Science & Math CESE Education

The BEACON

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President's Message: Lisa Durkin

Have you ever wanted to fix something in society? It might be how to lift folks out of poverty, how to mitigate the power of money in politics, or determine what can be done about long lines at the DMV that have you puzzled. That's how the people at CESE felt about science education. CESE was founded in 1997with the purpose of improving the quality of science education and resisting non-science influences. Eventually the conversation evolved from just math and science into how to improve education in general.

It was evident to us, and to just about anyone who lived in New Mexico, that our great state had serious issues with educating its children. Indeed, if we were to bolster student mastery of STEM (science, technology, engineering, and math) we needed to study the entire system of education.

As with any other group of humans, we had our own experiences and opinions about what was wrong. CESE is a group of science-minded people. Thus, we approached the educational quagmire in a scientific manner, methodically and without ambiguity. Some might even consider it boring!

Using the combined intelligence of some very fine minds attuned to education issues in New Mexico, and using statewide data, a statistical model was born that determined what factors had the greatest predictive value for educational outcomes. If you want to fix something you need to know exactly what's causing the problem. Other entities have endeavored to save the New Mexico school system from itself, but CESE recognized that it wasn't simply a matter of a handful of tweaks, a silver bullet or two and, badda-bing, all would be well. Educating kids is far more complex, because all kids aren't the same. They have their own talents, and they came from a myriad of homes, influences and cultures. We were not arrogant enough to think we could disentangle the spaghetti noodles and give advice for educating all kids properly and effectively. What CESE did instead, was to find a means to determine which schools were effective so we might use them to guide those that were struggling.

When I joined CESE 20 years ago, I was just a humble science teacher, a private in the war against ignorance. I was full of opinions based on anecdotes from my classroom, just like any other teacher. CESE Scientists involved in deriving the statistical modeling, rebuffed my notions, because they were simply anecdotal, limited to my classroom experience. You might think I would have been offended, but instead it was empowering.

Hopefully, you too will be empowered and encouraged by the research that is offered below by Kim Johnson, a former CESE president and retired physicist and 23-year student of education. It represents the culmination of over 20 years of analytic inquiry into the elements that predict student outcomes, it builds an index of school remediation needs, and it provides an avenue to change the dynamics that plague our state as indicated by the Martinez-Yazzie lawsuit.

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E-mail Beacon comments and submissions to Editor, Rebecca Reiss, rebecca.reiss@nmt.edu

A New Way to Calculate NM At-Risk Funding Using the CESE Method: Introducing the Opportunity and Equity Index

Over the last decade, we (CESE) have been trying to get broad, general usage of the CESE Method (more on the specifics directly). This method has been briefed to many people over the course of the last decade including the Legislative Education Study Committee, the Legislative Finance Committee, school districts, various civic organizations.

The Method offers the potential to identify those schools that are both significantly outperforming and underperforming expectations using a predictive procedure that accounts for schools' student demographics. As it turns out, this same performance predictive method can be used to identify schools both by name and their *degree* of "risk" as explained by those demographic factors associated with New Mexico's educational achievement gap that manifests from kindergarten through 12th grade.

Background

In January of 2020, pre-Covid-19, a Sunday morning breakfast meeting was called by a small group of charter school directors and consultants with Cypress Tree New Mexico. The participating charter schools united to do that so they could address educational issues they face with more consistency and influence than any could alone.

One of the major issues they faced was insufficient funding. The state was beginning to phase out the small school funding, the money provided to schools who could not take advantage of economy of scale in providing services that large districts provide. Also, other federal funding for students from low-income families (Title 1), students with disabilities (IDEA B), and others, was always intended as a supplement to state education funding, not as a replacement.

The federal funding supplements were simply not sufficient to support the at-risk students for the schools, especially those catering to at-risk students, as do many charter and non-charter schools.

Furthermore, the New Mexico district court determined that the state was not fulfilling the court's requirement to provide additional, targeted resources to at-risk students. Sufficient progress was not being made according to the court in answer to a later appeal by the state.

The CESE Method, however, provided a mathematically-based and scientifically understandable process to help identify those schools' students specifically identified by the courts; the high-risk schools with underachieving students who were in that situation through no fault of their own.

