PLOTTING EDUCATIONAL OUTCOMES

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ABSTRACT

Is there a relationship between the cost of education and the achievement of students on standardized test? This is a question that has become an increasingly important concern of parents as the costs of education have risen. In an effort to begin to address this question, this paper reports on how ArcGIS was used for the analyses of the spatial variations in standardized test scores across Pennsylvania/s school districts between 1997 and 2002. To address the central question of this research student achievement test scores are compared to expenditures for education by public school districts during the same time period.

PURPOSE OF STUDY

Within the Commonwealth of Pennsylvania, as within most states, there is an increasing concern with costs of education at all levels. This is especially true at the local K-12 level where the basic funding mechanism is often property taxes. For the 2001-2002 academic year, the schools districts within Pennsylvania received $16,755,930,435 in total revenue. Fifty-six percent of this total revenue came from local sources. The primary local source was real estate taxes, which in the 2001-02 academic year was $7,214,605,270 or 80% of all local revenue. Presently, the Governor's office is seeking an alternative to property taxes as the basis of funding education. In addition to the financial concern, there is also a concern with the quality of education being received by students as exemplified most recently by the No Child Left Behind Program that federally mandates improvement in basis education.

This study addresses these two concerns by look at the question: Is there a relationship between the costs of education and the achievement of students on standardized tests? Specifically this study looks at the spatial variations in standardized test scores and the expenditure for instruction by public school districts within Pennsylvania.

Following a discussion of the data sources and the development of the spatial database, the spatial relationship between costs and student achievement will be analyzed and discussed. The analyses will be based on comparison of maps and graphs, which is just one of the advantages of using GIS for analysis. The paper concludes with recommendation for further research.

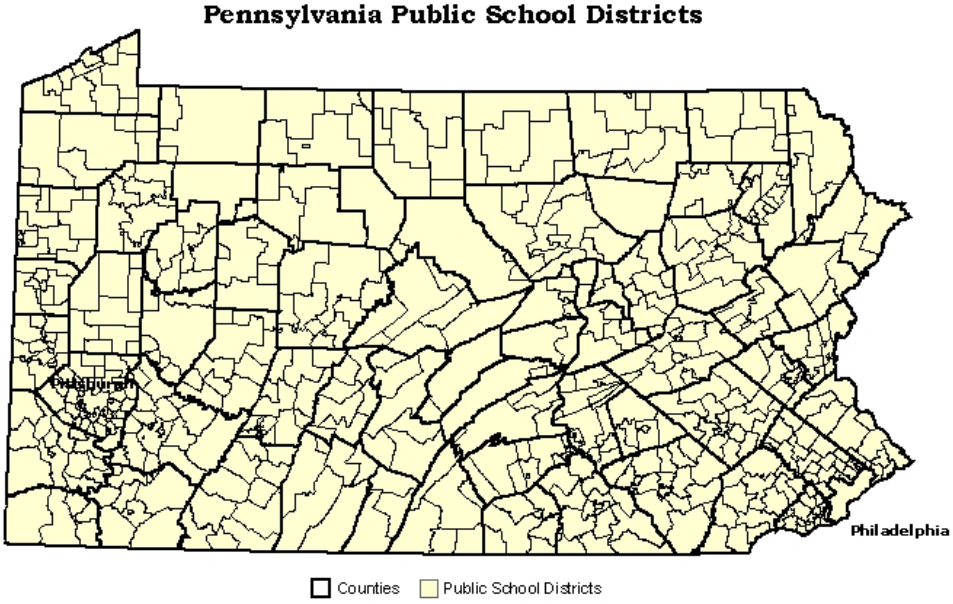
DATA SOURCES AND DATABASE DEVELOPMENT

The public school districts of Pennsylvania were the basic spatial units of analysis for this study. Using the U.S Bureau of the Census TIGER/Line files data link through the Geography Network website, the school districts within each of the sixty-seven counties

of Pennsylvania were downloaded. After extracting all the zipped county files, the polygons were merged into a single shapefile. Many of the polygons within this shapefile had to be merged since numerous school districts crossed county lines. This was accomplished by using the Dissolve Function within the Geoprocessing Wizard of ArcGIS. From the original 600 polygons, the five hundred and one public school districts were created.

Before the shapefile of the school districts could be used for analysis, two additional operations were necessary. First, the file was projected from its original geographic coordinates to an Albers Equal Area Conic projection centered on Pennsylvania. Thus every school district would be proportional to its true area in any map produced, see Figure 1. Second, each school district had to be assigned its unique Administrative Unit Number, AUN, as defined by the Pennsylvania Department of Education. The AUN is used in all reports for and by school districts available from the state.

