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ABSTRACT

During the 4-year period from 1995 to 1999, the mean mathematical and reading achievement scores of 11th graders at Slippery Rock Area High School (SRAHS) reflect a distinct decline. In the 1995-1996 school year, the SRAHS 11th grade standardized mathematics mean score was significantly higher than the Pennsylvania mean, as was the standardized reading mean. In the 1996-1997 school year, the SRAHS 11th grade mathematics mean was somewhat lower than that of the Commonwealth of Pennsylvania, but the difference was not statistically significant. The reading mean score was precisely the same as that of the Commonwealth in 1996-1997. Both the mathematics and the reading mean scores of SRAHS's 11th graders were significantly lower than the corresponding Commonwealth means for the 1997-1998 and the 1998-1999 school years. A cost-effectiveness analysis was performed to determine the relationship between district expenditures and 11th grade mathematics and reading achievement during the same 4-year period. Since the analysis was basically a correlational procedure, no cause-effect relationship can be assumed. Nevertheless, an inverse correlation of -0.960 was found between the two variables, thus indicating that increases in expenditures were accompanied by decreases in academic achievement. (Author/SLD)

Technical Report
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A Four-Year Analytic Comparison of Eleventh Grade Academic Achievement in the Slippery Rock Area High School, and District Pupil Expenditures

A Report Presented to

The Slippery Rock School District's Board of Directors

and

The Pennsylvania Department of Education

Educational Measurement and Evaluation Division

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ABSTRACT

A Four-Year Analytic Comparison of Eleventh Grade Academic Achievement in the Slippery Rock Area High School, and District Pupil Expenditures

During the four-year period of 1995-1999, the mean mathematical and reading achievement scores of Slippery Rock High School's (SRAHS) eleventh graders reflect a distinct decline. More specifically, in the 1995-1996 school year, the SRAHS eleventh grade standardized mathematics mean score was significantly higher than the Commonwealth mean, as was the standardized reading mean. In the 1996-1997 school year, the SRAHS eleventh grade mathematics mean was somewhat lower than that of the Commonwealth, but the difference was not statistically significant; and the reading mean score was precisely the same as that of the Commonwealth, also showing no significant difference between the two. However, both the mathematics and the reading mean scores of SRAHS's eleventh graders were significantly lower than the two Commonwealth means during the 1997-1998, as well as the 1998-1999 school year.

A cost-effectiveness analysis was performed to determine the relationship between District expenditures and eleventh grade mathematics and reading achievement during the same four-year period. Since the analysis was basically a correlational procedure, no cause-effect relationship can be assumed. Nevertheless, an inverse correlation of –0.960 was found between the two variables, thus indicating that increases in expenditures were accompanied by decreases in academic achievement.

A Four-Year Analytic Comparison of Eleventh Grade Academic Achievement in the Slippery Rock Area High School, and District Pupil Expenditures

Variables Examined

The mean mathematics and reading achievement scores and percentiles of the Slippery Rock Area High School (SRAHS) eleventh graders are reported for the 1995-1996, 1996-1997, 1997-1998, 1998-1999 school years, as measured and reported by the 1999 Pennsylvania System of School Assessment standardized tests (reliability coefficient for mathematics = 0.90 – 0.91; reliability coefficient for reading = 0.87 –0.88). Additionally, comparative figures juxtapose these students with eleventh graders representing the entire Commonwealth for these four school years.

District pupil expenditures are also reported for this four-year period. Moreover, a cost-effectiveness analysis depicting the relationship between District expenditures and SRAHS eleventh grade mean mathematics and reading scores is also provided for the four-year period.

