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**Does School Size Effect Students' Academic Outcomes?**

**Abstract**

*Does the size of a school's student population influence academic achievement levels among its students? Evolving from the "smaller is better" discussions and emergent theory on educational outcomes and school size, this question guided a study of 303 Georgia high schools to determine if the total high school population or school size influenced students' outcomes defined in terms of test scores and graduation rates. We followed two basic steps to complete the study: 1. Statistical correlations between school size and student achievement were determined, and 2. If statistically significant positive correlations were found between school size and measures of student achievement. We then looked for the statistical effect of student population size on student outcomes. Achievement was measured by scores from the Scholastic Aptitude Reasoning Test (SAT) and Georgia High School Graduation Test (GHSGT) that included data from standardized tests in English, Mathematics, Science, Social Studies, and Writing. Applying Pearson's r facilitated comparisons among school populations and academic achievement measures. Effect was then established through regression reduction analysis. Based upon the findings of this study, school size played no significant importance in students' academic achievement. Therefore, regarding Georgia high schools, the size of the student population (school size) has little to no impact on academic achievement or graduation rates. This conclusion, however, may complement the arguments and developing theory that there is a point of maximum benefit or achievement levels in curvilinear measures of school size as compared to student outcomes and economy of scale.*

What exactly is a "small high school or a large high school" in today's changeable social and economic environments? How do students attending small schools compare to those in larger schools in the area of academics? It is suggested that, on average, high schools having no more than 700 students are small, while schools with over 1000 in enrollment are considered large; and that ideally, the high school should have 75 students per grade level (Lawrence et al., 1978). One of the more popular and well-documented studies on this topic found that high schools having less than 1000 students, specifically enrollments between 600 and 900 students had the highest gains in achievement from the 8th grade through the 12th grade (Lee & Smith, 1997). The Lee and Smith study used achievement *gains* as the outcome measure.

According to the United States Department of Education (2011), only 25% of students in the United States attend schools with more than 1000 students. With this recent finding and our ex post facto study discussed herein as supporting evidence, we advocate an evolving guiding principle or theory that hypothesizes how and why school size relates to academic achievement.

## Toward a Possible Theory of School Size and Academic Achievement

Throughout recent history of institutionalized education people have debated issues related to school size. For example, beginning in the 1950s, school size concerns became slanted toward larger schools. While the size of schools increased, the number of schools and school districts decreased. The trend gained popularity with publications by James Conant (1959, 1967), President of Harvard in the 1960s, and was followed by an increase in the alleged need for larger schools. Paralleling Conant's work, the publication of a *Big School, Small School* by Barker and Gump (1964) reported a study of five Kansas high schools ranging in size from 83 to 2,287 students. These authors concluded that smaller schools offered students a better opportunity to get involved in extracurricular activities, while they found that in larger schools, with more activities available, there were too many people competing for available positions. These and similar works such as the one conducted by Lee and Smith (1997) have set a foundation for a theory of student achievement in "small schools vs. large schools" (p. 205).

The space race and the assumed need for more, smarter students have been driving forces in the movement for larger schools. Trends toward larger school populations caused many smaller schools to be closed and combined into larger schools, especially in the state of Georgia during the 1980s. This state trend notwithstanding, "75% of American public secondary school students now attend schools enrolling 1,000 or fewer students; 15% of secondary school students attend schools ranging in size from 300 to 499 students, while 38% attend schools having less than 300 students" (United States Department of Education, 2011, p. 85). This leaves 25% of students in the United States attending schools with more than 1,000 students.

Large urban high schools have been given the distinction as the commonsensical staging ground for launching civic-minded adults into the larger society. Larger schools have been described as the *American Way* of providing education. Our schools, especially high schools, have evolved into complex organizations, and in many cases, large urban high schools have become the capstone of the Americanization process – efficient factories for producing citizen-workers employable in the well-run engines of United States commerce (Allen, 2002).

The high school is far more than simply a place of learning. It may be one of the few entities that unify a community; it is likely a source of community pride and a central gathering place. As communities grow, they must choose between creating a second high school and increasing the size of the existing school. Frequently, they choose the latter course, often for quite understandable reasons, few of which have anything to do with teaching and learning. Schools are typically built with practical considerations that focus on accommodating particular numbers of students. Very seldom does logic drive answers to questions such as:

- What size high school might work best for the students?
- What do we really want to accomplish as a school?
- What is the optimal number of students to achieve these goals?
  (Ready, Lee, & Welner, 2004).

Larger student populations have been publicized as being ideal to provide a quality, well-rounded education, with many opportunities for academic, as well as other forms of student achievement. Reasons for the increased school size include more competitive sports teams, bands, and other competitive groups within the school. In addition, the concept of larger schools provides a means of keeping the cohesive nature of a community. One of the most frequently observed reasons for encouraging the construction of large high schools has been the perceived need to have a winning football team (Observation by the authors). Having a large pool of football players from which to choose a team has been prevalent among many school districts. Lack of land or the significant expense of acquiring additional land has also prompted school size to grow. Land requirements for schools are a significant problem. For example, a 1,000 student high school in the United States typically requires 40 acres of land (Langdon, 2000).

While growth in school size has continued, many negative factors have surfaced. Increased levels of school violence are commonly associated with large schools. An example of this scenario is the horrifying Columbine High School incident, which occurred in a poorly designed school of over 1,900 students. Subsequent research by Keiser (2005) showed that of 13 high school shootings, seven involved total school enrollments of more than 1,000 students. While these are just examples of school size and violence, as schools grow larger, research indicates an increase in unacceptable behavior in crowded places of learning. A National Center for Education Statistics project conducted by Heaviside, Rowand, Williams, Farris, and Westat (1998) indicated that schools over 1,000 students had moderate to serious problems with many discipline issues including tardiness, physical conflicts, robbery, vandalism, alcohol and drug offenses, and gang activity.

