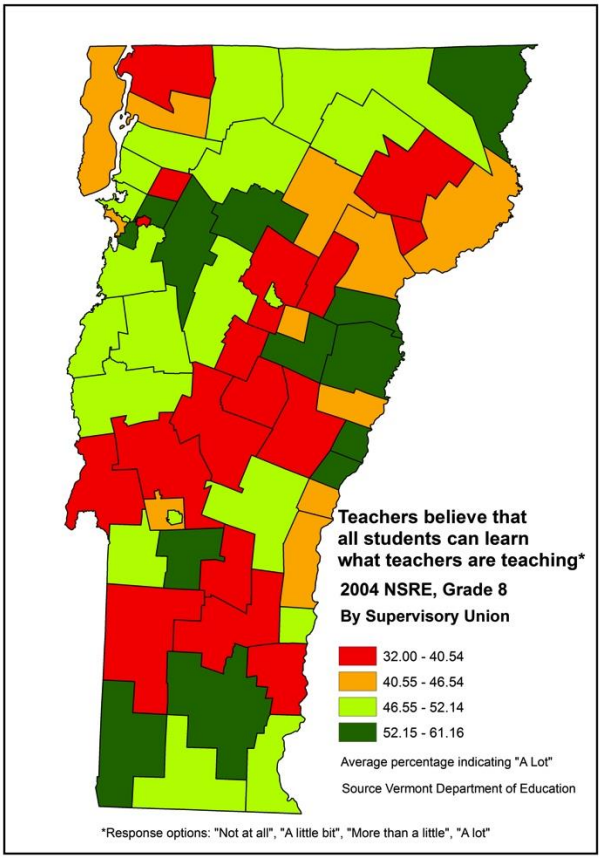
To evaluate the extent to which OTL varies by supervisory unions, and the implications of any variability, we compared results for the high and low rated 10th percentiles by dividing the mean for the 90th percentile group by the 10th percentile mean. The five supervisory unions in the 90th percentile OTL ratings had OTL scores that were 1.2 times higher than those in the 10th percentile (10th grade students). Although this ratio appears small, it is equivalent to a

substantial proportion of the overall range in OTL, which is based on a large set of questions. Individual items from the scale had much larger dispersion ratios, for example, the ratio for the question "I feel safe in my school" was 2.3 for 10th grade and 1.8 for 8th grade students. The impact of OTL dispersion can be seen in the equivalent ratios for the percent of students meeting the overall mathematics standard (Map 5). Across all grades, the *students in the highest rated 10th percentile of supervisory unions (for OTL) met the standard at 1.4 – 1.6 times the rate for the lowest rated 10%, with differences of about 20 percentage points for each grade*.

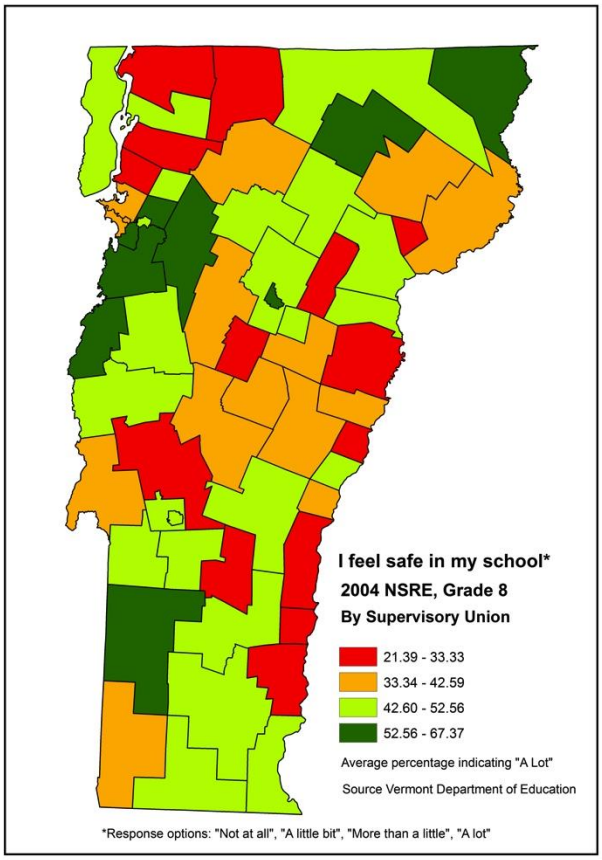
The maps on the following page show the mean percent of "A lot" ratings for two example items by supervisory union, again for 8th grade students. As in the previous example, supervisory unions are color-coded to provide a high-level view of variability, with low scores shown in red and high scores shown in green. One observation that can be made about these distributions of opportunities to learn is that there is considerable similarity in the patterns of students' ratings. That is, certain areas of the state appear to have "better opportunities to learn" as measured by the level of expectations that students sense their teachers have of their potential (Map 6). The patterns of these ratings are similar when related to safety (Map 7) and the frequency of the use of "inquiry" type of teaching methods (not shown).

