Trend Analysis of Educational Investments and Outcomes

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Abstract

It is generally expected that funds invested in public instruction will strengthen pupil achievement. Similarly, it is expected that enrollments of young children in preschool education should lead to higher achievement. In a trend analysis, we examined three variables as predictors of grade 8 achievement in 2007: (1) state expenditures per student in 2000, (2) state level percentage of 3 year old and 4 year old children who attended school in 2000, and (3) state level grade 4 achievement scores in 2003. State expenditures per pupil and percent participation in early childhood education at the state level were not significant predictors of grade 8 achievement. Grade 4 achievement explained more than 80 percent of the variance in grade 8 achievement.

On August 7, 2013, Bill Gates made a presentation at the National Governors Association Conference in which he stated what has been known for several years. We have been investing more in public education, measured as per-student achievement, while educational achievement has been flat (Gates, B., 2013). His presentation is based on a graph in which the curve of investment in public education is shown to steadily increase from 1975 to 2007, while both reading and math achievement remained virtually unchanged during the same time period.

Educational Investments

One would expect intuitively that greater investments in education would lead to improvements of several kinds. More investment in the form of bonds and sinking funds can be expected to support building and renovation. Investments in supplies and equipment will support classroom instruction. Educational theorists, advocates, and researchers, would likely postulate that children who are beneficiaries of enriched educational resources will experience greater school success. Thus it is not unreasonable to assume that school achievement should increase as when there are increases in per-pupil expenditures.

The assumption that it is wise to invest in public education is not completely without a base of evidence; however the base of evidence is not completely clear and is somewhat confusing. For example, there is evidence that school spending is associated with school success (Greenwald, Hedges & Laine, 2006; Verstegen & King, 1998). However, there is evidence as well of an inverse association between funding and achievement. Sharp (1993) found a slight negative correlation between spending and achievement at all grades except grade 11 and in all subject matter areas. Other research has suggested that the association of spending with achievement is uncertain (Ludwig & Bassi, 1999).

It is assumed that early childhood education, especially in the form of a well designed and expertly delivered curriculum, can compensate for a variety of deficits and risks that prevent low school achievement. The literature indicates that providing educational resources in the form of effective early childhood education programs can make a difference in achievement in the primary and later grades. This literature can be considered thoroughly established and well documented. These findings have been documented in numerous recent summaries of the literature (Barnett, 2011; Campbell & Ramey, 1994; Magnuson & Waldfogel, 2005; Mervis, 2011).

However, it is important to note that studies of the effects of early childhood education tend to describe the outcomes of unique educational programs, which are designed to achieve specific purposes for particular children. Much of the confidence placed in positive outcomes of early childhood education comes from experimental programs from the 1960s and 1970s (Besharov & Ramey, 2010). Early childhood education outcomes are related to the specific purposes for which programs are designed (Hines, McCartney, Mervis & Wible, 2011). It is important to acknowledge the impact of particular program models (Barnett, 2011). Some programs are designed to improve specific outcomes, such as the executive function in children four to twelve years old (Diamond & Lee, 2011). Clements and Sarama (2011) discuss teaching for early mathematics competence and later mathematics achievement.

There is no doubt that early childhood education can lead to higher achievement for particular children who experience a specific form of curriculum intervention in a particular context. However, is it to be expected that all early childhood education will boost later achievement? A series of large-scale experimental studies, perhaps varying both curriculum approaches and distinct groups of participating children, might demonstrate what has already been thoroughly documented – that when particular curriculum interventions are matched with particular groups of children, the outcomes are predictably good. This approach would not resolve the question of whether the level of early childhood education investment at the state level will predict educational outcomes.

State Level Analysis of Educational Investments and Outcomes

There is much variation across states, both in the provision of educational resources to children and in educational outcomes. Considerable attention is paid to describing state-level differences in educational inputs (National Center for Educational Statistics, 2004) and outputs (National

Center for Educational Statistics, 2012). Tabular presentation of input and output data encourage ranking of state with regard to a variety of indicators and metrics. The National Education Association ranks states on many indicators (National Education Association, 2013), as does the American Legislative Exchange Council (2013). *Education Week* (2013) announced the availability of "Quality Counts", a report on state educational policy and outcomes.