Figure 1
Pennsylvania Public School Districts



The time period from the 1997-1998 academic year to the 2001-2002 academic year was chosen because it provides five budget years to evaluate whether there is a relationship between expenditure for education and student achievement scores. In addition these five years provide a basis for comparison before the introduction of the No Child Left Behind program and its implementation. The data necessary for the 2002-03 school year, the

first year of NCLB reports for Pennsylvania, were not available at the time of this writing and therefore excluded from the study.

For each year of the study, data on expenditures and student standardized test scores were drawn from several reports available through the Pennsylvania Department of Education website, http://www.pde.state.pa.us/pde_internet/site/default.asp. Detailed financial information, both expenditure and revenue, for all school districts was available as Microsoft Excel files. Expenditure information within these files included amounts expended on instruction, transportation, instructional staff, administration expense, operation and maintenance, as well as many other categories. The specific reported variable used in this study is the Actual Instruction Expense per Weighted Average Daily Membership. According to the Pennsylvania Department of Education, this is defined as

> **Actual Instruction Expense** - Includes all general fund expenditures as reported on the annual financial report by the school districts except those expenditures for health services, transportation, debt service, capital outlay, homebound instruction, early intervention, community/junior college education programs and payments to area vocational-technical schools. Deductions are also made for selected local, state and federal revenues and for refunds of prior year expenditures and receipts from other local education agencies. It is calculated in accord with Section 2501 of the "Pennsylvania Public School Code of 1949." [PDE, 2004]

Divided by

> **Weighted Average Daily Membership (WADM)** - The assignment of weight by grade level to the average daily membership. The current weighting is half-time kindergarten at 0.5, full-time kindergarten at 1.0, elementary (grades 1-6) at 1.0, and secondary (grades 7-12) at 1.36. Where **Average Daily Membership (ADM)** - Includes all resident pupils for the school district for whom the school district is financially responsible. It is calculated by dividing the aggregate days membership for all children on active rolls by the number of days the school is in session. [PDE, 2004]

For each year of the study, the Administrative Unit Number, Average Daily Membership, Weighted Average Daily Membership, Total Expenditure and Actual Instruction Expenditure per Weighted Average Daily Membership, AIE, variables were extracted for each school district from the expenditure data files.

Student scores on achievement tests were available at the district and school level through a set of Microsoft Access databases. While both Scholastic Aptitude Test, SAT, and American Collegiate Testing, ACT, scores were available, the SAT scores were used for this analysis. In over 60% of the public school districts very few students took the ACT tests and for disclosure reasons no average scores were reported. While all but four public school districts had SAT scores for the time period of the study. For each public school district, the Administrative Unit Number, mean Verbal SAT, and mean math SAT were extracted from the achievement data files for each year of the study.

To create the spatial database for the analysis, the public school districts spatial data files and the tabular data files had to be merged. Using the Administrative Unit Number, AUN, as the unique identifier in all the files the extracted expenditure and SAT score data files were joined with the spatial shapefile.

SPATIAL ANALYSES OF ACHIEVEMENT SCORES AND EXPEDITURES

It was initially hypothesized that those school districts that spent more on instruction would have higher standardized test scores when compared to districts that spent less on instruction. For the five school years covered by this study, this initial hypothesis is **FALSE**. As is shown in the following graphs and maps, there is **NO** relationship between mean SAT scores and the actual instruction expenditure per student, AIE.

The graphs in Figure 2 show the relationships between standardized test scores on the horizontal axis and AIE on the vertical axis for the five years of the study. There is a strong scattering of the data points with no linear relationship. In fact, the relationships are shaped more like the letter "U". Please note that for the higher SAT scores there is a wide range of costs of instruction. In fact the range of AIE these range from $10,978 to $4,142 for the time period of the study.

Since the standardized test scores represent data measured on an interval scale while the AIE is measured on a ratio scale, I decided to look at the ranked values of the variables. By placing both the test scores and cost of instruction on an ordinal scale it was hoped that a relationship between student achievement and costs of education may become apparent. The mean verbal and math test scores were ranked from high to low as was the AIE for the school districts. The graphs in Figure 3 show the results of these rankings with the ranked test scores on the horizontal axis and ranked AIE on the vertical axis for the five years of the study. The results of ranking the data were worse in the sense that points are more scattered across the range of the rankings.