Taken together, the maps show the distributions of high achievement, high opportunities to learn and spending (particularly on teacher salaries) are coincident with the distribution of poverty as measured by eligibility for free and reduced lunch.

Map 6. Teachers Believe All Can Learn



Map 7. I Feel Safe in School



Question 2: What is the relationship among opportunities that students have to learn, the spending of public funds on those opportunities and the outcomes of student achievement identified by the state?

Relating Spending, Opportunity to Learn, Poverty and Student Achievement

To assess the relationship between OTL and academic performance, we used multiple regression analysis to control for factors such as gender, ethnicity, poverty, and total per-pupil spending.

Multiple regression analysis allows us to identify the influence of several factors at the same time on mathematics performance outcomes. In this case, we examined the relationship between student-reported OTL and the percent of students meeting the overall mathematics standard, controlling for the distributions of gender, ethnicity, free / reduced lunch status, and per-pupil spending. Descriptive statistics and regression results are shown below in the Appendix.

For each grade level the model accounts for a substantial proportion of variability in percent of students meeting the math standard. For example, more than half of the variation in math performance among 8th graders (56%) is accounted for by OTL, gender, ethnicity, poverty status, and per-pupil spending. The impact of poverty as measured by free / reduced lunch eligibility is most evident among grades 4 and 8, and independent effects for per-pupil spending were only evident among students in the 8th grade.

The relationship between OTL and mathematics achievement is significant and substantial at all grade levels. For every 1-point increase in mean ratings on the 4-point OTL scale, the expected percentage point increase in a supervisory union's students meeting the math standard is 44 in grade 4, 38 in grade 8, and 26 in grade 10.

For each grade level the model accounts for a substantial proportion of variability in percent of students meeting the math standard. For example, more than half of the variation in math performance among 8th graders (56%) is accounted for by OTL, gender, ethnicity, poverty status, and per-pupil spending. The impact of poverty as measured by free / reduced lunch eligibility is most evident among grades 4 and 8, and independent effects for per-pupil spending were only evident among students in the 8th grade.

The relationship between OTL and mathematics achievement is significant and substantial at all grade levels. For every 1-point increase in mean ratings on the 4-point OTL scale, the expected percentage point increase in a supervisory union's students meeting the math standard is 44 in grade 4, 38 in grade 8, and 26 in grade 10.

Relating Salary Expenditures, Opportunity to Learn, Poverty and Student Achievement

Separate multiple regression models were conducted using teacher salary expenditures, to avoid potential issues from multicollinearity (results shown in the Appendix).

For each grade level the models again accounted for a substantial proportion of variability in percent of students meeting the math standard (shown on the "Model R square" line). The impact of OTL and poverty (as measured by percent free / reduced lunch eligible) is most evident among grades 4 and 8. *Salary expenditures were significantly related to 10th grade mathematics performance.* An increase of one standard deviation in salary at the SU level ($5,278) is associated with an increase of 4.5 percentage points (.43 standard deviations) in the percent of 10th grade students meeting the math standard.