When states are ranked, profiles of strengths and deficits become more evident. Presumably policy makers in states that are ranked low will be motivated to address ways of optimizing educational issues and seek higher rakings. They may decide to make more substantial investments in educational inputs with the goal of boosting educational achievement. The problem is, as Mr. Gates has observed, the curve of educational achievement may continue to be flat.

Method

The analysis presented in this paper provides evidence in support of Mr. Gates' assertion about the relationship between educational investment and outcomes. It also expands the analysis to include early childhood education, which is a form of investment. A trend analysis is used in this study. While trend studies can be limited due to the use of data from samples at different points in time (Wimmer &Dominick, 2011), the method can be useful for considering patterns of overall stability and change over time across different samples. Trend analysis is used in epidemiologic research (Rosenberg, 1997). It can also be useful for educational policy research for identifying existing patterns. It can provide a broad perspective of aggregate demographic and geographic data over a period of several years. This is not possible through the use of case studies, which involve special selection of particular child participants and/or are based on particular expressions of curriculum concepts, thus limiting generalizability. Thus, in this analysis we examine whether per pupil expenditures or participation in early childhood education predict eighth grade academic achievement, along with a third predictor – achievement at the elementary level.

This analysis makes use of existing public state-level summary data for 50 states. The state is the unit of analysis. Individual pupil data were not analyzed. The following variables were used in this analysis.

- Percentage of 3 year old and 4 year old children in 2000 who attended school (United States Census Bureau, 2000)
- State per pupil expenditure in 2000 (National Center for Education Statistics, 2012a).
- State level average National Assessment of Educational Progress (NAEP) average grade 4 reading scale scores in 2003 (National Center for Educational Statistics, 2012b)
- State level average NAEP grade 4 mathematics scale scores in 2003 (National Center for Educational Statistics, 2012b)
- State level average NAEP grade 8 reading scale scores in 2007 (National Center for Educational Statistics, 2012b)
- State level average NAEP grade 8 mathematics scale scores in 2007 (National Center for Educational Statistics, 2012b).

Results

Descriptive statistics were computed, and two regression models were examined: a model of reading achievement and a model of mathematics achievement. SPSS Version 21 was used to examine reading and math models.

- *Per-Pupil Expenditures.* There was substantial variability in state level per pupil expenditures for instruction in the year 2000. The range was $4,378 to $10,337 per pupil. The mean was $6,779 (SD = $1,311).
- *Percentage of 3- and 4-Year Olds Enrolled in School*. Likewise, there was considerable variation in state level percentage of 3 and 4 year olds enrolled in school in the year 2000. The lowest percentage was 34.4, and the highest was 63.2. The mean percentage was 47.5 (SD= 6.73).
- *NAEP 2003 Grade 4 Reading.* The range of state level NAEP grade 4 reading achievement in year 2003 was from 203.0 to 228.0. The mean was 218.02 (SD = 6.45).
- *NAEP 2003 Grade 4 Math.* The range of state level NAEP grade 4 math achievement in year 2003 was from 223.0 to 243.0. The mean was 234.5 (SD = 5.41).
- *NAEP 2007 Grade 8 Reading.* The range of state level NAEP grade 8 reading achievement in year 2007 was from 250.0 to 273.0. The mean was 262.48 (SD = 6.27).
- *NAEP 2007 Grade 8 Math*. The range of state level NAEP grade 8 math achievement in year 2007 was from 265.0 to 298.0. The mean was 281.34 (SD = 7.47).

Correlations were computed. There was a relatively low correlation between per-pupil expenditure and grade 8 math ($r = .31$, $n = 50$, $p = <.05$). Likewise, there was a similarly low correlation between per-pupil expenditures and grade 8 reading ($r = .35$, $n = 50$, $p = <.05$). The correlation of enrollment of young children in school and grade 8 math is not significant ($r = .06$, $n = 50$, $p = >.05$). Likewise, the correlation between enrollment of young children in school and grade 8 reading is not significant ($r = .11$, $n = 50$, $p = >.05$).

Closer examination of the data provides insights into these low correlations. For example, New Jersey spent $10,337 per pupil in 2000 and had an average NAEP Grade 8 math score in 2008 of 292. New Jersey spent $5,667 per pupil in 2000 and had an average NAEP Grade 8 math score in 2008 of 289. Thus a difference of almost $5,000 resulted in a difference of only 3 points. And for New Jersey's investment of $10,337 per pupil in 2000, the NAEP Grade 8 reading score in 2008 was 270. For an investment of $5,632 per pupil in 2000, South Dakota also had an average NAEP Grade 8 reading score in 2008 of 270. Thus a difference of almost $5,000 resulted in no difference in NAEP reading score.