Researchers and writers have begun to compile information on the benefits of small school sizes. Almost every facet of the large school problem has been countered with arguments indicating that smaller schools are better. Smaller schools are safer, have higher graduation rates, fewer dropouts, and improved attendance; and they nurture better student/teacher relationships (ACEF, 2011). While some geographic areas have begun to accept this line of reasoning and decrease school size, many other school districts continue to build fewer and therefore larger schools. This is especially evident in the area of high schools that have over 1,000 students. Yet, evidence suggests that a total enrollment of 400 students is actually sufficient to allow a high school to provide an adequate curriculum (Howley, 1994).

When all else is held equal (particularly community or individual socioeconomic status), comparisons of schools and districts based upon differences in enrollment generally favor smaller units (Howley & Howley, 2002). Furthermore, small school size is also associated with lower high school dropout rates (Howley & Howley, 2002).

These benefits extend not only to achievement, but to aspects of behavior and attitude. Students' attitudes and behavior improve as school size decreases. Small schools more positively impact the social behavior of ethnic minority and low-SES students than that of other students (Cotton, 1996). Students in small schools took more responsibility and more varied positions in their school's settings (Barker & Gump, 1964). Additionally, small schools hold other benefits, especially when considering the demographics of students (ACEF, 2011).

Teacher morale and students' attendance also increases as school size decreases. This is a result in not only smaller school size, but also the accompanying smaller class sizes. Many students, teachers, and administrators in larger schools find it hard to form strong relationships in such impersonal settings. It is the increase in teacher collaboration and team teaching, greater flexibility and responsiveness to student needs, and the personal connections among everyone within the system that make smaller schools work (Cutshall, 2003). Studies conducted over the past 10 to 15 years suggest that in smaller schools, students come to class more often, drop out less, earn better grades, participate more often in extracurricular activities, feel safer, and show fewer behavior problems (Viadero, 2001).

Information on the costs per student is a significant part of the school size question. This issue ties in with economies of scale, which is a long run concept referring to reductions in unit cost as the size of a facility and the usage levels of other inputs increase (Sullivan & Sheffrin, 2007). Research conducted on this issue provided the following results. The size of the student body is an important factor in relation to costs and outputs, and small academic and articulated alternative high schools costs are among the least per graduate of all New York City high schools. Though these smaller schools have somewhat higher costs per student, their much higher graduation rates and lower dropout rates produce among the lowest cost per graduate in the entire New York City system (Stiefel, Iatarola, Fruchter, & Berne, 1998).

For at least the past decade, a growing body of research has suggested that smaller high schools graduate more and better-prepared students than mega-sized schools. Barnett, Glass, Snowdon, and Stringer (2002) found that school performance was positively related to school size. Small size is good for the performance of impoverished schools, but it now seems as well that small district size is also good for the performance of such schools in Georgia, where district size, in single-level analyses, had revealed no influence. Because of the consistency of school-level findings in previous analyses, we strongly suspect that the Georgia findings characterize relationships in most other states (Bickel & Howley, 2000).

While school size is hypothesized to be important, the effects of the socioeconomic situation in a community must be considered. The socioeconomic effect has been broken into the large school and small schools areas. In research conducted on schools from Georgia, Ohio, Texas, and Montana, smaller schools reduce the negative effect of poverty on school performance by at least 20% and by as much as 70% and usually by 30-50% (Howley & Howley, 2002). The smallest national defile of school size maximizes the achievement of the poorest quartile of students (Howley & Howley, 2004)

In our study, socio-economic status (SES) is defined as the percentage of those receiving free or reduced price lunches at each school. Past research has shown that SES influences academic achievement. Dills (2006) found a large gap between high and low socioeconomic status student test scores. SES has frequently and consistently been the variable accounting for the largest amount of variance in educational studies (Tanner, 2009).

**A Promising Theory of School Size and Student Outcomes**

Currently a theory of school size is emerging as we begin to think in terms of economies of scale and student outcomes, simultaneously. The literature on the effects of school size is tangled with economic efficiency, curricular diversity, academic achievement, and related variables (Slate & Jones, 2005). These authors contend that there exist two curvilinear relationships: one for economic efficiency and one for educational outcomes. In both cases, *increasing school size initially brings positive effects but these trends are reversed as size continues to increase.* The point of diminishing returns for educational outcomes occurs with fewer students than is the case for economic efficiency. Optimal school size can be defined by a range in which economic efficiency and educational outcomes both show positive relationships to larger school size (Slate & Jones, 2005).

For our ex post facto study, we focused only on student outcomes as they relate to school size, yet we are keenly aware of the many mixtures of economy of scale and class size that exists in the literature (Fox, 1981; McGuffy & Brown, 1978; Slate & Jones, 2005). We focused on the popular variable of school size without any consideration for economics of scale because most of our decision-making groups in Georgia appear to rarely go beyond the popular local belief that *bigger is better*. Only school size and student achievement enters into our portion of the developing theory. We consider this study to be linked to the development of a scientific theory focused on explaining empirical phenomena, where our portion of the concept modestly states that *the size of the student population influences student outcomes.* We selected this unadorned definition because Georgia educational decision makers are caught up in testing as the primary measure of student success and frequently use arguments for size to justify whatever they want construct – large schools or small schools.

