Washington State Institute for Public Policy

110 Fifth Avenue Southeast, Suite 214 • PO Box 40999 • Olympia, WA 98504-0999 • (360) 586-2677 • www.wsipp.wa.gov

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K–12 Education Spending and Student Outcomes: *A Review of the Evidence*

Does spending more taxpayer money on K–12 education improve student outcomes?

There has been a long-standing academic debate on this central public policy topic, and the question continues to be relevant for Washington in light of a recent court decision. In 2012, the State Supreme Court ruled unanimously in *McCleary v. State of Washington* that the "State has not complied with its [constitutional] duty to make ample provision for the education of all children in Washington."[1]

The Washington State legislature has recently enacted several reforms that will affect the total amount of funding and the way funds are allocated to school districts.[2] While there has not yet been a determination on the specific amount of increased resources needed to comply with the Court's ruling, one preliminary estimate indicates that, by 2018, the state may need to increase its share of K–12 expenditures by 20%.[3]

If K–12 spending is increased, is there reason to believe that student outcomes will improve and, if so, by how much?

To analyze this question, the Washington State Institute for Public Policy (Institute) reviewed the research evidence.[4] This report is organized in two sections. First, as background, we summarize long-term trends in public K–12 expenditures. Second, we highlight the findings of our evidentiary review of the relationship between K–12 per-pupil expenditures and student outcomes. The technical appendix provides details on the results.

[1] http://www.courts.wa.gov/opinions/pdf/843627.opn.pdf

[2] For a summary of the legislation, see: "Report to the Washington State Supreme Court by the Joint Select Committee on Article IX Litigation" http://www.leg.wa.gov/Senate/Committees/WM/Documents/Report% 20to%20Supreme%20Court%20with%20Date%20Stamped %20Cover%20Letter.pdf

[3] Communication with legislative fiscal staff. A 20% increase in state funding translates to roughly a 13% increase in total per-pupil funding, assuming local and federal funding remains constant.

[4] Since 2006, the legislature has directed the Institute to study "the cost-benefits of various K–12 educational programs and services." This research is part of that ongoing work.

Summary

The Washington State Institute for Public Policy updated its findings on a key public policy question for the Washington State legislature: does spending more money on the K–12 school system lead to better student outcomes?

To investigate, we conducted a systematic review of research by collecting all studies we could find on the topic. We screened for scientific rigor and, for our analysis, only included those studies with the strongest research designs. Most studies were from the United States, while some were from other industrialized countries. We identified 40 credible evaluations of whether K–12 per-pupil expenditures have a cause-and-effect relationship with student outcomes.

The student outcomes measured by these 40 studies include scores on standardized math or reading tests and high school graduation rates. Policymakers, understandably, want schools to produce other outcomes as well, but test scores and school completion are most often measured in the existing research literature.

Our review produced two main findings. First, the weight of the evidence indicates that, on average, there is a positive relationship between K–12 per-pupil expenditures and student outcomes. Second, the effect appears to be stronger in lower school grades than in upper grades.

Next steps. In an upcoming Institute report, due July 2013, the magnitude of this effect will be compared with other educational policy options under consideration in Washington State. We will apply the Institute's standard benefit-cost model to estimate the relative cost-effectiveness of evidence-based policy options, including general increases in expenditures and those focused specifically on improving overall teaching effectiveness.

Suggested citation: Aos, S. & Pennucci, A. (2012). *K–12 Education Spending and Student Outcomes: A Review of the Evidence.* (Document No. 12-10-2201). Olympia: Washington State Institute for Public Policy.

I. Trends in K–12 Education Per-Pupil Expenditures

As background, we provide an historical overview of K–12 per-pupil public expenditures in Washington and the United States. The expenditure data reflect public K–12 operating expenditures from all revenue sources (local, state, and federal).[5]

Exhibits 1 and 2 display two "big-picture" ways to view long-term trends in K–12 expenditures.