It is useful to consider also the following examples regarding early childhood education. In North Dakota, in 2000 only 34.4 percent of young children were in school. The average NEAP math score was 292. New Jersey had 63.2 percent of young children in school in 2000, yet in 2007 the New Jersey NAEP Grade 8 math average score was 289 – lower than North Dakota. Similarly, In South Dakota in 2000, only 39.9 percent of young children were in school. The

average NEAP reading score was 270. While New Jersey had 63.2 percent of young children in school in 2000, in 2007 the New Jersey NAEP Grade 8 reading average score was 270 – the same as South Dakota.

A multiple regression analysis was conducted to predict NAEP 2007 grade 8 reading scores from the following variables: (1) per pupil expenditures in 2000, (2) percentage of 3 year old and 4 year old children who attended school in 2000, and (3) NAEP average grade 4 reading scale scores in 2003. The regression was significant ($F (3, 46) = 74.88$, $p < .001$, $R^2 = .82$). Of the three predictor variables, only NAEP average grade 4 reading scale scores in 2003 was significant ($\beta = .91$, $t (49) = 13.78$, $p < .001$). State expenditure per pupil in 2000 was not a significant predictor of reading achievement ($\beta = .02$, $t (49) = .38$, $p > .05$. State level percent of 3 and 4 year olds enrolled in school in 2000 was not a significant predictor of reading achievement ($\beta = -.08$, $t (49) = -1.30$, $p > .05$).

A multiple regression analysis was conducted to predict NAEP 2007 grade 8 math scores from the following variables: (1) per pupil expenditures in 2000, (2) percentage of 3 year old and 4 year old children who attended school in 2000, and (3) NAEP average grade 4 math scale scores in 2003. The regression was significant ($F (3, 46) = 69.82$, $p < .001$, $R^2 = .82$). Of the three predictor variables, only NAEP average grade 4 math scale scores in 2003 was significant ($\beta = .89$, $t (49) = 13.79$, $p < .001$). State expenditure per pupil 2000-2001 was not a significant predictor of math achievement ($\beta = .05$, $t (49) = .38$, $p > .05$). State level percent of 3 and 4 year olds enrolled in school in 2000 was not a significant predictor of math achievement ($\beta = -.07$, $t (49) = -1.30$, $p > .05$).

Discussion

Using state-level data, this analysis explored the extent to which state-level participation in early childhood education, statewide expenditures for public instruction, and subsequent achievement in grade 4 predicted later academic achievement in grade 8. The results, based on state-level data, indicate that the best predictor of achievement in grade 8 was achievement in grade 4. In the model examined here, per-pupil expenditures were not a significant predictor of achievement. Nor was participation in early childhood education a significant predictors of achievement.

The results of this analysis should not be interpreted to indicate that it would be appropriate to reduce per-pupil expenditures or support for early childhood education for young children. However, it is important to examine educational investments in perspective. It is not clear that achievement within a state will be increased simply by increasing per-pupil expenditures or by augmenting support for early childhood education. Without specifically addressing how these resources are delivered based on particular contexts and including individual child needs, there will likely be little improvement in educational outcomes.

When districts receive funds, there is no assurance that the funds will be spent in ways that are matched with children's needs and abilities or with regard to the capacity of the district to deliver instruction. Funds may not be targeted toward the educational needs of children or congruent

with the realities of instructional possibilities. Therefore, investments of dollars will generally have unpredictable outcomes.

When educational resources are strategically targeted toward boosting school achievement, higher achievement will likely follow. Presently, resources may not be reliably matched with the needs or abilities of individual children within districts. Educational policy makers could benefit from information proposed provided by school districts concerning optimal allocation of resources, with a specific focus on how funds will be allocated for specific curriculum areas, such as reading, math, or science.

In addition, the most advantageous point of intervention may not necessarily be pre-kindergarten education. Pre-kindergarten education is necessary for the socialization of young children for good citizenship. It is evident that delivery of particular early education programs to select groups of young children is successful. However, the efficacy of early childhood education depends on delivery of particular kinds of early childhood education to children who need these particular experiences. The specifics of process are crucial to success, in that same way that specific processes of investment of dollars in public instruction shapes and determines educational outcomes.