Results

Eleventh Grade Mathematics Achievement. Statistical analytic comparisons between the SRAHS eleventh grade mathematics achievement means and those of the Commonwealth for the 1995-1996, 1996-1997, 1997-1998, and 1998-1999 school years are shown in Table 1. The overall mean mathematics test score for the SRAHS eleventh graders during 1995-1996 was 1380 (SD_{σ} = 100), while the overall mean statewide score was 1300 (SD_{σ} = 100). A z-test was computed to determine the

presence of a significant difference between the Slippery Rock eleventh grade mean score and the mean statewide test score, which was comprised of all tested eleventh graders in the Commonwealth. The result was significant ($z = 10.91$; $p < .05$), thus concluding that the Slippery Rock eleventh graders' mean performance was significantly higher than that of all tested eleventh graders in the Commonwealth.

The mean mathematics test score for the SRAHS eleventh graders during the 1996-1997 school year was 1290 ($SD_\sigma = 100$), while the overall mean statewide score was a 1300 ($SD_\sigma = 100$). Again, a *z*-test was used to determine the presence of a significant difference between the two mean scores. Although the SRAHS mean score was below the state average, the result was not significant ($z = -1.414$; $p > .05$). Hence, it is concluded that there was no significant difference between the mean mathematics score of the SRAHS eleventh graders, and the mean score of those eleventh graders tested throughout the Commonwealth.

The mean mathematics test score for SRAHS's eleventh graders during 1997-1998 school year was 1250 ($SD_\sigma = 100$), while the overall mean statewide score was 1300 ($SD_\sigma = 100$). A *z*-test determined the presence of a significant difference between the two mean scores ($z = -6.85$; $p < .05$), concluding this time that the mean score of the SRAHS eleventh graders was significantly lower than the Commonwealth's mean score.

The mean mathematics test score for SRAHS's eleventh graders during 1998-1999 school year was 1280, while the overall mean statewide score was 1300 ($SD_\sigma = 100$). A *z*-test determined the presence of a significant difference between the two mean scores ($z = -3.01$; $p < .05$), concluding this time that the mean score of the SRAHS eleventh graders was significantly lower than the Commonwealth's mean score.

Table 1

Descriptive Statistics for SRAHS Eleventh Grade Mathematics Achievement

Test	Date	M	SD_σ	z
Mathematics	1995-1996	1380	100	*10.91
Mathematics	1996-1997	1290	100	-1.414
Mathematics	1997-1998	1250	100	*-6.850
Mathematics	1998-1999	1280	83.50	*-3.010

* $p < .05$, two tailed

Note: The Commonwealth mean is 1300.

Eleventh Grade Reading Achievement. As depicted in Table 2, comparative statistical analyses were performed between SRAHS's eleventh grade mean reading achievement scores and those of the Commonwealth. The mean reading achievement test score for the SRAHS 1995-1996 eleventh graders was 1380 (SD_σ = 100), while the mean statewide score was 1300 (SD_σ = 100). A *z*-test revealed a significant difference ($z = 10.91$; $p < .05$) between the two means, thus disclosing that the mean reading achievement score of the SRAHS eleventh graders was significantly higher than the mean score of the total Commonwealth.

The mean reading achievement score for the SRAHS eleventh graders during the 1996-1997 school year was 1300 ($SD_\sigma = 100$), and the mean statewide score was also 1300 ($SD_\sigma = 100$). Obviously, a *z*-test ($z = 0.00$; $p > .05$) indicated no significant difference between the two means. Hence, the mean reading achievement score of these SRAHS eleventh graders was identical to that of the entire Commonwealth.

The mean reading achievement score for the 1997-1998 SRAHS eleventh graders was 1270 ($SD_\sigma = 100$), but the mean score of the Commonwealth was 1300 ($SD_\sigma = 100$). A *z*- test, computed to determine the presence of a significant difference between the SRAHS eleventh graders and the Commonwealth eleventh graders, disclosed a significant difference ($z = -4.11$; $p < .05$), thus concluding that the mean reading performance of the SRAHS eleventh graders was significantly lower than that of the Commonwealth's eleventh graders.

The mean reading achievement score for the 1998-1999 SRAHS eleventh graders was 1250, but the mean score of the Commonwealth was 1300 ($SD_\sigma = 80.40$). A *z*-test, computed to determine the presence of a significant difference between the SRAHS eleventh graders and the Commonwealth eleventh graders, disclosed a significant difference ($z = -7.76$; $p < .05$), thus concluding that the mean reading performance of the SRAHS eleventh graders was significantly lower than that of the Commonwealth's eleventh graders.