The Cypress Tree leaders soon realized that in trying to solve their own problems, they were also helping to solve the much larger problem that applied to the entire New Mexico Public School system. The CESE Method applied to all state schools with at-risk students, not just to a small portion of state charter schools. Even though they were born of the charter school system, this was too important to not to spend the time and effort needed to get this out to the state. It became clear at this breakfast meeting that using the CESE method to identify where to allocate added resources to schools with higher risk students was a winner.

How Does the CESE Method Work to Help At-Risk Based Resource Distribution?

The CESE Method uses a mathematical method known as a canonical correlation to best fit selected student demographic factors to overall performance. Canonical correlation is used because it correlates multiple input variables (schools' demographic factors) to multiple output factors (schools' percent proficient measurements for all end-of-year subjects tested; English language arts, math, and science.) This methodology provides the optimum fit of performance based on demographics.

What demographic factors are used? Figure 1 is the NM Public Education Department's compilation of the state's collected demographics versus proficiency percentages for school year (SY) 2018-2019, the last data available. It shows the percentage lag from Caucasian performance (measure of achievement gap). By studying data such as this, it becomes obvious that metrics associated with demographic classification should be used to correlate with performance. In addition to those highlighted, mobility percentage is also included (Figure 2), since it has moderate correlation with achievement in upper grades.

When the input and output data are collected, the canonical correlation calculation is performed by computer. This maximizes the correlation between schools' demographics shown in Figure 1 and the schools' performance as measured by the end-of-year

		ELA	Math	Science	Performance Gap (Percentage Proficient Compared to Caucasians)			
Percentage	Demographic Classification	Proficient & Above %	Proficient & Above %	Proficient & Above %	ELA	Math	Science	Achievement Gap Yes or No
295,171	Total Students	34%	20%	35%				
48.9%	Female	39%	20%	34%				
51.1%	Male	29%	21%	37%				
23.3%	Caucasian	48%	34%	57%	0.0%	0.0%	0.0%	
3.7%	**African American**	30%	15%	31%	**-37.5%**	**-55.9%**	**-45.6%**	**Yes**
58.8%	**Hispanic**	30%	16%	30%	**-37.5%**	**-52.9%**	**-47.4%**	**Yes**
2.2%	Asian	52%	42%	54%	8.3%	23.5%	-5.3%	**No**
12.0%	**Native American**	25%	12%	20%	**-47.9%**	**-64.7%**	**-64.9%**	**Yes**
74.0%	**Economically Disadvantaged**	28%	15%	28%	**-41.7%**	**-55.9%**	**-50.9%**	**Yes**
15.3%	**Students with Disabilities**	12%	8%	14%	**-75.0%**	**-76.5%**	**-75.4%**	**Yes**
16.8%	**English Language learners**	15%	8%	12%	**-68.8%**	**-76.5%**	**-78.9%**	**Yes**
0.3%	**Migrant**	23%	13%	23%	**-52.1%**	**-61.8%**	**-59.6%**	**Inconsistent Tracking**
2.6%	**Homeless**	18%	9%	18%	**-62.5%**	**-73.5%**	**-68.4%**	**Inconsistent Tracking**
1.1%	**Military**	51%	39%	61%	6.3%	14.7%	7.0%	**Inconsistent Tracking**
0.7%	**Foster**	22%	12%	23%	**-54.2%**	**-64.7%**	**-59.6%**	**Inconsistent Tracking**

Figure 1. Demographics versus proficiency. The dark shaded cells with white text show those demographic subgroupings where there is a significant achievement gap in performance. The lightly shaded cells (migrant, homeless and foster) are subgroups that could be included, but tracking data are far too inconsistent to justify their use. Table modified from SY 2018/2019 PED Assessment data. **https://webnew.ped.state.nm.us/bureaus/accountability/achievement-data**.

state tests in English language arts, math, and science. The specifics are too detailed for this article but are well documented elsewhere in CESE presentations that have been made, and are available from the author. The output provides all the needed information for both the proposed new at-risk calculation for the state and for the auditing process that allows the PED to observe outperforming schools for best practices to pass on to similar performing schools relative to their peer schools and

Comparing the current at-risk statutory requirements versus the Martinez-Yazzie judgment and the new Opportunity and Equity Index

How does the canonical correlation determined index for distributing at-risk funds compare to the current statutory at-risk index? How does this compare to the factors called out in the Martinez-Yazzie ruling? Figure 2 illustrates this along with the current NM statutory requirements. The Opportunity and Equity Index (OEI) is the name given to the new at-risk replacement index that uses the CESE Method of calculation.