In Exhibit 1 we plot inflation-adjusted K–12 per-pupil expenditures for Washington State since 1950. Per-pupil expenditures grew considerably in the post-World War II era. In 2011 dollars, expenditures increased from about $1,900 per student in school year 1949–50 to about $10,700 in 2010–11. Thus, even after accounting for the general rate of inflation, taxpayers spend over five times as much per pupil today as in 1950.[6]

In Exhibit 2 we show Washington's K–12 per-pupil expenditures relative to those for the United States as a whole. In the 1950s, Washington spent about 15% more per student than the average state, while in 2008-09, the most recent year data are available, Washington spent about 7% less per student than other states, on average.

Overall, the long-term trend data reveal that inflation-adjusted per-pupil spending in Washington State has increased during the last six decades, but the rate of increase in Washington has been lower than in most other states.

Exhibit 1
K–12 Per-Pupil Expenditures in Washington
1949-50 to 2010-11
(inflation-adjusted 2011 Dollars)

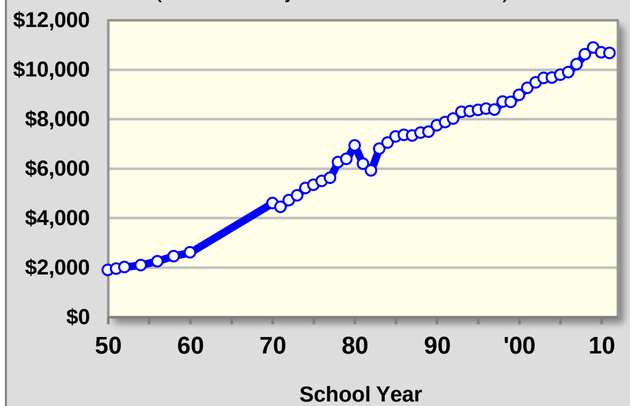
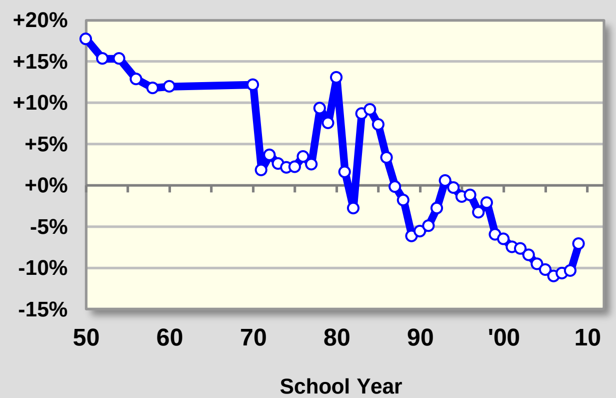


Exhibit 2
Washington K–12 Spending Relative to All States
1949-50 to 2008-09
(Ratio of Per-Pupil Expenditures: WA divided by US)



Note: We were not able to locate consistent historical data for all years. The data points with a circle show consistently-defined actual data, while the solid lines are linear interpolations between the actual data points. In Exhibit 1, data for school years 2009-10 and 2010-11 are estimates. See footnote 5 for more information on data sources.

[5] U.S. Department of Education, National Center for Education Statistics. *Digest of Education Statistics* (annual publications). The latest NCES data are for 2008-09. For Exhibit 1 we estimated later years with data from the Washington Office of Superintendent of Public Instruction. All expenditure data reflect operating costs only.

[6] The inflation-adjusted dollar figures shown in Exhibit 1 are expressed in 2011 dollars using the U.S. Implicit Price Deflator for Personal Consumption Expenditures—the same index used by the Washington Economic and Revenue Forecast Council. We also computed real expenditures using the U.S. Consumer Price Index for Urban Consumers. For the purpose of displaying the long-term trends shown in Exhibit 1, the choice of inflation index makes relatively little difference. Another type of adjustment is a comparable wage index that reflects how much a dollar can purchase in local labor markets. For an earlier Institute analysis using a comparable wage index, see Aos, S. Miller, M. & Pennucci, A. (2007). *Report to the Joint Task Force on Basic Education Finance: School Employee Compensation and Student Outcomes.* (Document No. 07-12-2201). Olympia: Washington State Institute for Public Policy.