Figure 2. AIE per Student vs Mean SAT Scores

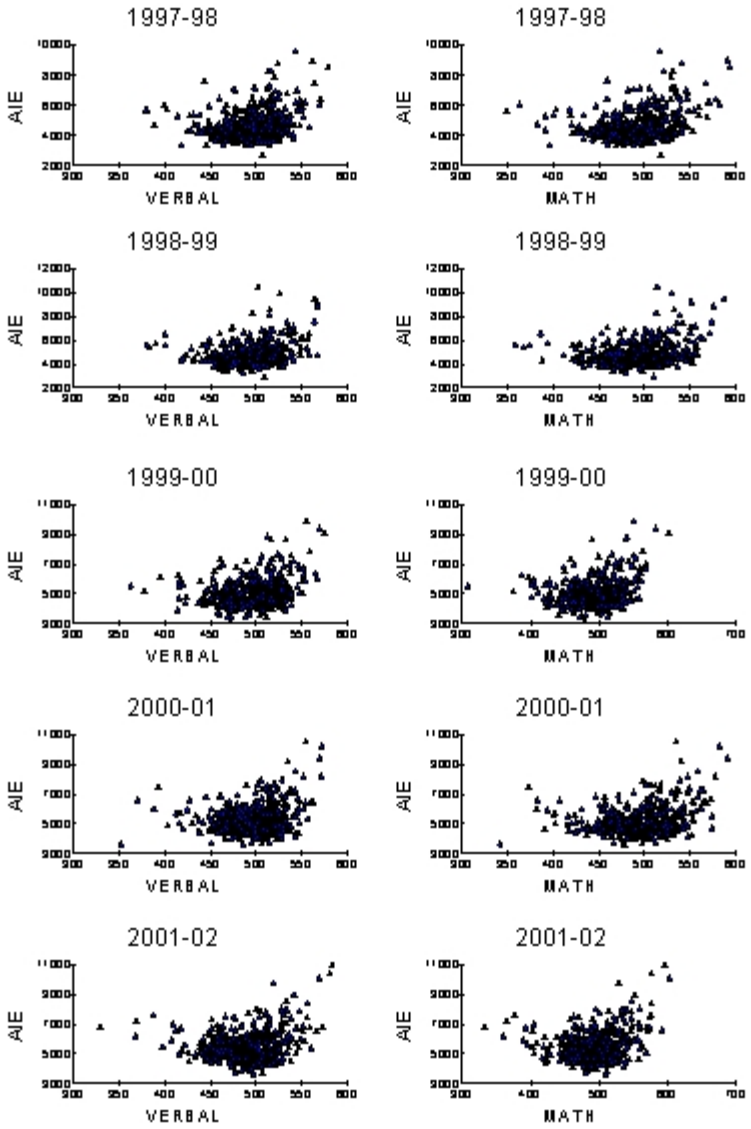
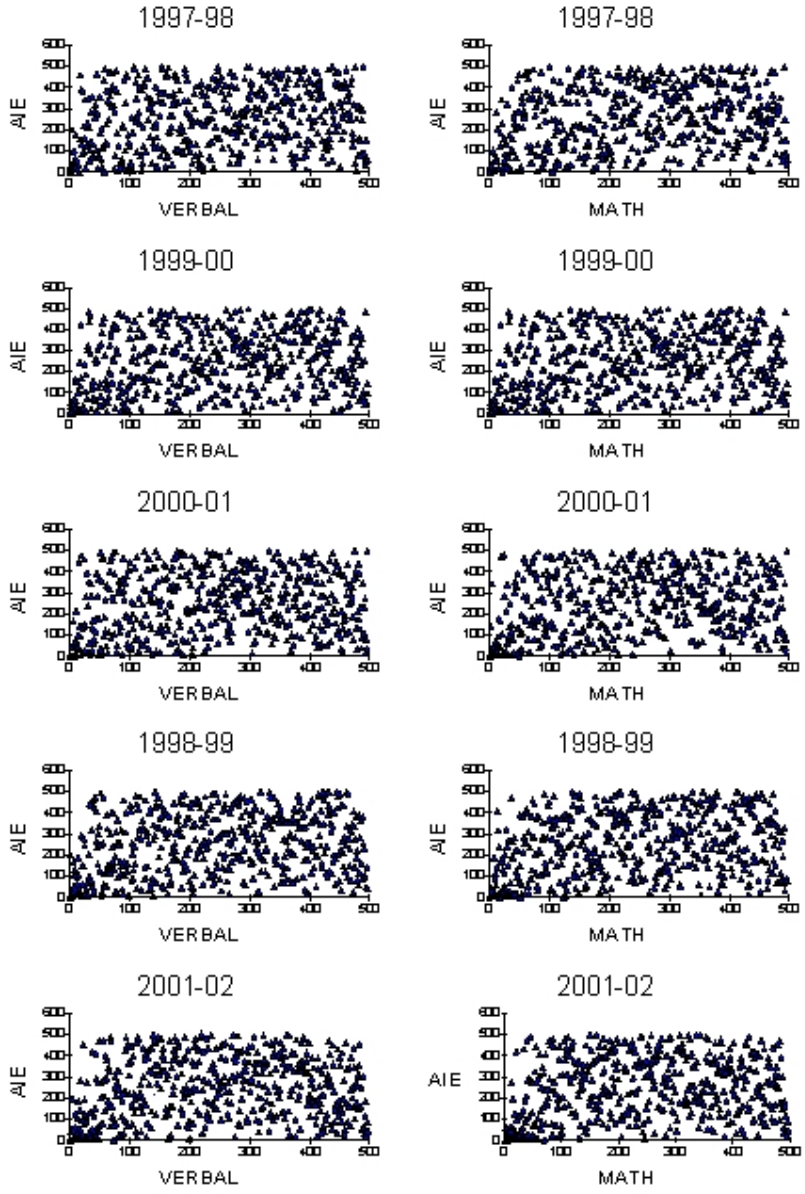