The current statutory index is determined subjectively. That is, it sums district wide three-year averages of Title 1 percentages plus English language learner percentages plus student mobility percentages for the district. This forms the "at-risk index" and is used to calculate the funding a school district gets for distribution. This is subjective, because it does not differentiate the individual impact of each element used to determine the index. When this index was created, someone decided that these elements have the precisely the same relative impact on performance. They do not. The current index also is calculated at the district level, as oppose to recognizing there are dramatic differences sometimes among schools within a district.

We propose replacing the current index with one that includes just those demographic factors associated with high achievement gaps in learning. Then let the math tell us how to weight the factors together so that we have the optimum correlation and can use the results, by school, to apportion the at-risk funds. This is objective. It is not guessing. The methodology can be readily understood by district-level analysts, as well as external reviewers, and validated or adjusted based on updated or corrected input data.

Additionally, the method accounts for all the factors included in the Martinez-Yazzie judgement as shown in the Figure 2.

Because of the nature of the canonical correlation, other input factors could be added in the future, such as digital distress or index (DDI), a measure of availability and access to wideband data needed for online teaching.

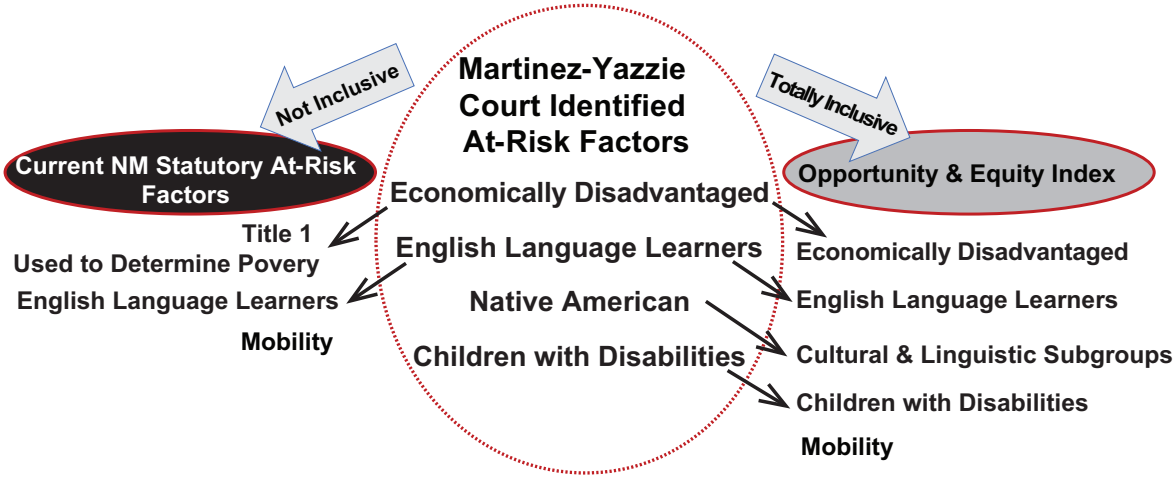


Figure 2. Comparison of Current Factors and OEI index. Relationship of demographic factors used in the current statutory at-risk formula to the Martinez-Yazzie factors and then to the new Opportunity and Equity Index.

provides a useable path for those schools to better understand what they might do to improve their performance.

In essence, the canonical correlation reduces to the expression:

$$\underbrace{(DF_1 \times UW_1) + (DF_2 \times UW_2) + \ldots + (DF_N \times UW_N)}_{\text{X (predicted)}} = \underbrace{\text{Combined Measured Performances}}_{\text{Y (Measured)}}$$

Where DF = Demographic Factor and UW = Fixed Unique Weighting

We now have a calculation where paired demographic factors with their combined performance outputs are used to calculate the optimum unique weighting factors that are applied to each school. We use both sides of this equation to determine the highest and lowest performing schools for studying best practices and identifying those that need the most help. We use the left side, or the predicted values for each individual school to calculate the new at-risk factor–the Opportunity and Equity Index (OEI.)

What Does the Output Look Like?