II. Per-Pupil Spending & Student Outcomes

The primary purpose of this report is to present an estimate of the degree to which student outcomes are affected by the level of K–12 expenditures. That is, does money matter?

This research question has been an active and controversial topic for over four decades.[7] In recent years, a number of new studies have been published using improved data and advanced statistical methods. To investigate the question of whether money matters, we conducted a systematic review of the research by collecting all studies we could find on the topic. Most studies were from the United States while some were from other industrialized countries. In our synthesis of the literature, we included studies with the strongest research designs, and excluded studies with weaker methods.[8]

It is important to note that this study is not an evaluation of how per-pupil expenditures in Washington State have affected student outcomes. Rather, this analysis uses the best national and international research to provide insights into the likely relationship in Washington.

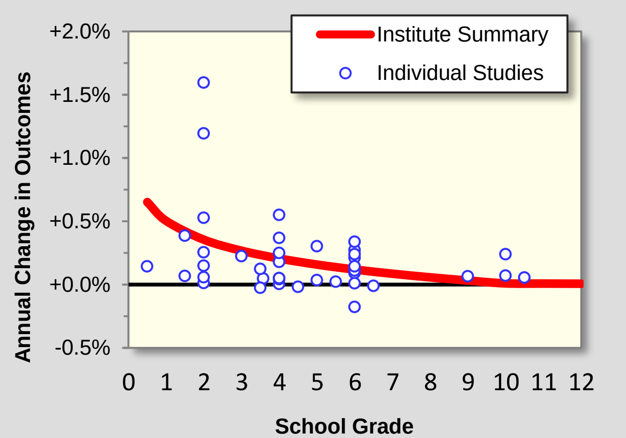
The studies included in our review estimate the relationship between student outcomes and expenditures in school funding systems. In the United States, about 80% of K–12 operating expenditures are spent on school employees.[9] Most of these employees, particularly teachers, are paid via a "single salary schedule."[10] A single salary schedule compensates school employees based on two factors: years of experience in the system and graduate degrees or credits earned. Some states, such as Washington, use a statewide salary schedule to distribute funds to districts; districts then use the same, or a separately negotiated, salary schedule to set pay levels for teachers. Since most school systems use some version of this type of funding structure, most studies in our systematic review provide estimates of how student outcomes are affected by expenditures delivered via a standard funding structure. As noted, Washington is reforming the way state resources are distributed to school districts. Whether these funding reforms will change the basic relationship we identify in this report remains to be tested.

We found 40 credible evaluations of the degree to which K–12 per-pupil expenditures have a cause-and-effect relationship with student outcomes. The outcomes measured include standardized test scores, high school graduation rates, and dropout rates. Policymakers, understandably, want schools to produce other outcomes as well, but test scores and school completion are the outcomes most often measured in the existing research literature.[11]

Our review produced two main findings. First, the weight of the evidence indicates that, on average, per-pupil expenditures are related to student outcomes. Second, the effect appears to be stronger in lower school grades than in upper grades.

Exhibit 3 displays the main findings. In the Exhibit, the effect from each of the 40 studies in our review is plotted as a circle, while our statistical summary is the solid red line.

Exhibit 3
Example: How a 10% Increase in Per-Pupil Expenditures Leads to an Annual Change in Student Outcomes
(results from a review of high quality studies, N=40 effects)



[7] See, for example, the debate summarized in: G. Burtless (Ed.) (1996). *Does money matter? The effect of school resources on student achievement and adult success.* Washington, D.C.: Brookings Institute Press. Classic papers in this debate include: Hanushek, E.A. (1997). "Assessing the effects of school resources on student performance: an update." *Educational Evaluation and Policy Analysis*. *19*(2), 141-64; and Hedges, L., Laine, R. & Greewnwald, R. (1994). "An exchange, part I: does money matter? A meta-analysis of studies of the effects of differential school inputs on student outcomes." *Educational Researcher*, *23*(3), 5-14.