We also investigated the relationship between teacher salaries and OTL ratings. In this model, we looked at the relationship between teacher salaries and student-reported OTL, controlling for the distributions of gender, ethnicity, and free / reduced lunch status.

For each grade level these models accounted for a somewhat smaller proportion of variability in OTL than was evident for mathematics performance but still showed a substantial impact, ranging between 22 and 34 percent variance explained in each model. The impact of poverty as measured by free / reduced lunch eligibility is most evident for grade 4.

Discussion: Relating Spending, Opportunity to Learn, Poverty and Student Achievement

The relationships among the distribution of spending (Map 1) generally follow the distribution of wealth as measured by poverty indices (Map 3); the distribution of teacher costs (Map 2); the distribution of opportunities to learn (Map 4); and the distribution of mathematics achievement (Map 5). Despite the decline in enrollments across the state, spending for education continues to increase. If per-pupil costs continue to rise, concern for controlling spending will likely increase in the months and years ahead.

Most of the Vermont finance studies have used only the statewide average, range, and standard deviation when attempting to relate spending to outcomes. However, Michelle Mathias' doctoral dissertation (Mathias, 2009) was different in that it sought to differentiate relationships among the types of spending from aggregate per pupil spending with respect to the inputs (opportunities to learn) and outcomes (test scores and graduation rates). When total spending was disaggregated by types including instructional support (less teacher salaries), books and equipment, and teacher salaries Mathias found that Instructional Support, a subset of Direct Instruction, proved to be of significant importance in student outcomes and ironically, is a category of investments that is more vulnerable to budget cuts. It includes dollars for professional development, curriculum development, technology and libraries. The dollars represent a comparatively small proportion of education budgets, from a low of 1.5% to a high of 5%. The cumulative per pupil investment for the eight year period ranged from $752 to $4,453 with a mean of $2,054, or $256 per pupil per year. Over time, the relatively small cuts in instructional support when applied to cohorts of students can have a cumulative effect. The mean difference in assessment scores for groups of students formed by low and high investment in this area by tenth grade is statistically significant ($p<.05$) at 24.6 points. The point differentials could mean that the difference between Substantially below Proficient and Distinguished in the distribution of NECAP scores may be

influenced by spending in instructional support. The point here is that in order to understand the importance of investment on achievement the specific investments that represent the most classroom-related spending must be separated from the larger category of Direct Instruction and must be tracked over time.

Without a clear understanding of the patterns and effects of spending in communities with such different levels of poverty and levels of opportunities to learn, efforts to control spending could easily worsen the equity of opportunity to learn and achievement in districts already behind in teacher and school quality. As observed earlier by Fishel (1998), the best of intentions may result in undermining equal educational opportunity for all.

Scholarly Significance

This study contributes to the literature on the relationships among the opportunities that students have to learn the curriculum upon which they are tested and the support that a state system of schools is willing and able to provide students. The appropriate test of adequacy of educational support is one that "levels the playing field" at the level of the individual student. No longer can society afford to retreat behind complex taxation formulae to determine tax equity while students continue to experience the lack of educational resources that is their birthright in a democracy. The study findings are presented to enable policy makers to think about how the patterns of school spending might be related to longer term outcomes for generations of students. A visual representation of these relationships matches the testimony of school administrators, students, teachers and citizens involved in the governance of schools. The study's findings add to the literature that supports the hypothesis that the effects of investment in education at the student level may be cumulative and related to both skill development in reading and mathematics,

opportunities to learn, and, in longer term, outcomes like graduation and employment prospects. It also provides a methodology for examining the relationships between spending and outcomes which may enable states to develop clearer profiles of districts that are able to spend more or less per-pupil on instruction and achieve better outcomes than other districts. Closer examination of outlier schools and districts that provide higher levels of opportunity to learn at a lower rate of investment, particularly in high poverty areas, should be the next phase of this research. There is also an urgent need for renewed measurement of opportunities to learn, and for deeper, multilevel analyses incorporating data at the level of individuals, schools, and local educational agencies.