**Purpose of the Study**

The purpose of this ex post facto study was to determine the effect of the total high school population (net enrollment) on students' outcomes defined in terms of test scores and graduation rates. If a relationship were found to exist, then tests were completed to determine the extent of statistical effects. Achievement was measured by scores from the Scholastic Aptitude Reasoning Test (SAT) and Georgia High School Graduation Test (GHSGT). Data for the 2008-2009 school year were analyzed in this study.

**Research Hypothesis**

Guiding this study was the straightforward hypothesis that there is no statistically significant effect of the size of the student population in Georgia high schools on the academic achievement of students as measured by seven variables: Scholastic Aptitude Test (SAT), graduation rate per school, and average scores on the Georgia High School Graduation Tests in English, Mathematics, Science, Social Studies, and Writing. These variables are currently part of the Georgia testing program used to ensure that students qualifying for a diploma have mastered essential core academic content and skills.

**Constraints for the Study**

The following constraints helped to frame the study:

1. The study was limited to Georgia secondary schools configured for grades 9 through 12 on one campus. All schools meeting the criteria in the 2008-2009 school year were included.
2. All students were tested by valid means and the data were reported accurately.
3. School setting (rural, suburban, or urban) was not considered.
4. The unit of analysis was the school.
5. Socioeconomic status (SES) was used as the primary covariate in this study. This variable was represented as the percentage of students in each school receiving free and reduced price lunches. SES is the variable accounting for the largest amount of variance in educational studies (Tanner, 2009).
6. Economies of scale were not part of this study.

**Data Sources**

Annually, data from K-12 schools are submitted to the Governor's Office of Student Achievement (GOSA) by the Georgia Department of Education. For the 2008 school year, Georgia Department of Education analyzed and reported the test results according to specifications provided by GOSA in order that the state's Report Cards would comply with both federal and state laws.

## Collection and Analysis of the Data

The data for this ex post facto study were obtained from the Technology Management office of the Georgia Department of Education. Initially, it was in separate spreadsheets for each of the data points. These data were coded and transferred onto the Statistical Package for Social Sciences (SPSS) for analysis.

Table 1 reveals a summary of the complete data set. A total of 17 variables includes SES, SAT, student achievement data for five academic areas, graduation rates, size of the student population, levels of teacher training, and teacher experience per school. Regarding Table 1, SAT is the combined score of the mathematics, verbal, and writing portions of the SAT Reasoning Test. Student population is the net enrollment in the high school. Student population ranged from 284 to 4,116. The proxy for SES is the percentage of students receiving free or reduced price lunch. It is an indicator of a school population's poverty level. Graduation rate is calculated by dividing the number of students that graduated by the number entering the ninth grade four years earlier; however, it is adjusted for students that move to other school districts and those that move into the school district during this four-year time span. The Georgia High School Graduation Test, GHSGT, scores indicate the percentage of students that passed the five individual portions of the exam. Teacher education level is the number of teachers within each school that hold a certain degree level of certification. Teacher experience is the number of teachers within each school with a range of experience broken into 10-year increments.

Table 1

*A Summary of Data Collected for This Study (N = 303)*

| Variables | Min | Max | Mean | | Std. Deviation |
|---|---|---|---|---|---|
| | | | Statistic | Std. Error | Statistic |
| SAT | 1083.7 | 1743.8 | 1411.758 | 7.34 | 127.83 |
| Student Population | 284 | 4116 | 1370.71 | 39.20 | 682.45 |
| SES - % of Free and Reduced Lunch | .03 | .940 | .484 | .01 | .20 |
| Graduation Rate | 53.00 | 100.0 | 80.208 | .52 | 9.00 |
| English | .77 | 1.000 | .917 | .00 | .05 |
| Mathematics | .81 | 1.000 | .947 | .00 | .04 |
| Science | .64 | 1.000 | .898 | .00 | .06 |
| Social Studies | .55 | 1.000 | .872 | .00 | .08 |

(continued)

| Variables | Min | Max | Mean | | Std. Deviation |
|---|---|---|---|---|---|
| | | | Statistic | Std. Error | Statistic |
| GHSGT Writing | .68 | 1.000 | .901 | .00 | .06 |
| Teachers With BS | 8 | 74 | 33.23 | .91 | 15.80 |
| Teachers With Master's | 1 | 46 | 12.48 | .45 | 7.90 |
| Teachers With Specialist Degree | 4 | 115 | 39.70 | 1.17 | 20.45 |
| Teachers With Doc. | 0 | 12 | 2.29 | .13 | 2.19 |
| Experience < 10 Years | 6 | 113 | 39.22 | 1.30 | 22.63 |
| 11 - 20 Years Exp. | 2 | 80 | 24.89 | .67 | 11.65 |
| 21 - 30 Years Exp. | 0 | 55 | 15.02 | .44 | 7.77 |
| 30 + Years Exp. | 1 | 21 | 4.67 | .17 | 2.91 |

The comparisons among school population and academic achievement measures were made through Pearson's r, multiple regression, and regression reduction. Alpha was set at the .05 level. Assuming significant correlations among selected variables, effects of school size on SAT and GHSGT scores were determined by taking the difference between $R^2$ of the full regression and the $R^2$ of the reduced regression models. The reduced regression included the two sets of test variables (SAT and GHSGT) and a proxy for socioeconomic status (SES). SES is frequently used as a predictor of differences in achievement (Ferguson, 2002).

The full regression included the two test variables (SAT and GHSGT), SES, and school size. That is, in the final analysis it was projected that scores on SAT and GHSGT would be predicted by SES and school size.