[8] The Institute's approach to conducting meta-analyses is described fully in: Lee, S., Aos, S., Drake, E., Pennucci, A., Miller, M., & Anderson, L. (2012). *Return on investment: Evidence-based options to improve statewide outcomes, Technical Appendix Methods and User-Manual, April 2012* (Document No. 12-04-1201B). Olympia: Washington State Institute for Public Policy.

[9] U.S. Department of Education, National Center for Education Statistics. *2006 Digest of Education Statistics.* (2011). Table 188: http://nces.ed.gov/programs/digest/d11/tables/dt11_188.asp

[10] Harris, D. (2007). *The promises and pitfalls of alternative teacher compensation approaches.* Madison: Wisconsin Center for Education Research, University of Wisconsin, p. 5.

[11] Duncan, G. J. & Magnuson, K. (2011). The nature and impact of early achievement skills, attention skills, and behavior problems. In G. J. Duncan & R. J. Murnane (Ed.), *Wither opportunity? Rising inequality, schools, and children's life chances*. New York: Russell Sage Foundation, pp. 47–69.

The relationship displayed is what economists call an "elasticity"—how, for example, a 10% change in per-pupil spending leads to an annual percentage change in student outcomes.

There is variation in the individual estimates from this group of studies; some show that spending has a larger effect on student outcomes while other studies show no effect. Our summary measure (the red line in Exhibit 3) is a weighted average of all of the studies—a "best estimate" drawn from all of the most credible research to date.

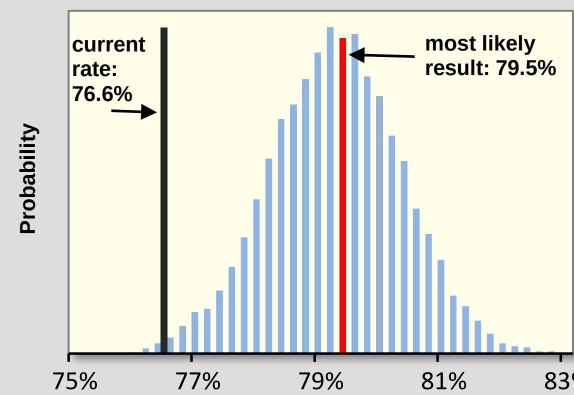
What is the practical magnitude of the results? The relationship can be interpreted more intuitively by focusing on a specific outcome such as high school graduation.

The current "on-time" high school graduation rate in Washington is 76.6%.[12] Thus, for an incoming kindergarten class, if everything else stays the same, we would predict 76.6% of the kindergartners will graduate from high school 13 years later.

If K–12 per-pupil expenditures were increased across the board by, for example, the 10% illustrated in Exhibit 3, then, using the grade-by-grade summary estimates from our review, we would predict that by the time the kindergartners were in twelfth grade, 79.5% of them would graduate from high school that year. This result indicates that a 10% increase in spending, with all else remaining constant, would produce a long-term 3.7% improvement in graduation rates.[13]

Naturally, all predictions involve risk. We computed a likely margin of error for the high school graduation rate prediction. The range is shown in Exhibit 4. The chart displays the current on-time graduation rate of 76.6% along with the single-point prediction of 79.5% for a 10% increase in per-pupil expenditures. The chart also shows the relative likelihood of that prediction given the risk in our estimates. We ran our analysis 10,000 times; while the average prediction was 79.5%, in some cases the graduation rate increased to over 81%, and in a few cases it was up only slightly from current levels.[14]

Exhibit 4
Predicted On-Time High School Graduation Rate for Incoming Kindergartners with a 10% Increase in K–12 Per-Pupil Expenditures
Results from a simulated risk analysis



