Quality Education Commission

Best Practices Brief #2:

Making Our Money Work Harder: Allocating Resources to Increase Student Learning

February 2013

Learning is a cumulative process. As children grow, they draw on prior learning to supplement current lessons as they build a body of knowledge and skills. Higher levels of prior learning enhance the effectiveness of current lessons, which in turn enhance the effectiveness of future lessons. Recent research finds that the positive effect of prior learning on later learning increases as children get older, and that the impact of investment (i.e., education spending) is larger for students with greater skills.[1] This means early investments that improve student learning tend to increase the impact of later investments.

But just as we can't expect to grow all the world's food in a flowerpot simply by adding more and more seeds, water, and nutrients, there are limits to the amount students can learn in a given period of time. We can't, for example, prepare students to learn advanced chemistry and calculus in the 6th grade simply by adding more and more teachers and other resources in grades K through 5. In other words, there are **diminishing returns** to the resources we employ in teaching students over a given period of time (say, a school year). That means we need to think hard about how we distribute resources over the years students are in school to get the most learning possible: spend too much in the early grades, and there are insufficient resources left to be effective in the later grades; spend too little early-on, and students are not adequately prepared to fully benefit from the lessons in the higher grades.

As part of its 2012 report, the Quality Education Commission followed cohorts of students as they progressed through the grades. The analysis combined student-level demographic and achievement data with school-level resource data to evaluate how resource allocations across schools influence cumulative learning as students advanced through the grades. Because we currently do not have comparable data for Pre-K students, we were unable to estimate the impacts of additional resources at that level. Given the considerable body of research that finds large benefits to increased investment in Pre-K programs, we will enhance our analysis to include those students when better data becomes available.

The model we developed estimates current year student achievement as a function of 1) the prior year's achievement and 2) current year spending for each grade for which Oregon administers the Oregon Assessment of Knowledge and Skills (OAKS). The model also includes variables for school size and student attendance rates.

The two factors of primary interest—ones that can be influenced by district resource allocation decisions—are ***prior student learning*** and ***current resources devoted to instruction.*** In our model, we use prior year OAKS scores and current year instructional expenditures per student as the measures for those variables.

School districts face a myriad of choices for how to allocate resources across schools and grade levels. Districts could, for example, allocate relatively more funding to elementary schools, anticipating that better student performance there will carry over and indirectly increase performance in middle school and then high school. Alternatively, districts could increase funding in high schools, foregoing the indirect impacts of added funding in elementary schools, but gaining direct impacts on student achievement of the increased high school spending.

The goal is to allocate resources in a way that gets students to the highest level of achievement by the time they finish high school (given that this analysis is limited to K-12). This requires balancing the indirect impacts on later achievement that added resources have in the early grades with the more direct impacts that more resources have in the later grades.

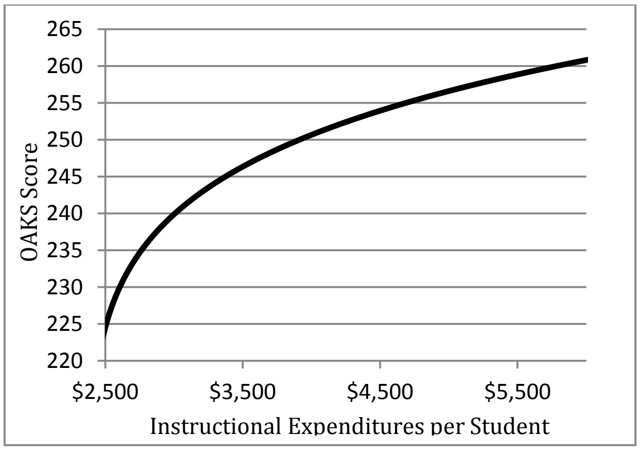
Evaluated this way, the rule for allocating resources is straightforward: allocate resources across schools (and across grades) so that the eventual impact on high school achievement is equalized across schools/grades. For example, if adding resources in middle schools improves performance more than adding resources in high schools, then devoting more resources to middle schools will result in a higher level of cumulative student learning.

While the analysis required to get to this result is complex, the policy implications are quite intuitive: districts should add resources in the grades where they get the most bang-for-the-buck, where bang-for-the-buck is defined as the impact on your desired outcome—high school achievement. As more resources are added in a particular grade, the increases in student learning will eventually diminish and fall below those that can be achieved by adding resources in other grades. At that point, adding resources to those other grades will yield a higher achievement boost.

[1] Cunha, Heckman, and Schennach, Estimating the technology of cognitive and noncognitive skill formation, NBER working paper 15664, National Bureau of Economic Research, January 2010

With the detailed student and financial data that Oregon now has, we were able to follow cohorts of students over time, and we used multiple regression analysis to relate prior learning and current spending to current achievement levels. With this information we can begin to understand how resources affect achievement at different grade levels and how they ultimately impact high school achievement.

The diminishing returns to education spending are portrayed in the graph below, where we measure student learning in terms of OAKS scores. Over a given period of time (say, a school year) the amount of added student learning from each additional dollar devoted to instruction goes down as more and more spending is added.



The additional learning from adding resources is represented by the slope of the line. Because the slope falls as spending increases, adding more and more resources in a given school or grade eventually adds very little to student learning, indicating those resources are likely to be more productive if used at a different grade level. Cumulative learning is maximized where the additional learning from additional resources is equalized across all grades.

In our analysis we estimated the shape of the curves in grades four through ten for both math and reading using student-level OAKs scores and school-level expenditure data. The results of our estimated equations are shown in the table in the next column. The coefficients are averages estimated over multiple cohorts and multiple years of data.

The objective is to allocate more resources to the grades where the added resources have the biggest impact on learning. The first column of the table shows the coefficients from our regression analysis for Instructional Spending. The coefficients measure the size of the impact on student test scores of additional instruction spending. The coefficients are greatest in grades 4, 6, and 7 for both math and reading, suggesting that those are the grades where districts will get the most bang-for-the-buck from additional spending.

The coefficients for Prior Year Achievement in the second column are a measure of the amount learning retained from one year to the next. They are considerably below 1.0, suggesting significant amounts of learning are lost over the summer break.

Estimated Coefficients

	Instructional Spending		Prior Year Achievement	
	Math	Reading	Math	Reading
4th Grade	1.098	0.098	0.752	0.707
5th grade	-0.037	-0.285	0.741	0.696
6th Grade	0.383	0.095	0.830	0.794
7th Grade	0.449	0.711	0.757	0.811
8th Grade	-0.039	-0.154	0.873	0.708
10th Grade	0.189	-0.256	0.663	0.717

The Quality Education Commission will continue to develop and refine these types of models to assist school districts in making resource allocation decisions to increase student learning. But even this initial effort contains some valuable lessons for districts:

1) To be effective at raising achievement, the relative amounts of resources allocated to different schools should be based on the specific characteristics of the students currently in the schools. That means that allocating resources based on simple formulas (such as one teacher for each 24 students) is unlikely to be optimal.

2) Information from student assessments, such as OAKS or the formative assessments used to guide classroom instruction, should be one of the key elements in making resource allocation decisions.

3) More resources in grades 4, 6, and 7 may be warranted in some school districts—that's where the most bang-for-the-buck seems to be. Districts should evaluate their specific circumstances to determine whether a shift of resources to those grades makes sense for them.

4) Efforts to reduce the loss in knowledge that students experience over the summer break can pay big dividends. Our analysis suggests that the loss, is in the range of 20 to 30 percent.

The full Quality Education Model report can be accessed at the following link:

http://www.ode.state.or.us/search/results/?id=166