Table 2 reveals the relationships among size of the school population and variables representing student achievement. For example, the correlation (r) between students' SAT scores and school size (STU POP) was $r = .327$, $\alpha = .001$. This may lead to the tentative finding that as the school size increases there is a significant chance that the students' SAT scores will also increase. Conversely, as the size of the student population decreases, the probability of a school having a lower SES is significant ($\alpha = .001$). Hence, $r = -381$, $\alpha = .001$ suggested a negative correlation between school size and SES.

Table 2

*Correlations Among the Variables (Pearson's r) (N = 303)*

| Variables as Coded | | SAT | Grad Rate | English | Math | Science | Social Studies | GHSGT Writing | SES | Stu Pop |
|---|---|---|---|---|---|---|---|---|---|---|
| SAT | Pearson r | 1 | .570** | .700** | .691** | .696** | .705** | .644** | -.800** | .327** |
| | p 2-tailed | | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 |
| Grad Rate | Pearson r | .570** | 1 | .645** | .551** | .606** | .681** | .657** | -.671** | .245** |
| | p 2-tailed | .000 | | .000 | .000 | .000 | .000 | .000 | .000 | .000 |
| English | Pearson r | .700** | .645** | 1 | .832** | .835** | .869** | .735** | -.750** | .338** |
| | p 2-tailed | .000 | .000 | | .000 | .000 | .000 | .000 | .000 | .000 |
| Math | Pearson r | .691** | .551** | .832** | 1 | .867** | .823** | .623** | -.691** | .242** |
| | p 2-tailed | .000 | .000 | .000 | | .000 | .000 | .000 | .000 | .000 |
| Science | Pearson r | .696** | .606** | .835** | .867** | 1 | .885** | .656** | -.719** | .238** |
| | p 2-tailed | .000 | .000 | .000 | .000 | | .000 | .000 | .000 | .000 |
| Social Studies | Pearson r | .705** | .681** | .869** | .823** | .885** | 1 | .724** | -.737** | .317** |
| | p 2-tailed | .000 | .000 | .000 | .000 | .000 | | .000 | .000 | .000 |
| GHSGT Writing | Pearson r | .644** | .657** | .735** | .623** | .656** | .724** | 1 | -.674** | .429** |
| | p 2-tailed | .000 | .000 | .000 | .000 | .000 | .000 | | .000 | .000 |
| SES | Pearson r | -.800** | -.671** | -.750** | -.691** | -.719** | -.737** | -.674** | 1 | -.381** |
| | p 2-tailed | .000 | .000 | .000 | .000 | .000 | .000 | .000 | | .000 |
| Stu Pop | Pearson r | .327** | .245** | .338** | .242** | .238** | .317** | .429** | -.381** | 1 |
| | p 2-tailed | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | |

*Note*: ** Correlation is significant at the 0.01 level (2-tailed)

The correlation between the school's graduation rate and school size (STU POP) was r = .245, α = .001. This might lead to a speculative finding that as the school size increases there is a significant chance that the graduation rate will also increase. The correlation between the student's score on the English, Mathematics, Science, Social Studies, and Writing portions of the Georgia High School Graduation Test and school size (STU POP) was r =.338, r = .242, r = .238, r = .317, and r = .429 respectively, all at α = .001. These results may also lead to the provisional finding that as the school size increases there is a significant chance that the student's scores for these tests will also increase. This assertion is challenged in the following analysis.

**Controlling for Variables That May Influence Student Achievement**

The discussion about data in the preceding tables dealt with basic, Pearson's correlations. Now consider this question: What if several variables are linked together to determine the influence of school size on student achievement? To begin this analysis, data in Table 3 were generated with the objective to find a defensible predictor or a set of significant predictors of student accomplishments from variables such as SES, experience levels of teachers, and the education levels of teachers. The question of concern was: What variable identified in this study and data set, other than school size, might influence student outcomes? The first model to assist in answering this question is shown in Table 3. The model included all variables in the data set except the size of the school (student population) since it was the dependent variable of concern or focus for this study. That is, how does the size of the student population in a school influence student outcomes?

Table 3

*Selecting Control Variables (N = 303) - Descriptive Statistics*

| Variables as Coded | Range | Minimum | Maximum | Mean | |
|---|---|---|---|---|---|
| | Statistic | Statistic | Statistic | Statistic | Std. Error |
| SAT | 660.1 | 1083.7 | 1743.8 | 1411.76 | 7.34 |
| Stu Pop | 3832 | 284 | 4116 | 1370.71 | 39.21 |
| SES | .910 | .031 | .940 | .49 | .01 |
| Grad Rate | 47.0 | 53.0 | 100.0 | 80.21 | .52 |
| English | .230 | .770 | 1.0000 | .92 | .00 |
| Mathematics | .187 | .813 | 1.0000 | .95 | .00 |
| Science | .360 | .640 | 1.0000 | .90 | .00 |
| Social Stu | .450 | .550 | 1.0000 | .87 | .00 |
| GHSGT Writing | .317 | .683 | 1.0000 | .90 | .00 |
| Teacher BS | 66 | 8 | 74 | 33.23 | .91 |

(continued)

| Variables as Coded | Range Statistic | Minimum Statistic | Maximum Statistic | Mean | |
|---|---|---|---|---|---|
| | | | | Statistic | Std. Error |
| Teacher MS | 45 | 1 | 46 | 12.48 | .45 |
| Teacher SP | 111 | 4 | 115 | 39.70 | 1.18 |
| Teacher Doc | 12 | 0 | 12 | 2.29 | .13 |
| T less 10years | 107 | 6 | 113 | 39.22 | 1.30 |
| T 11 to 20 years | 78 | 2 | 80 | 24.89 | .67 |
| T 21 to 30years | 55 | 0 | 55 | 15.02 | .45 |
| T 30 Plus | 20 | 1 | 21 | 4.67 | .17 |

Power analysis was the technique employed to select the control variables (Table 4), a statistical test for making a decision as to whether or not to reject the null hypothesis when the alternative hypothesis is true (i.e., that a Type II error will be avoided). According to Cohen (1988), as power increases, the chances of a Type II error decrease. The probability of a Type II error is referred to as the false negative rate (β). Therefore, power is equal to $1 - \beta$. This analysis was conducted with the standard $\alpha = .05$, meaning that there is a 95% chance, or higher, of accepting the null hypothesis when it is true. Type II errors occur when a null hypothesis is incorrectly accepted when it should be rejected. The index of power reveals that SES is the only significant predictor variable in the data set (Table 4).