III. Next Steps: Return on Investment

The research presented in this report is part of a larger Institute study examining a wide array of policies to increase Washington's high school graduation rate.[15] The Institute's final report on this topic will be completed by July 2013. The project will apply the Institute's standard benefit-cost model to estimate the relative cost-effectiveness of different combinations of policy options, including those aimed at improving teaching effectiveness. The Institute has previously found that policies focused on enhancing teaching effectiveness can have large impacts on student achievement.[16]

As the Legislature continues to reform K–12 education, this information may be helpful in crafting a set of evidence-based policies that use taxpayer dollars efficiently to improve student outcomes in Washington.

[12] Dorn, R. (2012). *Graduation and dropout statistics annual report 2010-11*. Olympia: Washington State Office of Superintendent of Public Instruction.

[13] The magnitude of our estimated high school graduation elasticity, 3.7%, is consistent with the range of elasticities found in Loeb & Page (2000), a widely cited study which estimated a K–12 dropout/graduation elasticity between 3.0% and 4.0%.

[14] For technical readers, we conducted a Monte Carlo simulation using the from our preferred regression equation discussed in this report's Technical Appendix.

[15] This project is funded by the MacArthur Foundation and was approved by the Institute's Board of Directors.

[16] Aos et al., 2007.

Meta-Analysis

If K–12 spending is increased, is there reason to believe that student outcomes will also increase and, if so, by how much? To analyze this policy question, the Washington State Institute for Public Policy conducted a systematic review of research evidence. We gathered all the studies we could locate on the topic; most were from the United States while some were from other industrialized countries. We screened the studies for scientific rigor and, for our analysis, only included those with the strongest research designs. Based on this body of research, we then estimated the expected effect of K–12 per-pupil expenditures (PPE) on measured student outcomes.

Most research literature on the effect of school expenditures on student outcomes uses an econometric estimation of a production function. Typically, these regressions use a continuous variable representing expenditures per pupil to predict either continuously measured test scores or dichotomously measured graduation rates. The coefficients from these studies can usually be expressed as elasticities. An elasticity measures how a percentage change in one variable leads to a percentage change in another variable. For this study, we calculated an elasticity measuring the degree to which a 10% change in expenditures leads to a percentage change in student outcomes.

For each study included in our review of the literature, we computed an elasticity from each author's preferred regression coefficients. We also collected information from each study that allowed us to: (a) calculate an inverse variance weight, and (b) impute an intra-class correlation to account for clustering levels contained in this wide array of studies.

Since the development of human capital can be viewed as a multi-year process, and since the studies in our review estimated elasticities that cover different grade intervals between measured outcomes and prior outcomes, we standardized each study's elasticity. For each study, we calculated an *annualized* elasticity that, when applied to the number of investment years measured in the study, would reproduce the study's total elasticity. The annualized elasticity is calculated as:

$AnnElas_s = (1+Elas_s)$^$^{(1/Nper_s)}$ $- 1$,

where for each study, *s*, an annualized elasticity for a 10% change in per pupil spending, $AnnElas_s$, is computed as one plus the elasticity measured in the study, $Elas_s$, raised to one divided by the number of annual K–12 investments included in the study, $Nper_s$, minus one.

$Nper_s = OutcomeGrade_s – PriorOutcomeGrade_s$,

where the number of annual investments included in a study, $Nper_s$, is the difference between the grade at which the outcome is measured in the regression's dependent variable, $OutcomeGrade_s$, and the grade of a prior outcome included as a covariate in a study's regression, $PriorOutcomeGrade_s$. If no prior outcome is included in a study's production function (i.e., if it is not a "value added" production function), then $PriorOutcomeGrade_s$ is set to zero.

We meta-analyzed the annualized elasticities for this group of studies using an inverse-variance random effects model.[17] The meta-analysis included 40 effects from 33 separate studies. Some studies measured two outcomes. If a study measured both reading and math test scores at the same grade level, we averaged the two effect sizes to minimize problems of independence of observations. The citations to the studies included in our review are listed on page 8.