Appendix: Descriptive Statistics and Regression results

DESCRIPTIVE STATISTICS FOR VARIABLES IN REGRESSION MODEL

	Grade 4 (n = 60)	Grade 8 (n = 60)	Grade 10 (n = 58)
OTL Scale mean			
Mean	3.42	3.05	2.98
SD	0.15	0.13	0.15
% Met math standard			
Mean	52.52	43.46	40.98
SD	14.06	12.99	10.56
% Male			
Mean	50.38	51.31	50.96
SD	5.97	5.29	5.76
% Nonwhite			
Mean	3.64	3.69	4.18
SD	3.51	3.19	3.80
% Free / reduced lunch			
Mean	28.44	23.84	16.60
SD	12.91	11.00	10.20
Per Pupil Spending (all grades)			
Mean	11,330	11,330	11,340
SD	1,279	1,279	1,298

For percent nonwhite, n = 59 in grade 8; n = 54 in grade 10.

STANDARDIZED REGRESSION COEFFICIENTS ON PERCENT MEETING OVERALL MATHEMATICS STANDARD, WITH PER PUPIL SPENDING

	Grade 4 (n = 60)	Grade 8 (n = 59)	Grade 10 (n = 54)
OTL (mean)	.47***	.38***	.35*
% Male (mean)	-.16	.01	.03
% Non-white (mean)	.05	-.07	-.00
% Free / Reduced Lunch (mean)	-.44***	-.58***	-.26
Per Pupil Spending (mean)	.19	.25**	-.42
Model R square	.42	.56	.27

* $p < .05$

** $p < .01$

*** $p < .001$

STANDARDIZED REGRESSION COEFFICIENTS FOR PERCENT MEETING OVERALL MATH STANDARD, WITH TEACHER SALARY EXPENDITURE

	Grade 4 (n = 60)	Grade 8 (n = 59)	Grade 10 (n = 54)
OTL (mean)	**.43****	**.27***	.21
% Male (mean)	-.15	.01	.01
% Non-white (mean)	-.03	-.12	-.14
% Free / Reduced Lunch (mean)	**-.34***	**-.46*****	-.12
Mean Teacher Salary Expenditure	.16	.21	**.43****
Model R square	.40	.52	.38

* $p < .05$

** $p < .01$

*** $p < .001$

STANDARDIZED REGRESSION COEFFICIENTS FOR OPPORTUNITIES TO LEARN RATINGS, WITH TEACHER SALARY EXPENDITURE

	Grade 4 (n = 59)	Grade 8 (n = 58)	Grade 10 (n = 54)
% Male (mean)	**-.34****	.21	**-.26***
% Non-white (mean)	-.01	.02	-.05
% Free / Reduced Lunch (mean)	**-.41****	-.01	-.24
Mean Teacher Salary Expenditure	.30	**.44****	**.38***
Model R square	.28	.22	.34

* $p < .05$
** $p < .01$
*** $p < .001$

References

Altemus, V., Taylor, G., Hock, M., Magill, S., Hayes, S., Remick, J., and King, C. (2008). 2008 Report on Act 60 of 1997: An Act Relating to Equal Educational Opportunity: Measuring Equity. Vermont Department of Education.

Barre, D., Derby, D., Ferrara, J., James, B., King, C., Meyers, B., Reedy, B., Talbott, B., Thomas, P. (2001). The Equal Educational Opportunity Act: Measuring Equity. Vermont Department of Education.

Burstein, L. & McDonnell, L., Van Winkle, J., Ormseth, T., Mirocha, J. & Guiton, G. (1995) Validating National Curriculum Indicators. Santa Monica, CA: RAND Corp. Available at: http://www.rand.org/pubs/monograph_reports/2007/MR658.pdf

Costrell, R. (2007). The winning defense in Massachusetts. School money trials, a legal of educational adequacy. P. Peterson, West, M. Washington, D.C., Brookings Institute**:** 278-304

Brigham v. State, 692 A.2d 384 (Vt. 1997) Vermont Supreme Court, (1997). Amanda BRIGHAM, et al. v. STATE of Vermont., State of Vermont. **No. 96 502.**

Fishel, W. A. (1998). School finance litigation and property tax revolts: How undermining local control turns voters away from public education. Cambridge, MA: The Lincoln Institute of Land Policy.