Table 4

*Power Analysis*

| Effect | Value | F | Sig. | Observed Power |
|---|---|---|---|---|
| Intercept | .01 | 3721.66 | .00 | 1.00 |
| SES | .29 | 96.01 | .00 | 1.00 |
| Teacher BS | .98 | .51 | .82 | .22 |
| Teacher MS | .95 | 1.96 | .05 | .76 |
| Teacher SP | .94 | 2.34 | .02 | .85 |
| Teacher Doc | .92 | 3.15 | .00 | .94 |

(continued)

| Effect | Value | F | Sig. | Observed Power |
|---|---|---|---|---|
| T less 10 years | .97 | 1.09 | .36 | .47 |
| T 11 to 20 years | .94 | 2.22 | .03 | .82 |
| T 21 to 30 years | .95 | 2.07 | .04 | .79 |
| T 30 Plus | .96 | 1.39 | .20 | .58 |

SES was found to be a significant predictor of student outcomes; observed power = 1.0. It was selected to serve as an independent variable in each test of the seven research questions generated from the research hypothesis. An observed power of .95 or higher was the decision index employed to select or reject a variable as a significant predictor. Note at this stage in the analysis, school size had not been considered, since it was to be included with all other variables that might significantly influence student achievement or outcomes as defined in this study.

**Determining the Correlation Coefficients between Student Outcomes and the Independent Variables in the Prediction Model**

In statistical analysis, the coefficient of determination, $R^2$ is used in models whose main purpose is the prediction of future outcomes on the basis of other related information. It is the proportion of variability in a data set that is accounted for by the statistical model. The $R^2$ provides a measure of how well future outcomes are likely to be predicted by the model. This study employed $R^2$ in the context of linear regression; where $R^2$ is the square of the correlation coefficient between the outcomes and their predicted values, or in the case of simple linear regression in this study, the correlation coefficient between the outcome and the values being used for prediction. In such cases, the values vary from 0.0 to 1.0 (Steel & Torrie, 1960).

Since the power analysis found SES as the only significant predictor of student outcomes, the next step entailed the calculation of $R^2$ for this prediction model by including SES first, and then school size. The analysis pertaining to the influence of SES is found in Table 5. The analysis of the dominant independent variable, SES, was analyzed through regression procedures that included comparisons with the seven dependent variables (measuring student outcomes) (Table 5). The $R^2$ per dependent variable to be included in the analysis is found at the end of Table 6 (Regression); for example, the $R^2$ for SAT was .640.

Table 5

*Establishing $R^2$ for SES per Variable*

| Variable | Mean | Std. Deviation |
|---|---|---|
| Grad Rate | 80.208 | 9.004 |
| English | .917 | .046 |
| Mathematics | .947 | .038 |
| Science | .898 | .063 |
| Social Stu | .872 | .075 |
| GHSGT Writing | .901 | .058 |
| SAT | 1411.758 | 127.827 |

(Wilks' Lambda)[a]

| Effect | Value | F | Hypothesis df | Error df | Sig. | Observed Power[α] |
|---|---|---|---|---|---|---|
| Intercept | .003 | 12011.940[a] | 7.000 | 295.000 | .000 | 1.000 |
| SES | .259 | 120.669[a] | 7.000 | 295.000 | .000 | 1.000 |

*Note*: [a] Design: Intercept + SES

Table 6

*Reduced Regression*

| Source | Dependent Variable | Type III Sum of Squares | df | Mean Square | F | Sig. | Observed Power[b] |
|---|---|---|---|---|---|---|---|
| Corrected Model | Grad Rate | 11018.564[a] | 1 | 11018.564 | 246.355 | .000 | 1.000 |
| | English | .359[c] | 1 | .359 | 387.254 | .000 | 1.000 |
| | Mathematics | .204[d] | 1 | .204 | 274.890 | .000 | 1.000 |
| | Science | .627[e] | 1 | .627 | 321.459 | .000 | 1.000 |
| | Social Stu | .934[f] | 1 | .934 | 357.105 | .000 | 1.000 |