Our meta-analytic result is an annualized elasticity of .0022 with a standard error of .0006. As an illustration of the magnitude of this average annual effect, if the annualized elasticity is applied to 13 years of K–12 spending, then the elasticity for high school graduation would be 0.29 [=((1+.0022)^13)-1]. That is, a 10% increase in PPE applied to a kindergarten class and for twelve subsequent years would increase the cohort's high school graduation rate by 2.9%.

Next, to analyze this basic meta-analytic finding in greater detail, we conducted a regression analysis of the 40 annualized elasticities. We were particularly interested in testing whether results were stronger in lower grades than in upper grades. In the regressions, we controlled for: (a) the average grade level measured in each study—a study's annualized elasticity was coded at the mid-point of its *Nper* range; (b) whether the study used instrumental variables estimation (coded 1)—the remaining studies typically used fixed effects models or value-added multivariate specifications (coded 0); (c) the type of outcome measured—a dummy-coded variable was created for high school graduation (coded 1) or standardized test scores on math or reading (coded 0); and (d) whether the study was from the United States (coded 1) or elsewhere (coded 0). The inverse variance weights from the random effects meta-analysis were used in weighted ordinary least squares regression (WLS). We also tested our models without weighting.

Exhibit T1 shows the regression results. The constant-only models (model 1) for both the unweighted and weighted models are quite similar, and produce 13-year elasticities around 3%, meaning a 10% change in spending leads to a long-term gain in outcomes of 3%. In Model 2, the natural log of the grade level was added. In Model 3, we estimated models with a first order and second order polynomial on the grade variable. In Models 4 and 5, we added the other study characteristics. Our preferred specification is the weighted version of model 4. This elasticity (0.37) is within the range estimated by Loeb & Page (2000), a widely cited study, which identified a K–12 elasticity between 0.30 and 0.40.

[17] The Institute's approach to conducting meta-analyses is described fully in: Lee et al., 2012.

Exhibit T1
Regression Results from the Meta-Analysis
(dependent variable = annualized elasticities)

Specification	OLS (Unweighted)					Weighted Least Squares				
	Coef	SE	t	p-value	Computed 13-yr. Elasticity	Coef	SE	t	p-value	Computed 13-yr. Elasticity
Model 1					2.7%					2.9%
Constant	0.020	0.005	4.071	0.000		0.022	0.006	3.342	0.002	
Model 2					2.4%					2.6%
Constant	0.041	0.017	2.419	0.020		0.053	0.024	2.196	0.034	
LOG(GRADE)	-0.015	0.010	-1.595	0.119		-0.022	0.014	-1.628	0.112	
Model 3					2.7%					3.1%
Constant	0.056	0.026	2.153	0.038		0.073	0.036	2.000	0.053	
GRADE	-0.012	0.008	-1.488	0.145		-0.018	0.012	-1.555	0.129	
GRADE^2	0.001	0.001	1.303	0.201		0.001	0.001	1.454	0.155	
Model 4					4.2%					3.7%
Constant	0.031	0.012	2.520	0.016		0.043	0.017	2.495	0.017	
LOG(GRADE)	-0.015	0.008	-1.767	0.086		-0.021	0.012	-1.760	0.087	
IV	0.018	0.011	1.650	0.108		0.014	0.012	1.198	0.239	
HSGRAD	0.001	0.008	0.163	0.871		0.001	0.012	0.096	0.924	
US	0.003	0.007	0.369	0.714		0.002	0.009	0.210	0.835	
Model 5					4.9%					4.8%
Constant	0.050	0.022	2.242	0.032		0.070	0.032	2.198	0.035	
GRADE	-0.014	0.008	-1.664	0.105		-0.020	0.011	-1.711	0.096	
GRADE^2	0.001	0.001	1.503	0.142		0.001	0.001	1.603	0.118	
IV	0.018	0.011	1.637	0.111		0.013	0.011	1.169	0.250	
HSGRAD	0.006	0.008	0.795	0.432		0.008	0.011	0.732	0.469	
US	0.001	0.007	0.113	0.910		-0.002	0.008	-0.224	0.824	