When the equation is graphed using the calculated weightings, each school's demographic factors (fraction of school students), and the schools' corresponding measured performances, Figure 3 shows the results where each dot is a school, the black line is the best fit for the prediction of scores versus actual scores, and the x-axis is the basis for the Opportunity and Equity Index.

The Opportunity and Equity Index is linearly proportional to the x-axis in Figure 3. This represents the sum of the demographic factors unique weighting values times each school's individual fractional demographic amounts. The plot in figure 2 shows the highest at-risk schools closest to 0.0 and the least at-risk schools closest to 1.0.

The OEI is linearly scaled against the axis such that these values are subtracted from 1.0 and linearly rescaled such that the highest at-risk school's OEI is set to 1.0, and the lowest at-risk school is the value as calculated from the canonical correlation. In short,

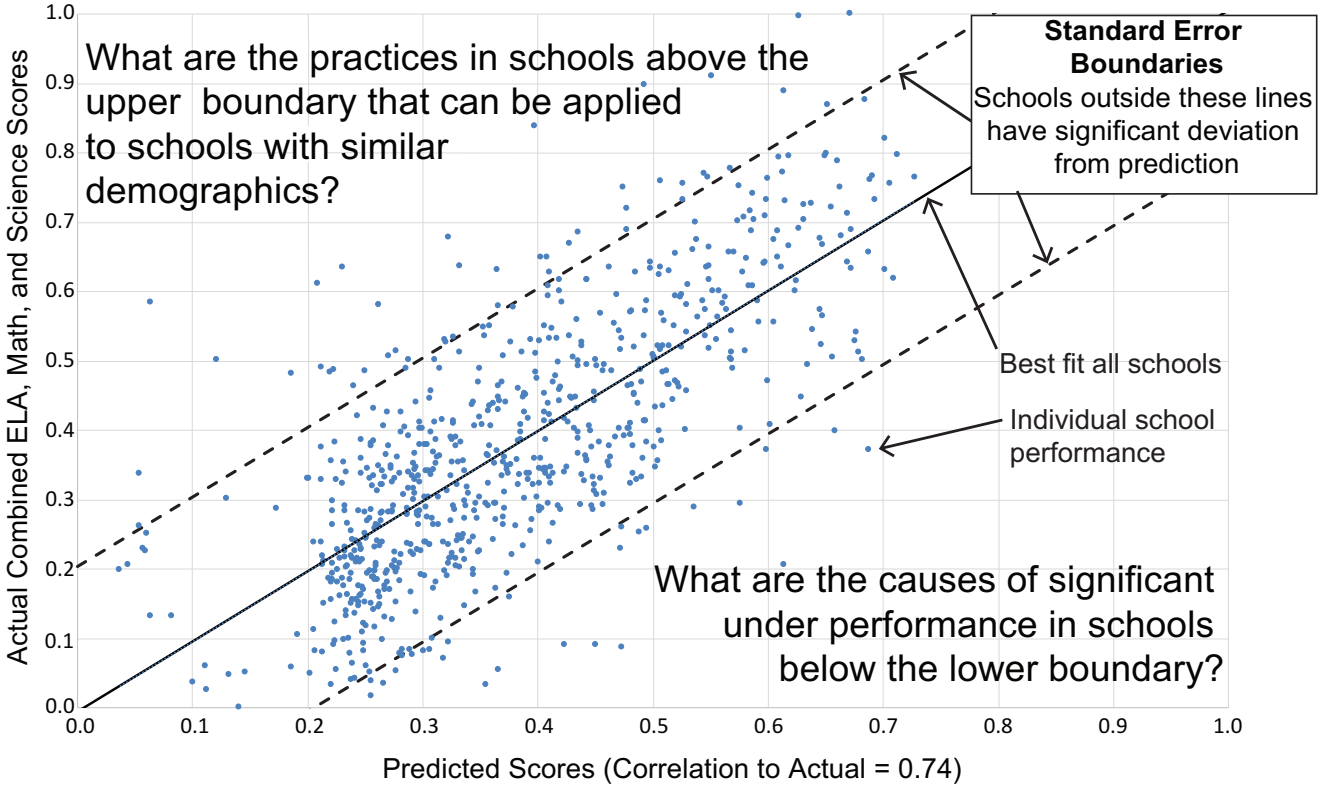


Figure 3. The CESE Method. This is the canonical correlation standard output plot; the CESE Method separates outperforming schools and underperforming schools. The Opportunity and Equity Index is the x-axis or the combined, calculated demographic weighting factors calculated by the canonical analysis and linearly scaled as discussed herein.

the x-axis is the predicted value for the combined ELA, math, and science achievement. The OEI reverses the order and rescales the values. This is done so that the OEI may be used in calculating funding allocated to each school more easily.