(continued)

| Source | Dependent Variable | Type III Sum of Squares | df | Mean Square | F | Sig. | Observed Power[b] |
|---|---|---|---|---|---|---|---|
| Corrected Model, cont. | GHSGT Writing | .458[g] | 1 | .458 | 250.300 | .000 | 1.000 |
| | SAT | 3.159E6 | 1 | 3.159E6 | 535.672 | .000 | 1.000 |
| Intercept | Grad Rate | 390318.073 | 1 | 390318.073 | 8726.807 | .000 | 1.000 |
| | English | 43.346 | 1 | 43.346 | 46732.918 | .000 | 1.000 |
| | Mathematics | 44.215 | 1 | 44.215 | 59573.663 | .000 | 1.000 |
| | Science | 44.090 | 1 | 44.090 | 22615.377 | .000 | 1.000 |
| | Social Stu | 43.951 | 1 | 43.951 | 16804.622 | .000 | 1.000 |
| | GHSGT Writing | 42.965 | 1 | 42.965 | 23496.095 | .000 | 1.000 |
| | SAT | 1.195E8 | 1 | 1.195E8 | 20260.953 | .000 | 1.000 |
| SES | Grad Rate | 11018.564 | 1 | 11018.564 | 246.355 | .000 | 1.000 |
| | English | .359 | 1 | .359 | 387.254 | .000 | 1.000 |
| | Mathematics | .204 | 1 | .204 | 274.890 | .000 | 1.000 |
| | Science | .627 | 1 | .627 | 321.459 | .000 | 1.000 |
| | Social Stu | .934 | 1 | .934 | 357.105 | .000 | 1.000 |
| | GHSGT Writing | .458 | 1 | .458 | 250.300 | .000 | 1.000 |
| | SAT | 3.159E6 | 1 | 3.159E6 | 535.672 | .000 | 1.000 |
| Error | Grad Rate | 13462.625 | 301 | 44.726 | | | |
| | English | .279 | 301 | .001 | | | |
| | Mathematics | .223 | 301 | .001 | | | |
| | Science | .587 | 301 | .002 | | | |

(continued)

| Source | Dependent Variable | Type III Sum of Squares | df | Mean Square | F | Sig. | Observed Power[b] |
|---|---|---|---|---|---|---|---|
| Error, cont. | Social Stu | .787 | 301 | .003 | | | |
| | GHSGT Writing | .550 | 301 | .002 | | | |
| | SAT | 1.775E6 | 301 | 5897.895 | | | |
| Total | Grad Rate | 1.974E6 | 303 | | | | |
| | English | 255.203 | 303 | | | | |
| | Mathematics | 272.366 | 303 | | | | |
| | Science | 245.598 | 303 | | | | |
| | Social Stu | 232.055 | 303 | | | | |
| | GHSGT Writing | 247.156 | 303 | | | | |
| | SAT | 6.088E8 | 303 | | | | |
| Corrected Total | Grad Rate | 24481.189 | 302 | | | | |
| | English | .638 | 302 | | | | |
| | Mathematics | .427 | 302 | | | | |
| | Science | 1.214 | 302 | | | | |
| | Social Stu | 1.721 | 302 | | | | |
| | GHSGT Writing | 1.008 | 302 | | | | |
| | SAT | 4.935E6 | 302 | | | | |

*Note*: a. R Squared = .450 (Adjusted R Squared = .448) – Graduation Rates
c. R Squared = .563 (Adjusted R Squared = .561) – English
d. R Squared = .477 (Adjusted R Squared = .476) – Mathematics
e. R Squared = .516 (Adjusted R Squared = .515) – Science
f. R Squared = .543 (Adjusted R Squared = .541) – Social Studies
g. R Squared = .454 (Adjusted R Squared = .452) – Writing
h. R Squared = .640 (Adjusted R Squared = .639) – SAT

**Determining the Significance of SES and School Size on Student Outcomes**

The next step was to isolate the $R^2$ for the independent variable (SES) and the seven independent variables. Therefore, the set of $R^2$s per the seven independent variables represents the *full regression* (Table 7). Next, the information needed to determine the effect of school size was determined. Table 8 shows the $R^2$ values for the full regression.

Table 7

*Establishing $R^2$ for SES and Size of the School*

| Variable | Mean | Std. Deviation |
|---|---|---|
| Grad Rate | 80.208 | 9.003 |
| English | .917 | .046 |
| Mathematics | .947 | .038 |
| Science | .898 | .063 |
| Social Stu | .872 | .075 |
| GHSGT Writing | .901 | .058 |
| SAT | 1411.758 | 127.827 |

(Wilks' Lambda) [a]

| Effect | Value | F | Hypothesis df | Error df | Sig. | Partial Eta Squared | Observed Power[b] |
|---|---|---|---|---|---|---|---|
| Intercept | .009 | 4864.098[a] | 7.000 | 294.000 | .000 | .991 | 1.000 |
| SES | .294 | 100.669[a] | 7.000 | 294.000 | .000 | .706 | 1.000 |
| Stu Pop | .893 | 5.016[a] | 7.000 | 294.000 | .000 | .107 | .997 |

*Note:* [a] Design: Intercept + SES + STU POP

Table 8

*Full Regression*

| Source | Dependent Variable | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared | Observed Power [b] |
|---|---|---|---|---|---|---|---|---|
| Corrected Model | Grad Rate | 11021.991[a] | 2 | 5510.995 | 122.838 | .000 | .450 | 1.000 |
| | English | .361[c] | 2 | .181 | 195.498 | .000 | .566 | 1.000 |
| | Mathematics | .204[d] | 2 | .102 | 137.283 | .000 | .478 | 1.000 |
| | Science | .628[e] | 2 | .314 | 161.133 | .000 | .518 | 1.000 |
| | Social Stu | .937[f] | 2 | .468 | 179.099 | .000 | .544 | 1.000 |
| | GHSGT Writing | .493[g] | 2 | .246 | 143.386 | .000 | .489 | 1.000 |
| | SAT | 3.162E6 | 2 | 1.581E6 | 267.634 | .000 | .641 | 1.000 |
| Intercept | Grad Rate | 160521.903 | 1 | 160521.903 | 3577.967 | .000 | .923 | 1.000 |
| | English | 17.409 | 1 | 17.409 | 18844.518 | .000 | .984 | 1.000 |
| | Mathematics | 18.154 | 1 | 18.154 | 24403.719 | .000 | .988 | 1.000 |
| | Science | 18.279 | 1 | 18.279 | 9373.233 | .000 | .969 | 1.000 |
| | Social Stu | 17.608 | 1 | 17.608 | 6733.489 | .000 | .957 | 1.000 |
| | GHSGT Writing | 16.360 | 1 | 16.360 | 9522.209 | .000 | .969 | 1.000 |
| | SAT | 4.822E7 | 1 | 4.822E7 | 8161.441 | .000 | .965 | 1.000 |
| SES | Grad Rate | 9556.678 | 1 | 9556.678 | 213.014 | .000 | .415 | 1.000 |
| | English | .288 | 1 | .288 | 312.083 | .000 | .510 | 1.000 |
| | Mathematics | .179 | 1 | .179 | 240.974 | .000 | .445 | 1.000 |
| | Science | .559 | 1 | .559 | 286.874 | .000 | .489 | 1.000 |