There are 40 observations in each regression; each observation is an annualized elasticity so that 1.0 equals a 10% change in outcome from a 10% change in spending. We use White heteroskedasticity-consistent standard errors. The computed 13-year elasticity for each model is for a 10% change in per-pupil expenditures for an incoming kindergarten class by the time the class finishes 13 years of K–12 education. The weights used in WLS are the inverse variance weights from the random effects meta-analysis of the 40 studies.

Computation of Cumulative End-of-High-School Elasticties

As described, in the meta-analysis the elasticties from the studies in our review were converted to *annualized* elasticites. We computed the cumulative effect after 13 years of K–12 education using the following procedure:

GR_0 = *Expected high school graduation rate for incoming kindergarten class*
TS_0 = *Expected average 10th grade test score for incoming kindergarten class*

For each grade level, *g*, from kindergarten to 12th grade, we calculated the cumulative elasticity as follows:

$$GR_g = GR_{g-1} + (GR_{g-1} * PPE\%\Delta_g * AnnElas_g)$$
$$TS_g = TS_{g-1} + (TS_{g-1} * TSdecay_g * PPE\%\Delta_g * AnnElas_g)$$

where,

$PPE\%\Delta_g$ = the percentage change in per-pupil expenditures at each grade level; and
$TSdecay_g$ = the degree to which a test score gain at grade *g* fades out by the end of high school. The Institute conducted an analysis of program evaluations with longitudinal test score data to estimate fade-out.[18]

[18] Lee et al., 2012. Our results are similar to those found in other analyses of test score fade out. See, e.g., Leak, J., Duncan, G., Li, W., Magnuson, K., Schindler, H., & Yoshikawa, H. (2010, November). *Is timing everything? How early childhood education program impacts vary by starting age, program duration, and time since the end of the program.* Paper prepared for presentation at the meeting of the Association for Policy Analysis and Management, Boston, MA; Camilli, G., Vargas, S., Ryan, S., & Barnett, W. S. (2010). Meta-analysis of the effects of early education interventions on cognitive and social development. *Teachers College Record*, *112*(3), 579-620; Goodman, A. & Sianesi, B. (2005). Early education and children's outcomes: How long do the impacts last? *Fiscal Studies*, *26*(4), 513-548.

Institute Analysis of NAEP and CCD Data

One of the studies included in the meta-analysis reported in this paper is the Institute's own analysis of student outcomes and per-pupil expenditures, not previously published. Using state-level data, we estimated models with the following form:

O = f(PPE, X, S, T, e), where

O represents a student test score or graduation outcome; *PPE* is the per-pupil expenditures described below; *X* is a vector of covariates on basic teacher characteristics; *S* is a state fixed effect; *T* is a time fixed effect; and *e* is the error term. We were unable to identify a plausible instrumental variable to use with this dataset.

We collected a balanced panel of state-level data from the National Assessment of Educational Progress (NAEP) for 4^{th} and 8^{th} grade reading and math scale scores, and from the Common Core of Data (CCD), state-level on-time high school graduation rates, teacher education and experience characteristics, and per-pupil expenditures. The NAEP scores are for 2003, 2007, and 2009. The high school graduation rates include 2002 through 2009. The CCD expenditure data were available through 2008–09.

Per-pupil expenditures were inflation-adjusted using the Implicit Price Deflator (IPD) for personal consumption expenditures. For 4^{th} grade outcomes, we used the average expenditures and teacher characteristics for the prior four years; for 8^{th} grade outcomes, the prior eight years; and for high school graduation rates, the prior 12 years. We took the natural logarithms of the dependent variables and the expenditure variables so that the coefficient can be read directly as an elasticity.