Table 2

Descriptive Statistics for SRAHS Eleventh Grade Reading Achievement

Test	Date	M	SD_σ	z
Reading	1995-1996	1380	100	*10.91
Reading	1996-1997	1300	100	0.00
Reading	1997-1998	1270	100	*-4.11
Reading	1998-1999	1250	80.40	*-7.76

$p < .05$, two tailed

Note: The Commonwealth mean is 1300.

Effect Sizes and Relative Standings of SRAHS Eleventh Graders

In efforts to portray the SRAHS eleventh grade mathematics and reading percentiles within the entire Commonwealth, effect sizes were computed for the 1995-1996, 1996-1997, 1997-1998, and 1998-1999 school years (Table 3; Figures 1 and 2). In the 1995-1996 school year, the mathematics effect size for the SRAHS eleventh graders was 0.800. This indicates that, on average, a SRAHS eleventh grader moved upward from the 50th to the 78th percentile in standard deviation units. Also during this same school year, the reading achievement effect size was

0.800, thus indicating another upward move from the 50th to the 78th percentile for a typical SRAHS eleventh grader.

In the 1996-1997 school year, the SRAHS eleventh grade mathematics achievement effect size decreased to –0.100, showing that the typical SRAHS eleventh grader moved downward from the 50th to the 46th percentile in standard deviation units. During this same period, the reading achievement effect size was 0.000, indicating that the average SRAHS eleventh grader remained at the 50th percentile.

In the 1997-1998 school year, the SRAHS eleventh grade mathematics effect size was –0.500, reflecting a downward move from the 50th to the 31st percentile for the typical SRAHS eleventh grader. Moreover, the reading achievement was also comparatively lower; in this instance it was –0.300, indicating that the average SRAHS eleventh grader moved downward from the 50th to the 38th percentile.

In the 1998-1999 school year, the SRAHS eleventh grade mathematics effect size was –0.240, reflecting a downward move from the 50th to the 40th percentile for the typical SRAHS eleventh grader. Moreover, the reading achievement was also comparatively lower; in this instance, it was –0.623, indicating that the average SRAHS eleventh grader moved dramatically downward, from the 50th to the 27th percentile.

Table 3

Effect Sizes and Relative Standings of SRAHS Eleventh Graders

Test	Date	ES	Percentile Rank
Mathematics	1995-1996	0.800	78th Percentile
Mathematics	1996-1997	-0.100	46th Percentile
Mathematics	1997-1998	-0.500	31st Percentile
Mathematics	1998-1999	-0.240	40th Percentile
Reading	1995-1996	0.800	78th Percentile
Reading	1996-1997	0.000	50th Percentile
Reading	1997-1998	-0.300	38th Percentile
Reading	1998-1999	-0.623	27th Percentile