Figure 3. Ranked AIE vs Ranked SAT Scores



While graphically there appears to be no relationship between achievement scores and the costs of education, there is still the question of whether there is any spatial pattern or relationship exists between the SAT scores and the actual instructional expense per student. Figures 4 through 8 show spatial variations in the mean verbal and math SAT scores and AIE for each school year of the study.

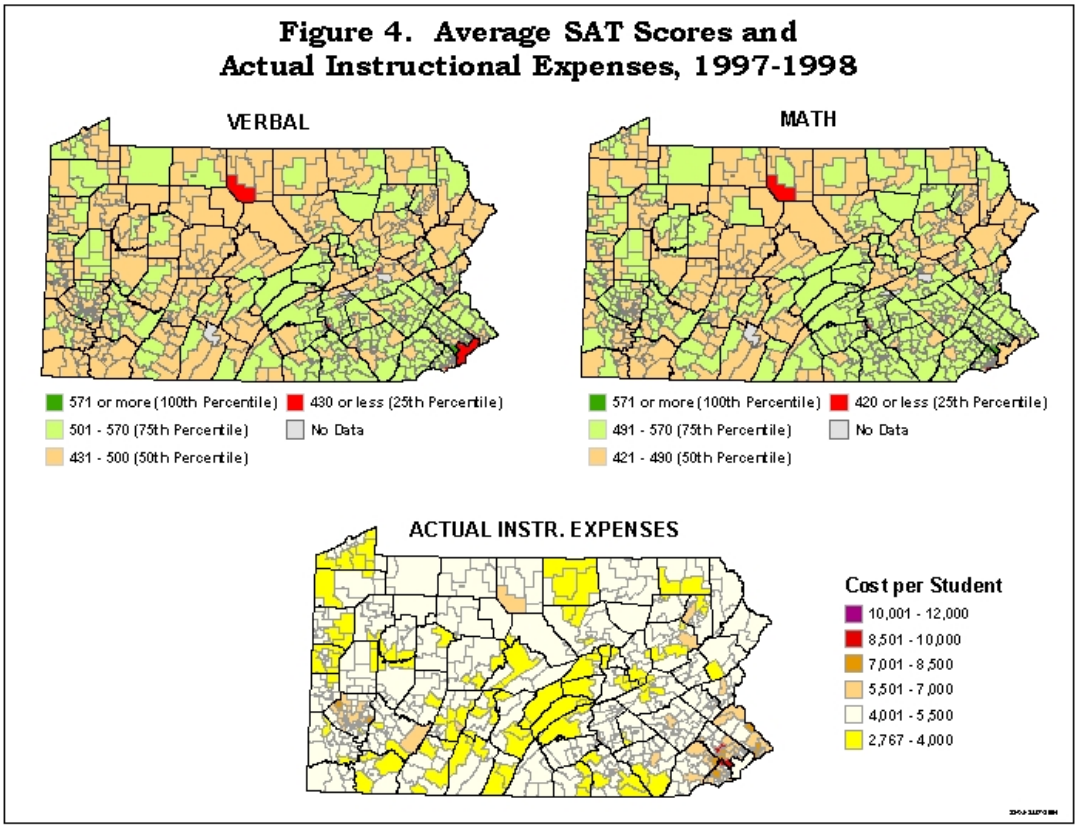


Figure 5. Average SAT Scores and Actual Instructional Expenses, 1998-1999