A sample of OEI values is shown in Figure 4. The highest at-risk schools are in the upper grouping, schools with moderate risk are in the middle, and lowest risk schools are in the lower grouping. Note that all schools in the state have students that are at risk based on their demographics. New Mexico has a majority of high to medium risk schools. This should come as no surprise to people who have lived in the state and traveled throughout. The OEI makes it possible to objectively classify each school as to degree of risk. Figure 5 shows the distribution of schools by OEI (demographic factor). The figure shows that there are significantly more schools with higher risk than not.

School Numerical Rank	Opportunity and Equity Index
1	1.0000
2	0.9973
3	0.9789
4	0.9768
5	0.9766
6	0.9730
⋮	⋮
459	0.6835
460	0.6831
461	0.6823
462	0.6821
463	0.6817
464	0.6813
⋮	⋮
809	0.3285
810	0.3248
811	0.3222
812	0.3188
813	0.3182
814	0.3177

Figure 4. Examples of Schools versus OEI values and numerical rank. The upper group are the highest at risk; the middle is moderate risk; and the lower group is the least at risk.

What Does this Actually Do for New Mexico Schools?

The very highest risk schools do need significant help, above and beyond what we see them getting. This may sound like "throwing money at the problem," but it really isn't. Rather it is allocating resources already on-hand more equitably: where they are needed the most. This cannot solve all societal problems associated with the achievement gap. But schools are the centers of communities. They are the very first places that most students are really evaluated and continually evaluated. Schools are on the frontline for determining and categorizing problems and perhaps more basically, the unique needs of the students. Schools are where students who need additional help or additional tailored instruction and support often find it or are referred to needed social services.

Schools cannot be made from the same mold, especially in a state such as ours. We are very diverse with multiple cultures, levels of income, and uniqueness. Placing needed additional resources where they are required to help raise the education of all students raises the prospects of all New Mexico's citizens. We think application of the Opportunity and Equity Index to distributing these additional resources is something we, as a state, must do, if our younger citizens are to have a chance at equitable opportunity when they become adults. This is good for everybody in the state.