(continued)

| Source | Dependent Variable | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared | Observed Power [b] |
|---|---|---|---|---|---|---|---|---|
| SES, cont. | Social Stu | .763 | 1 | .763 | 291.876 | .000 | .493 | 1.000 |
| | GHSGT Writing | .307 | 1 | .307 | 178.801 | .000 | .373 | 1.000 |
| | SAT | 2.633E6 | 1 | 2.633E6 | 445.766 | .000 | .598 | 1.000 |
| Stu Pop | Grad Rate | 3.427 | 1 | 3.427 | .076 | .782 | .000 | .059 |
| | English | .002 | 1 | .002 | 2.199 | .139 | .007 | .315 |
| | Mathematics | .000 | 1 | .000 | .308 | .579 | .001 | .086 |
| | Science | .002 | 1 | .002 | .907 | .342 | .003 | .158 |
| | Social Stu | .003 | 1 | .003 | 1.042 | .308 | .003 | .174 |
| | GHSGT Writing | .035 | 1 | .035 | 20.367 | .000 | .064 | .994 |
| | SAT | 2923.097 | 1 | 2923.097 | .495 | .482 | .002 | .108 |
| Error | Grad Rate | 13459.198 | 300 | 44.864 | | | | |
| | English | .277 | 300 | .001 | | | | |
| | Mathematics | .223 | 300 | .001 | | | | |
| | Science | .585 | 300 | .002 | | | | |
| | Social Stu | .785 | 300 | .003 | | | | |
| | GHSGT Writing | .515 | 300 | .002 | | | | |
| | SAT | 1.772E6 | 300 | 5907.811 | | | | |
| Total | Grad Rate | 1.974E6 | 303 | | | | | |
| | English | 255.203 | 303 | | | | | |

(continued)

| Source | Dependent Variable | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared | Observed Power [b] |
|---|---|---|---|---|---|---|---|---|
| Total, cont. | Mathematics | 272.366 | 303 | | | | | |
| | Science | 245.598 | 303 | | | | | |
| | Social Stu | 232.055 | 303 | | | | | |
| | GHSGT Writing | 247.156 | 303 | | | | | |
| | SAT | 6.088E8 | 303 | | | | | |
| Corrected Total | Grad Rate | 24481.189 | 302 | | | | | |
| | English | .638 | 302 | | | | | |
| | Mathematics | .427 | 302 | | | | | |
| | Science | 1.214 | 302 | | | | | |
| | Social Stu | 1.721 | 302 | | | | | |
| | GHSGT Writing | 1.008 | 302 | | | | | |
| | SAT | 4.935E6 | 302 | | | | | |

*Note*: a. R Squared = .450 (Adjusted R Squared = .447) – Graduation Rate
c. R Squared = .566 (Adjusted R Squared = .563) – English
d. R Squared = .478 (Adjusted R Squared = .474) – Mathematics
e. R Squared = .518 (Adjusted R Squared = .515) – Science
f. R Squared = .544 (Adjusted R Squared = .541) – Social Studies
g. R Squared = .489 (Adjusted R Squared = .485) – GHSGT Writing
h. R Squared = .641 (Adjusted R Squared = .638) - SAT

**The Impact of School Size on Student Outcomes**

School size in this study was used interchangeably with the size of the student population. However, size did not include architectural square footage per school. That distinction may be used in a future study where square footage is considered. This issue relates to freedom of movement, a variable found to be significant in student achievement (Tanner, 2009).

The difference in the $R^2$ per variable (Compare the difference between R-squares in Table 6 and Table 8) represents the statistical effect that school size (size of the student population) has on each independent variable. Effect size is a measure of the strength of the relationship between two variables in a population, or a sample-based estimate of that quantity. An effect size calculated from data is a descriptive statistic that conveys the estimated magnitude of a relationship (Wilkinson, 1999). By testing the significance of difference between two R-squares, the effect of adding the independent variable (school size) to the model can be determined. In this study, the difference between the two R-squares is the effect of adding school size as found in Table 9.

Table 9

*The Effect of School Size on Student Achievement*

| Variable | $R^{2\ \text{SES and School Size}}$ When SES and School Size Are Included | $R^{2\ \text{SES}}$ When SES is Included | Effect (Change in $R^{2}$) $R^{2\ \text{SES and School Size}} - R^{2\ \text{SES}}$ | Significance of Effect [a] $\alpha \leq .05$ |
|---|---|---|---|---|
| SAT | .641 | .640 | .001 | .482 |
| Graduation Rate | .450 | .450 | .000 | .782 |
| English | .566 | .563 | .003 | .139 |
| Mathematics | .478 | .477 | .001 | .579 |
| Science | .518 | .516 | .002 | .342 |
| Social Studies | .544 | .543 | .001 | .308 |
| GHSGT Writing | .489 | .454 | .035 | .001 ** |

*Note*: [a] An example of the calculations for the significance of $R^2$ change (Effect) on SAT is found in the Appendix. Because of the extensive number of calculations, the other six variables are excluded, but may be obtained from the lead author.
** Significant at the .001 level.