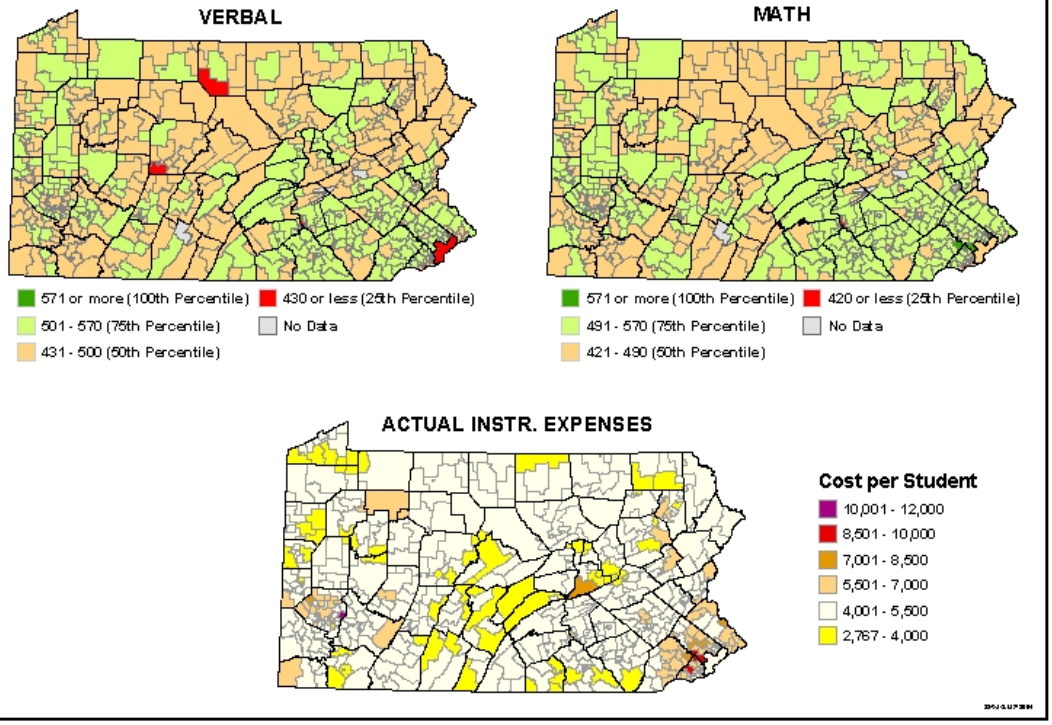


Figure 6. Average SAT Scores and Actual Instructional Expenses, 1999-2000

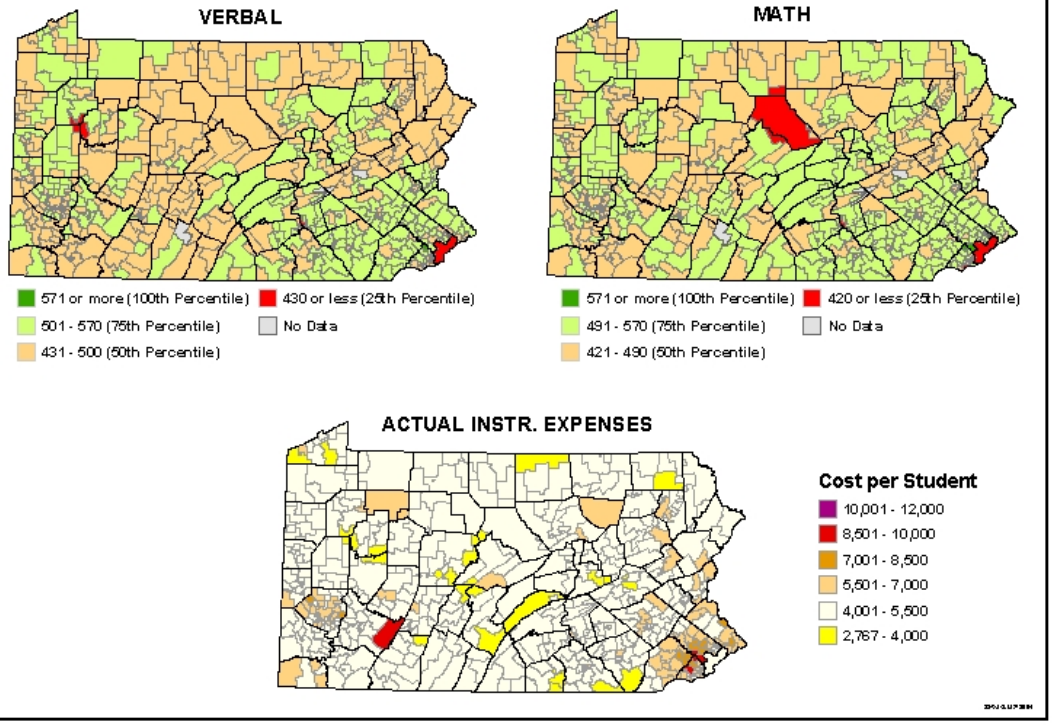
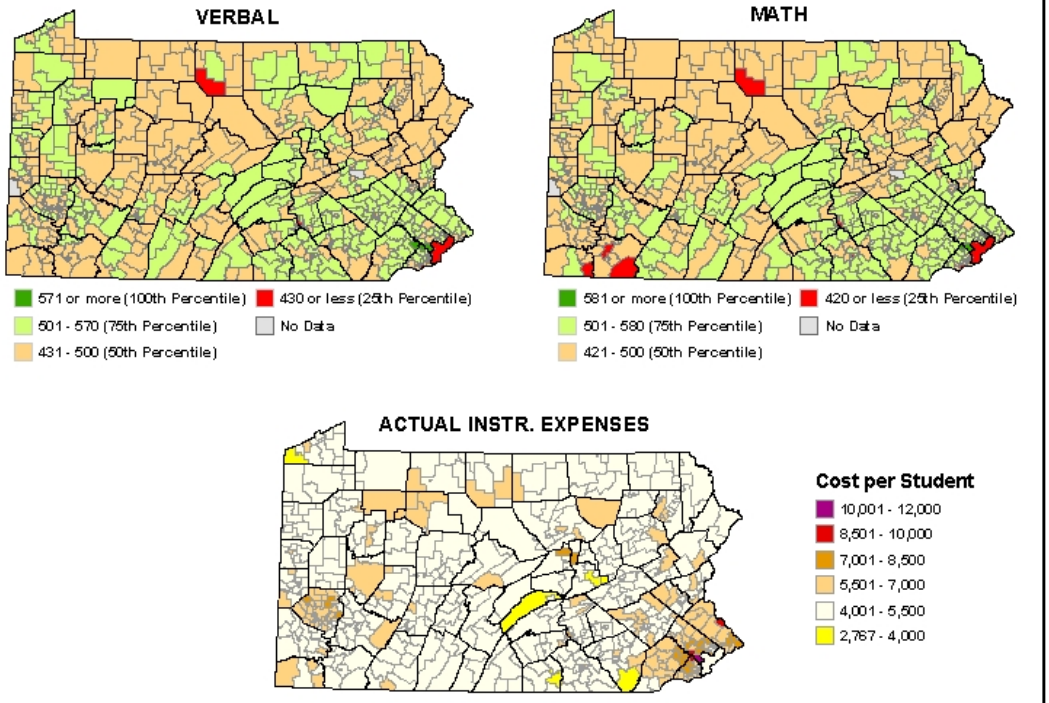
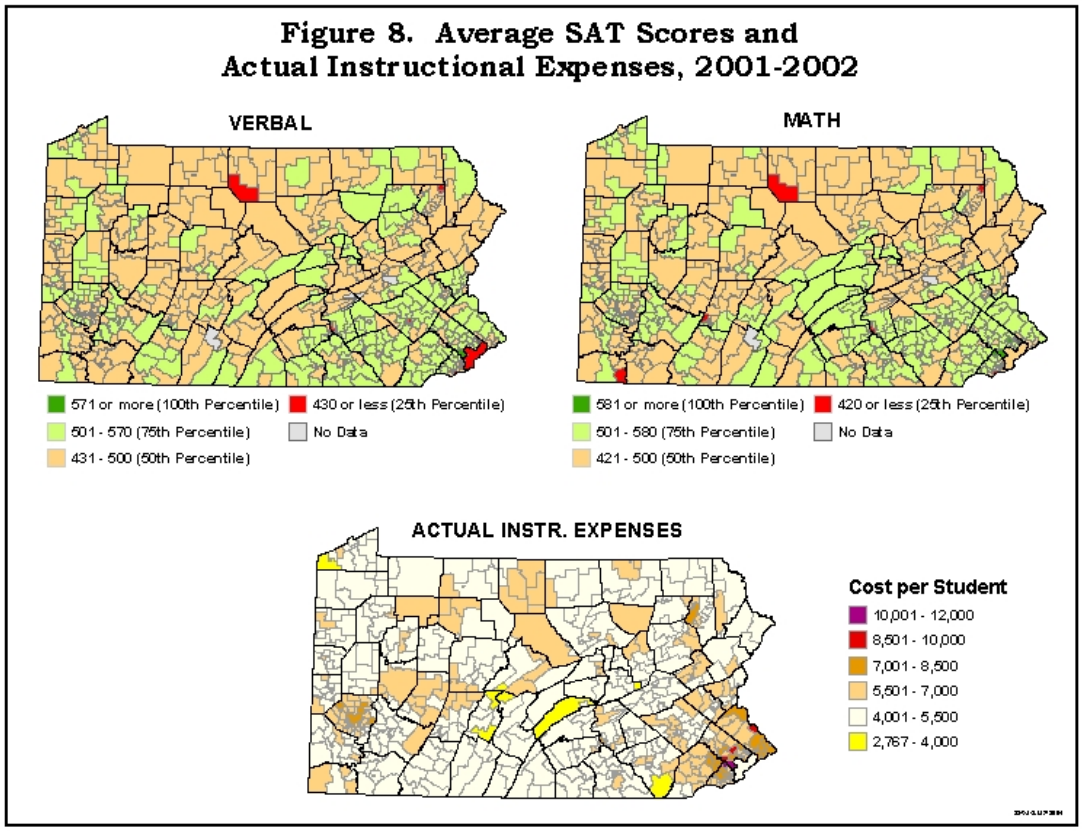