Foote, K. & Lynch, M. (2000). The Geographer's Craft Project, Department of Geography, The University of Colorado at Boulder. http://www.colorado.edu/geography/gcraft/notes/intro/intro.html

Greenwald, R., Hedges, R., and Laine, R. (1996). "The effect of school resources on student achievement." Review of educational research **66**(3): 361-396.

Hanushek, E. (1997). "Assessing the effects of school resources on student performance: An update." American educational research association **19**(2): 141-164.

Hanushek, E. (2007). The alchemy of "costing out" an adequate education. School money trials, the legal pursuit of educational adequacy. M. a. P. West, P. Washington, D.C., Brookings Institution Press**:** 77-101.

Jenks, George F. 1967. "The Data Model Concept in Statistical Mapping", International Yearbook of Cartography 7: 186-190.

Killeen, K. (2012). Educational Productivity and Opportunities to Learn: An overview of concepts and discussion points. Issue Brief. James M. Jeffords Center. 2(3) http://www.uvm.edu/~jeffords/reports/pdfs/Issue%20Brief_Educational%20Productivity%20and%20Opportunities%20to%20Learn.pdf

Meyers, H. (2012) Student mobility and opportunity to learn: Money Matters. Issue Brief. James M. Jeffords Center. 1(2) http://www.uvm.edu/~jeffords/reports/pdfs/Student_Mobility_Opportunity_to_Learn.pdf

Morgan, A. (2005) Student Mobility in Vermont Schools: A Multilevel Evaluation of Education Equity (Doctoral dissertation). University of Vermont, Burlington, VT.

Odden, A. (1990). "Class size and student achievement: Research-based policy alternatives." Educational Evaluation and Policy Analysis **12**(2): 213-227.

National Research Council. (2014). *Developing Assessments for the Next Generation Science Standards*. Committee on Developing Assessments of Science Proficiency in K-12. Board on Testing and Assessment and Board on Science Education, James W. Pellegrino, Mark R. Wilson, Judith A. Koenig, and Alexandra S. Beatty, *Editors*. Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press. P. 6-1.

Paik, S., & Phillips, R. (2002). Student mobility in rural communities: What are the implications for student achievement? : North Central Regional Educational Laboratory. Retrieved February 29, 2004 from NCREL Web site: http://www.ncrel.org/policy/pubs/html/mobile/effect.htm

Rebel, M. (2002). America's schools: providing equal opportunity or still separate and unequal? Health, Education, Labor and Pensions. Washington, D.C., Campaign for Fiscal Equity, Inc.**:** 12.

Remsen, N. (2014). "Forum addresses Vermont's education funding formula". http://www.burlingtonfreepress.com/article/20140114/NEWS03/301140021/Forum-address

Rogers, J.D. & Meyers, H. (2013). Teacher Salaries and Opportunities to Learn. Issue Brief. The James M. Jeffords Center. 3(3). http://www.uvm.edu/~jeffords/reports/pdfs/Teacher%20Salaries%20and%20Opportunities%20to%20Learn.pdf

Rumberger, R., Larson, K., Ream, R., & Palardy, G. (1999). The educational consequences of mobility for California students and schools (Research Series 99-2). Berkeley, CA: Policy Analysis for California Education: University of California, Berkeley & Stanford University.

Serrano v. Priest, 487 P.2d 1241, 96 Cal. Rptr. 601 (1971) ("Serrano I"); 557 P.2d 929, 135 Cal. Rptr. 345 (1976) ("Serrano II")

Wenglinski, H. (1998). "Finance equalization and within-school equity: The relationship between education spending and the social distribution of achievement." Educational Evaluation and Policy Analysis, **20**(4): 269-283.

Woolf, A. & Heaps, R. (2012). The Local Impacts of Vermont's Education Finance System.Westford, VT: Northern Economic Consulting, Inc.