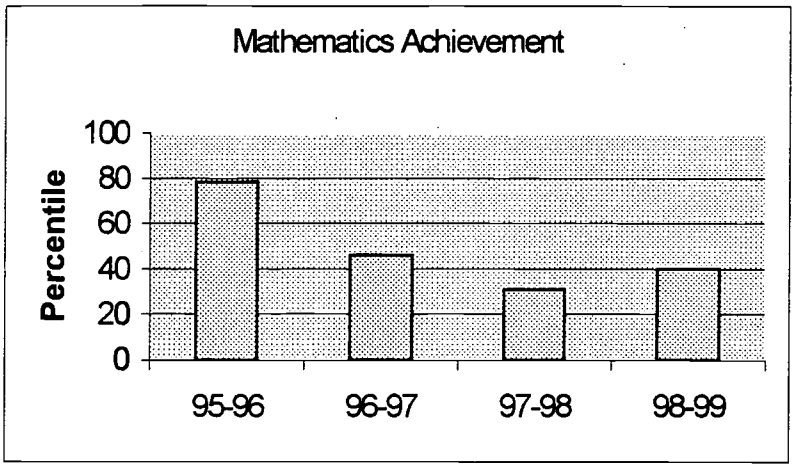

Figure 1. *SRAHS Eleventh Grade Mathematics Achievement Trend Analysis*

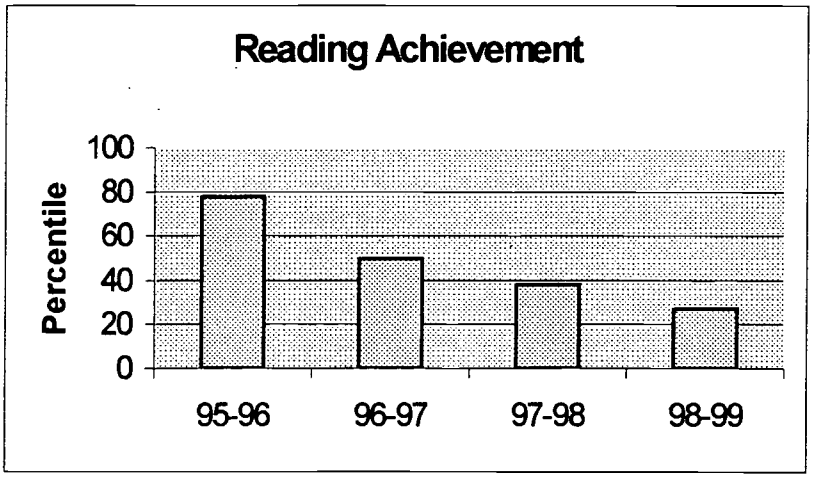

Figure 2. *SRAHS Eleventh Grade Reading Achievement Trend Analysis*

Relationship Between District Cost Per Student and SRAHS Eleventh Grade Mathematics and Reading Achievement

A cost-effectiveness analysis was performed to determine the presence of a relationship between District pupil expenditures and SRAHS eleventh grade academic achievement. As illustrated in Table 4, there was definitely a significant difference, $r = -0.960$, $n = 8$, $p < .01$, two tails; and Figure 3 displays a scatterplot reflecting a high correlation between the SRAHS mean eleventh grade mathematics and reading scores, and district pupil expenditures. However, this high correlation is negative. In essence, there is a high -- near perfect – inverse relationship between pupil expenditures and academic achievement in that as pupil expenditures rose, mathematics and reading achievement fell.

Table 4
Cost-effectiveness Analysis

Test/Year	Cost Per Student	Test Score	C/E Per Point
Mathematics/95-96	$6,178.00	1380	$4.48
Mathematics/96-97	$6,673.00	1290	$5.17
Mathematics/97-98	$6,915.00	1250	$5.53
Mathematics/98-99	$7,046.00	1280	$5.50
Reading/95-96	$6,178.00	1380	$4.48
Reading/96-97	$6,673.00	1300	$5.13
Reading/97-98	$6,915.00	1270	$5.44
Reading/98-99	$7,046.00	1250	$5.63

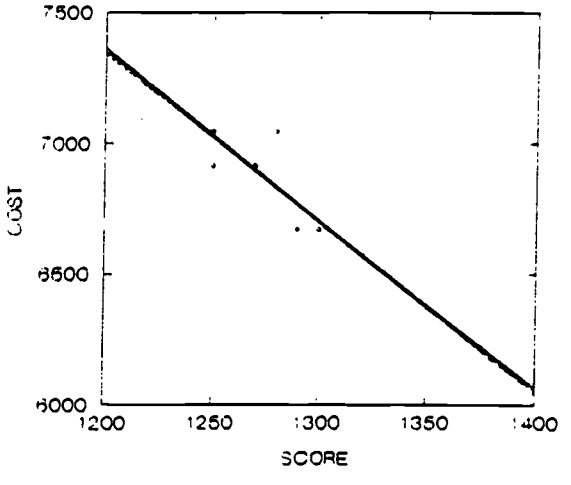

Figure 3. **Relationship Between District Cost Per Student and SRAHS Eleventh Grade Academic Achievement**

Summary

Both the standardized mean mathematics and reading scores of SRAHS's eleventh graders evidenced a pronounced downward trend during the investigated four-year period. More specifically, only during the 1995-1996 school year were both the mathematics and the reading means of SRAHS's eleventh graders significantly higher than those of the Commonwealth.