We conducted an ordinary least squares regression analysis with and without state and time fixed effects. All regressions were estimated with White heteroskedasticity-consistent robust standard errors.

	4^{th} Grade Test Scores				8^{th} Grade Test Scores				High School Graduation	
Independent Variables	ln(reading)		ln(math)		ln(reading)		ln(math)		ln(graduation rate)	
C	4.7476 (0.1352)	4.9544 (0.232)	4.8854 (0.1186)	4.9704 (0.2343)	5.1267 (0.134)	5.4116 (0.1597)	5.0545 (0.1611)	5.2948 (0.2005)	2.7354 (0.3726)	0.6552 (0.2005)
Ln(per-pupil expenditures)	**0.0331** (0.0187)	**0.0598** (0.0252)	**0.0378** (0.0176)	**0.0596** (0.026)	**0.0289** (0.0149)	0.0276 (0.0169)	**0.0476** (0.0191)	**0.0513** (0.0205)	**0.1237** (0.0273)	**0.3279** (0.1511)
% teachers with a master's degree or higher	0.0000 (0.0002)	-0.0004 (0.0004)	**-0.0003** (0.0002)	0.0001 (0.0004)	-0.0002 (0.0002)	0.0001 (0.0002)	**-0.0006** (0.0002)	-0.0003 (0.0003)	**-0.0034** (0.0004)	0.0011 (0.0013)
% teachers with 3-9 years of experience	0.0042 (0.0026)	-0.0011 (0.0013)	0.0034 (0.0025)	-0.0005 (0.001)	0.0016 (0.0025)	-0.0017 (0.0011)	0.0023 (0.0033)	-0.0013 (0.001)	-0.003 (0.0041)	0.0097 (0.008)
% teachers with 10-20 years of experience	**0.0035** (0.002)	-0.0006 (0.0012)	0.0027 (0.0019)	-0.0002 (0.0008)	0.0027 (0.0019)	-0.0003 (0.001)	0.0021 (0.0025)	-0.0009 (0.0009)	-0.0016 (0.003)	**0.0082** (0.0046)
% teachers with >20 years of experience	**0.0041** (0.0018)	-0.0014 (0.0016)	0.0027 (0.0017)	-0.001 (0.0011)	0.0023 (0.0017)	-0.0014 (0.0009)	0.0017 (0.0023)	**-0.0016** (0.0008)	**0.0035** (0.0028)	0.0064 (0.0067)
State fixed effects?	no	yes	no	yes	no	yes	no	yes	no	yes
Year fixed effects?	no	yes	no	yes	no	yes	no	yes	no	yes
Periods	3	3	3	3	3	3	3	3	8	8
Cross-sections	51	51	51	51	51	51	51	51	51	51
Total obs.	153	153	153	153	153	153	153	153	408	408
R-squared	0.1481	0.9571	0.1198	0.9658	0.1237	0.9703	0.1070	0.9799	0.2967	0.9050

Bolded coefficients are significant at $p < 0.10$. White heteroskedasticity-consistent robust standard errors are in parentheses.

Four of the five expenditure elasticities in our preferred fixed-effects models were statistically significant at $p < 0.10$; the fifth elasticity, eighth grade reading, had a p-value of 0.11. The magnitude of the high school graduation elasticity, 0.3279, is consistent with the range of elasticities found in Loeb & Page (2000), a widely cited study, which estimated a K–12 dropout/graduation elasticity between 0.30 and 0.40.

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WSIPP study, unpublished (2012). We conducted a multi-year, state-level, fixed-effects analysis of NCES data on per pupil expenditures, student test scores, and on-time graduation rates. See the technical appendix in this report for details.

For further information, contact:
Steve Aos at (360) 586-2740, saos@wsipp.wa.gov
Annie Pennucci at (360) 586-3952, pennuccia@wsipp.wa.gov.

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