In this analysis, achievement in grade 4 was the best predictor of achievement in grade 8. This suggests the efficacy of strengthening educational quality and outcomes in grades 1, 2, and 3. Funding could be targeted to districts that show poor trend patterns in the early grades, specifically targeted toward curriculum improvement, appropriate human resources or other district needs. The result of the present analysis suggests that optimizing allocations leading to and including the fourth grade level can be advantageous for predicting achievement in later years.

References

American Legislative Exchange Council (2013). Report Card on American Education. Accessed August 4, 2013 at http://www.alec.org/publications/report-card-on-american-education/

Barnett, W.S. (2011). Effectiveness of early educational intervention. *Science, 333 (6045*), 975-978.

Besharov, D.J. & Ramey, C. (2008). Preschool puzzle. *Educationnext.* Retrieved from http://educationnext.org/preschool-puzzle/

Campbell, F.A. & Ramey, C. (1994). Effects of early intervention on intellectual and academic achievement: A follow-up study of children from low income families. *Child Development, 65,* 684-698.

Clements, D.H. & Sarama, J. (2011). Early childhood mathematics intervention. *Science, 333 (6045)*, 968-970.

Diamond, A. & Lee, K. (2011). Interventions shown to aid executive function development in children 4 to 12 years old. *Science, 333 (6045*), 959-964.

Education Week (2013). States Show Spotty Progress on Education Gauges. Accessed August 4, 2013 at http://www.edweek.org/ew/articles/2013/01/10/16sos.h32.html?intc=EW-QC13-TOC

Gates, B. (2013). Flip the curve: Student achievement vs. school budgets. Accessed on August 8, 2013 at http://www.huffingtonpost.com/bill-gates/bill-gates-school-performance_b_829771.html

Greenwald, R., Hedges, L, & Laine, R. (1996). The effect of school resources on student achievement." *Review of Educational Research, 66,* 361-396. doi: http://dx.doi.org/10.2307/1170528

Hines, P., McCartney, M., Mervis, J. & Wible, B. (2011). Laying the foundation for a lifetime learning. *Science, 333 (6045),* 951.

Ludwig, J. & Bassi. L. (1999). The puzzling case of school resources and student achievement. *Educational Evaluation and Policy Analysis, 21 (4),* 385-403.

Magnuson, K. & Waldfogel. J. (2005). Early childhood care and education: Effects on ethnic and racial gaps in school readiness. *The Future of Children, 15 (1*), 169-196.
Mervis, J. (2011). Past successes shape effort to expand early childhood education. *Science, 333 (6045),* 952-956.

National Center for Education Statistics (2012a). NCES Common Core of Data. Table 8-11. Current expenditures per pupil for elementary and secondary public schools, by state: 2000, 2005, and 2009. Accessed August 4, 2013 at http://www.nsf.gov/statistics/seind12/c8/c8s1o11.htm

National Center for Education Statistics (2012b). NAEP State Comparisons. U.S. Department of Education. Institute of Education Sciences.
http://nces.ed.gov/nationsreportcard/statecomparisons/

National Education Association (2013). Rankings of states and estimates of school statistics. Access August 4, 2013 at http://www.nea.org/home/44479.htm

Rosenberg, D. (1997). Trend analysis and interpretation. Division of Science, Education and Analysis, Maternal and Child Health Bureau, Department of Health and Human Services. http://mchb.hrsa.gov/publications/pdfs/trendanaylsis.pdf

Sharp, W. (1993). School spending: Is there a relationship between spending and student achievement? A Correlation study of Illinois schools. Paper presented at the annual meeting of the American Education Finance Association, Albuquerque, NM, March.

United States Census Bureau (2000). Census Summary File 3, Table PCT 23 and the National Center for Educational Statistics (United States Department of Education) 1999 Household Education Survey. http://nieer.org/resources/facts/index.php?FastFactID=10

Verstegen, D.A. & King, R.A (1998). The relationship between school spending and student achievement: A review and analysis of 35 years of production function research. http://ezproxy.msu.edu/login?url=http://search.proquest.com/docview/62451622?accountid=12598

Wimmer, R.D. & Dominick., J.R. (2011). *Mass media research: An introduction*. Boston: Wadsworth.