Figure 7. Average SAT Scores and Actual Instructional Expenses, 2000-2001

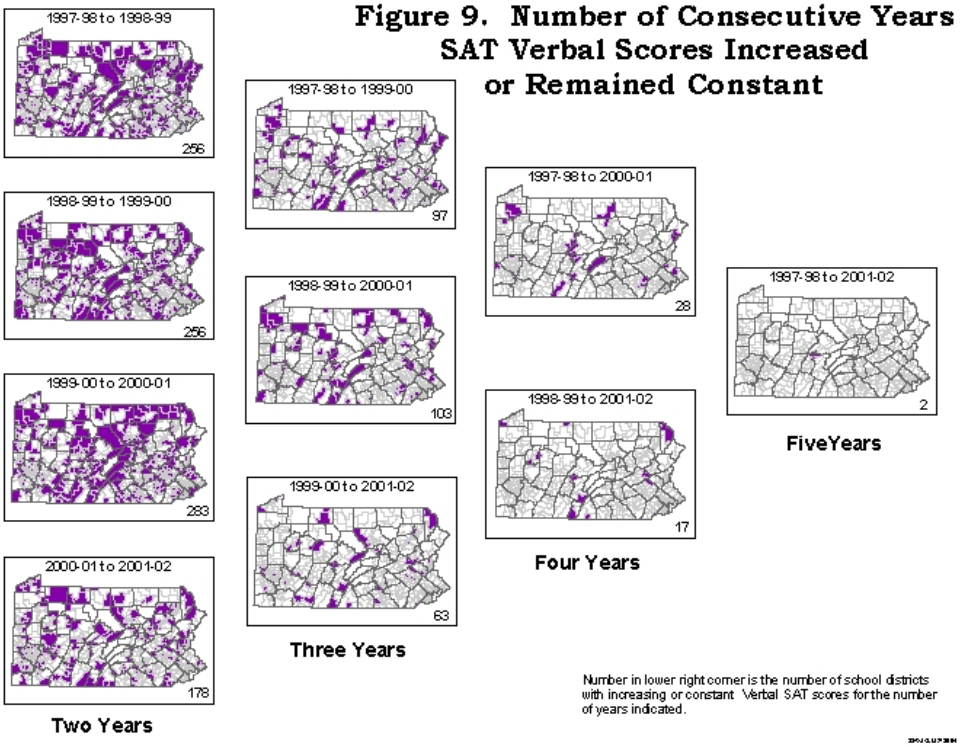




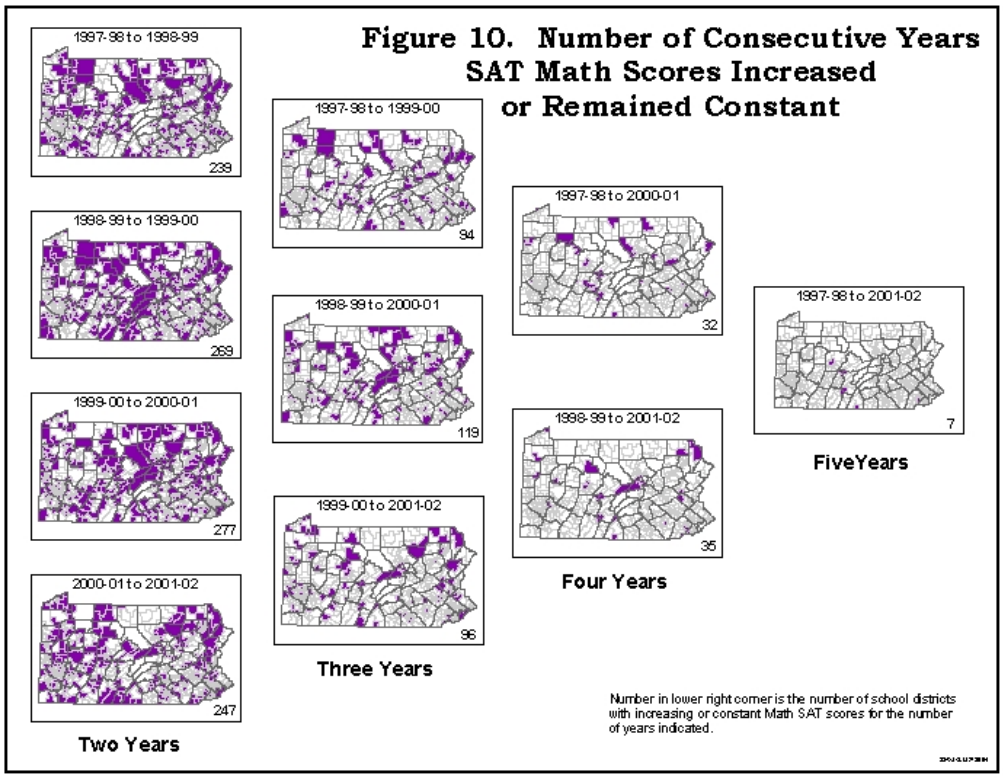
After studying these maps one must again come to the conclusion that there is **no** systematic pattern or relationship evident in the spatial distribution of scores or costs. Some districts such as the Austin Area School District in north central Pennsylvania has consistantly low SAT scores with relatively high AIE. While across the time period of the study, many public school districts score in the 51st to 75th percentile, the light green on the SAT maps, but have relatively low costs of instruction per student.