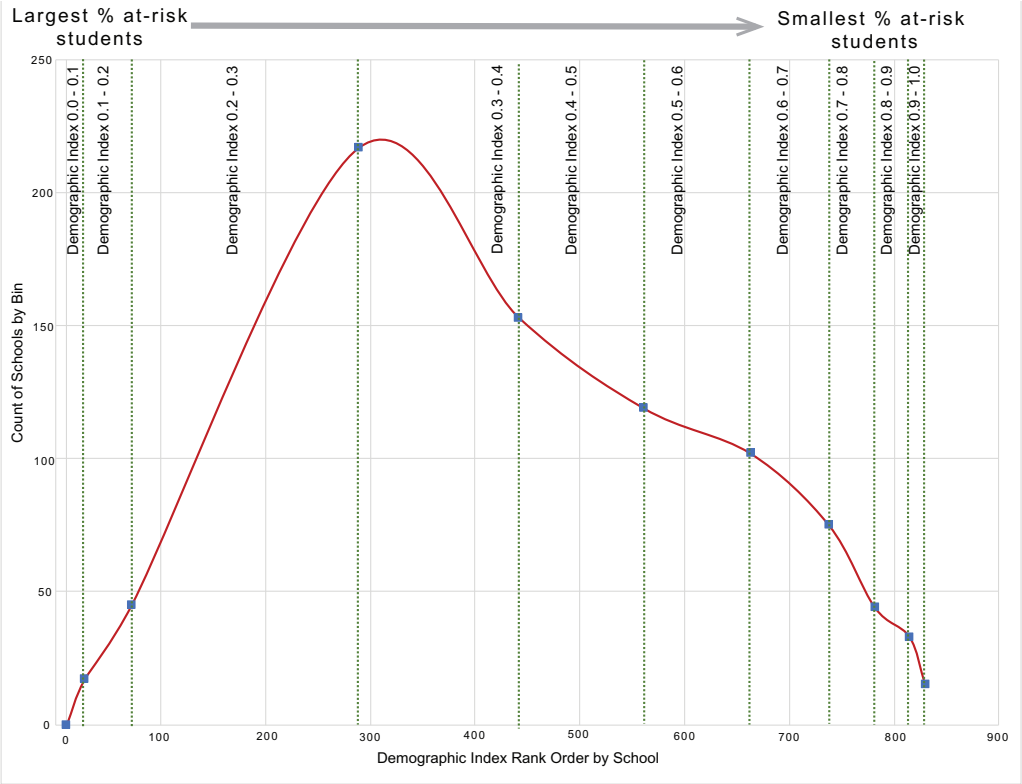
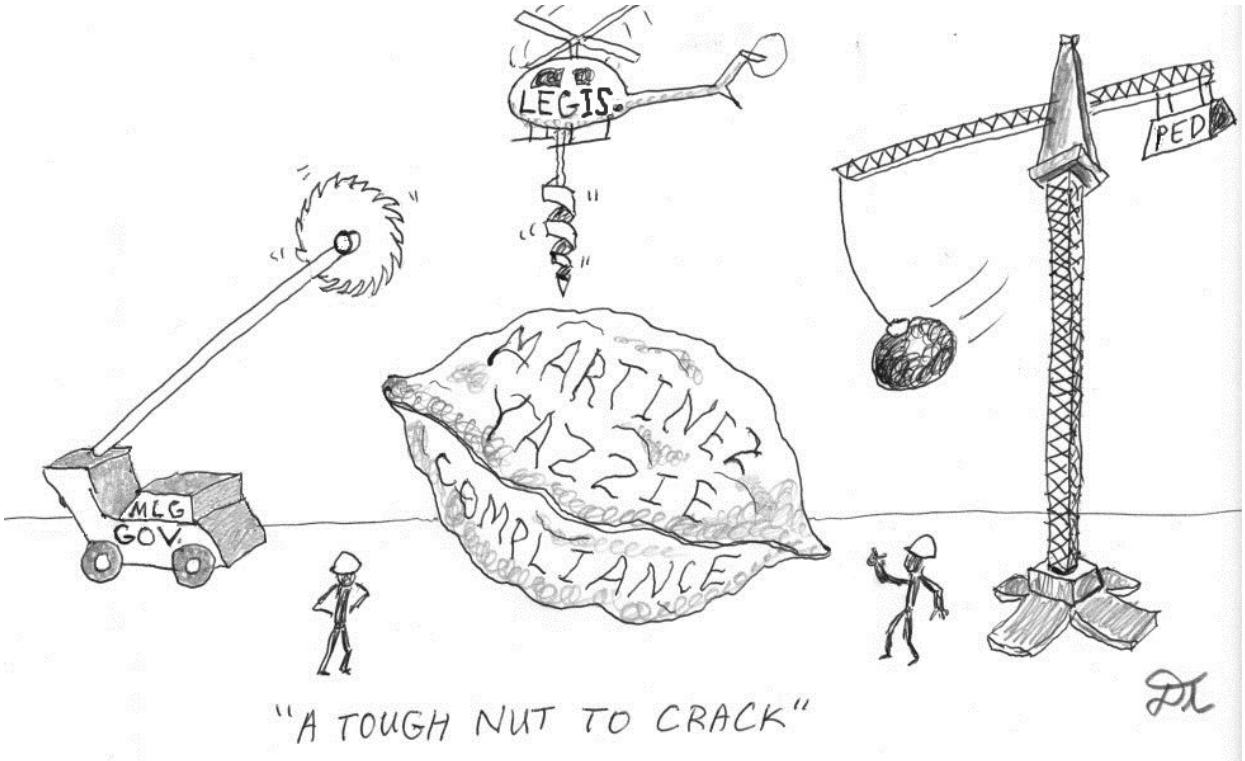


Figure 5. Distribution of the density of schools versus the demographic index. shows that the majority of schools in New Mexico contain high numbers of at-risk students. Out of 820 schools shown here, more than half have a majority of students who are at very high risk levels based on their school's overall academic performance. (not yet scaled to the Opportunity Index values) All schools have the same problem to one degree or another.

A Toon by Thomas



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