In the following school year, 1996-1997, the SRAHS eleventh grade mathematics mean was lower than the Commonwealth mean, but the difference was not statistically significant. Additionally, the SRAHS eleventh grade mean reading score also fell, but to the exact level of the statewide mean; hence, there was no significant difference between the two means.

The 1997-1998 school year reflected a continued, if not an accelerated decline in the SRAHS eleventh grade mathematics and reading mean scores. During this period the two SRAHS means were significantly lower than those of the Commonwealth.

The 1998-1999 school year was a continuation of the decline in the SRAHS eleventh graders' mean mathematics and reading scores. Specifically, both SRAHS eleventh grade means were significantly lower than the Commonwealth means.

Computations of the SRAHS eleventh grade effect sizes provide, perhaps, a more distinct profile of the downward progression of the SRAHS eleventh grade mean scores in these two academic areas during the 1995-1999 period. More specifically, during the 1995-1996 school year the typical SRAHS eleventh grader moved upward from the 50th to the 78th percentile in both mathematics and reading. Then in the 1996-1997 school year, the average SRAHS eleventh grader fell from the 50th to the 46th percentile in mathematics, while remaining at the 50th percentile in reading.

However, it should be remembered that, on average, these eleventh graders had been at the 78th percentile in both mathematics and reading during the previous year. Yet, with the 1997-1998 school year, the SRAHS eleventh grade students dropped from the 50th to the 31st percentile in mathematics, and from the 50th to the 38th percentile in reading. Then, in the 1998-1999 school year the SRAHS eleventh graders fell from the 50th percentile to the 40th percentile in mathematics, and from the 50th to the 27th percentile in reading. Obviously, moves from the 78th to the 40th and 27th percentiles constitute a glaring pattern of decline over the four-year period.

A cost effectiveness statistical procedure was performed to determine the presence of a correlation between the Slippery Rock Area School District's (SRASD) pupil expenditures and the mean standardized mathematics and reading scores of its eleventh graders over a three-year period. It should be understood, however, that virtually any correlational technique simply discloses the degree of a relationship between two variables – not a cause-effect relationship. Hence, it would be totally presumptuous to assume that either pupil expenditures or academic achievement is the cause (independent variable) and the other is the effect (dependent variable).

Nevertheless, the cost-effectiveness analysis disclosed an indisputably high negative correlation between the District's pupil expenditures and academic achievement in mathematics and reading. Almost synchronistically, as pupil expenditures increased, academic achievement fell. Again, this is not to imply a cause and effect relationship, simply a relationship between two variables.

Any possible cause-effect relationship proffered here is completely conjectural. Yet, the District achievement of those goals specified by the Commonwealth is questionable. Moreover, it is somewhat questionable as to whether the District's teachers have been properly informed of these statewide goals, which serve as the

basis for the Pennsylvania System School Assessment tests. However, if there are concerns about the concurrent validity of the Commonwealth's instrument, correlation figures should be obtained between it and the California Achievement Test; but it is the opinion here that such figures will be relatively high.

Undoubtedly, the SRASD directors have maintained a comparatively low tax base for the District's residents, despite the inverse relationship between pupil expenditures and academic achievement. Thus, it is possible that a redirection of monies rather than an increase in spending may be, at least, a partial solution to the downward trend in academic achievement that has characterized the District during the reported four-year period.

Reference

Pennsylvania Department of Education (1999). The Pennsylvania State Assessment System: Supplemental Documentation for 1999 Reading, Mathematics, and Writing Assessment Reports. Harrisburg, PA: Pennsylvania Department of Education Division of Reports.

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