In general, expenditures on instruction have increased over the time period, yet SAT scores have changed very little. In fact the College Board reports that mean scores may change by 10 point up or down on an annual basis for over fifty percent of all high schools. One comparison that brings this home is the series of maps shown in Figures 9 and 10. Using the verbal and math scores, a set of variables was created by calculating whether the school districts' mean scores increase or remained constant over two, three, four, and five consecutive years.

Figure 9. Number of Consecutive Years SAT Verbal Scores Increased or Remained Constant



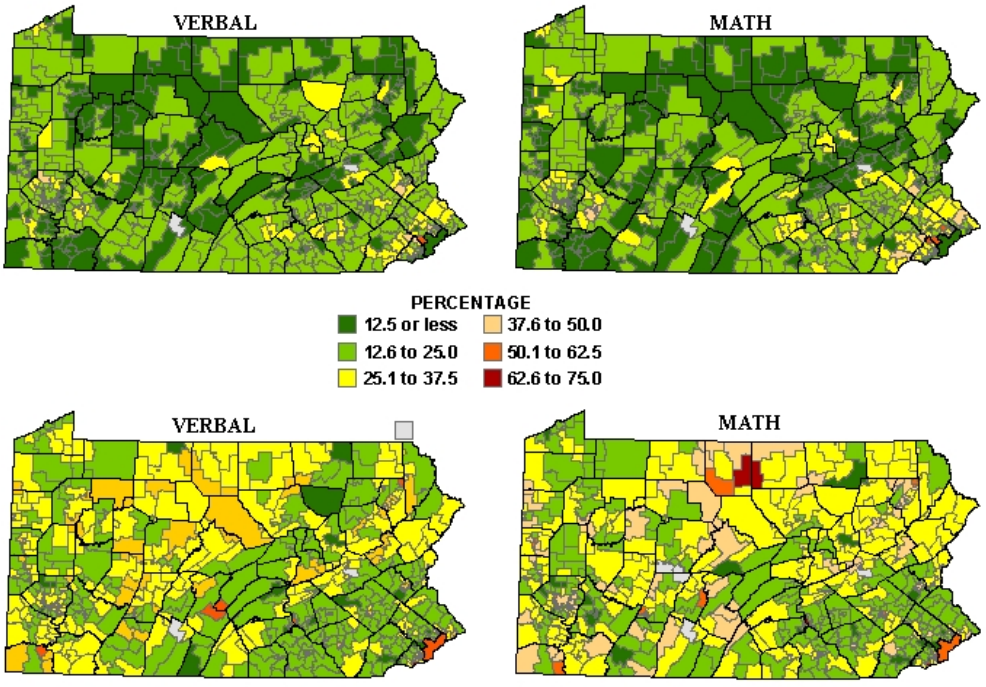
Number in lower right corner is the number of school districts with increasing or constant Verbal SAT scores for the number of years indicated.



These map series show that very few districts maintain or increase their scores over the period of the study. However, I believe that this is one of two approachs to better measure improvements in standardized test scores. Ideally, one would want districts' scores to remain constant or increase over time and therefore increase the number of consecutive years the district appears in the maps.

An alternative approach is to measure the change in the percent of district students falling into the first to twenty-fifth percentile and the seventy-six to one hundredth percentile. In this scenario one would want the student percentage to remain constant or increase for the upper percentile and remain constant or decrease for the lower percentile. Unfortunately, data was available for the 2001-02 school year only. However, by looking at Figure 11, you will note that ther are a number of districts in which the percentage of students within the lowest percentile is very high. These districts might be appropriate candidates for improvement.

Figure 11.
Percentage of District's Students Scoring in 75th Percentile or Higher



Percentage of District's Students Scoring in 25th Percentile or Lower

CONCLUSIONS AND RECOMMENDATIONS

Given that increased level of funding seems to have no relationship to achievement on standardized tests, the results of this study allows us to now start looking for those factors that do influence the quality of education, such as good teachers and small classes. It is apparent from the maps presented in this study that a number of school districts have been able to maintain a high level of achievement. What factors within these districts are allowing this to occur?

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