In this study of 303 high schools in Georgia, school size had no effect on the SAT, high school graduation rate, English scores, mathematics scores, science scores, and scores on social studies tests. However, when the writing test was considered, the $\alpha = .001$ revealed that the effect of .035 was statistically significant. This statistic might lead to the conclusion that the larger the high school in Georgia, the higher the probability that students will make better scores in writing. Since this was the only significant finding out of seven variables, we may deliberate whether this was a random effect or whether the effect was actually significant.

## Summary of the Findings

Reviewing the data generated in Table 9, note that school size had an effect of .001 ($\alpha =$ .482) on SAT scores. This is contrary to findings of the Texas policy report (Texas Education

Agency, 1999) that indicated that larger schools had a positive effect upon SAT scores. It does not contradict the Lee and Smith (1997) study and calls into question the notion that large urban high schools are best as reported by Allen (2002).

The effect upon graduation rate was 0.0 ($\alpha$ = .782). This disagrees with research indicating that size affects dropout rates and therefore graduation rates (ACEF, 2011; Cotton, 1996). The effect of school size on the student's GHSGT score in English was .003 ($\alpha$ = .139), while the effect of school size on Mathematics was .001 ($\alpha$ = .579), on GHSGT in Science was .002 ($\alpha$ = .342), and on the GHSGT in Social Studies was .001 ($\alpha$ = .308). Gardner (2001) found similar results in studying high schools in Maine using a similar testing system.

The effect of school size on the Writing portion of the GHSGT was found to be .035 ($\alpha$ = .001). This is significant, but cannot be ruled out as a random effect.

## Conclusion

Based upon the findings of this study, school size plays little importance in the measures of academic achievement in Georgia high schools. Our Supporters of large or small high schools in Georgia can say that when controlling for SES, *school size* has little to no impact on academic achievement or graduation rates. This does not deny or refute works supporting small schools as they relate to increased attendance, safety, and many other documented benefits.

Our emerging theory indicating that *the size of the student population (school size) influences student outcomes* cannot be supported by the analysis of this data set when used separately from economies of scale and curve linear modeling. Our unadorned theory component cannot be justified from this study. Therefore, educational decision makers in Georgia may continue to use arguments for school size to justify whatever they want to build.

Our component of theory served its purpose for one population. Only after we get serious about conducting research suggested by Slate and Jones (2005) can we clearly defend an emerging theory about school size, economies of scale, and student achievement. Slate and Jones (2005) stated:

> We hope that readers have a deeper understanding of the current literature on school size and educational quality. . . . The major need is for a comprehensive theoretical model to guide research efforts, integrate the results, and facilitate decision making. One of our purposes in writing this paper was to stimulate discussion among researchers that will lead to such a model. In addition, what is currently known about school size is not well utilized by educational decision-makers. Conflicts in the literature that are more apparent than real have, unfortunately, decrease the perceived usefulness of the existing knowledge base. In addition, there has been an overemphasis on reducing expenditures rather than a focus on how school size affects the quality of students' education. . . . If we have stimulated your curiosity, and created the desire to address the issues involved, we have fulfilled our purposes. (p. 16)

Unfortunately, in Georgia we exist in a political climate dominated by leaders that hold measurement of achievement as the primary indicator of student success. Until we educate school leaders, school boards, planners, architects, and the general public about the importance of variables such as increased student attendance, student participation in extra curricula activities, improved student/teacher relationships, and safety in smaller schools, as compared just to test scores, we are going to be *stuck* with too many individuals that support large high schools.

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**Appendix**
Statistical Analysis of Effect (R Square Change)
(N = 303)

| Variable | Mean | Std. Deviation |
|---|---|---|
| SAT | 1411.758 | 127.827 |
| SES | .484 | .198 |
| STU POP | 1370.71 | 682.451 |

Correlations

| | | SAT | SES | STU POP |
|---|---|---|---|---|
| Pearson Correlation | SAT | 1.000 | -.800 | .327 |
| | SES | -.800 | 1.000 | -.381 |
| | STU POP | .327 | -.381 | 1.000 |
| Sig. (1-tailed) | SAT | . | .000 | .000 |
| | SES | .000 | . | .000 |
| | STU POP | .000 | .000 | . |

Model Summary

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate | Change Statistics | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | R Square Change | F Change | df1 | df2 | Sig. F Change |
| 1 | .801[a] | .641 | .638 | 76.862 | .641 | 267.634 | 2 | 300 | .000 |
| 2 | .800[b] | .640 | .639 | 76.798 | -.001 | .495 | 1 | 300 | .482 |

*Note*: a. Predictors: (Constant), STU POP, SES
b. Predictors: (Constant), SES

ANOVA

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 3.162E6 | 2 | 1.581E6 | 267.634 | .000[a] |
| | Residual | 1.772E6 | 300 | 5907.811 | | |
| | Total | 4.935E6 | 302 | | | |
| 2 | Regression | 3.159E6 | 1 | 3.159E6 | 535.672 | .000[b] |
| | Residual | 1.775E6 | 301 | 5897.895 | | |
| | Total | 4.935E6 | 302 | | | |

*Note*: a. Predictors: (Constant), STU POP, SES
b. Predictors: (Constant), SES
c. Dependent Variable: SAT