Elementary Science Student Achievement and School District Enrollment Sizes in Texas

Glenda Holland, EdD
Chair of Educational Leadership and Counseling
Texas A&M University Kingsville
Kingsville, TX

Matthew Mann
Christopher Daniels
Jessica Hester
Doctoral Students in Educational Leadership
Texas A&M University Kingsville
Kingsville, TX

ABSTRACT

Determining the best school size to maximize student achievement is a longstanding topic within educational research. This study examined this question through the parameters of elementary science as measured by the 5th grade science Texas Assessment of Knowledge and Skills (TAKS). This ex-post facto study examined student averages and economically disadvantaged identified students from all reporting school districts in Texas. The finding of this study indicates that a difference exists in student achievement in science by district size. Larger school districts had higher student scores on the 5th grade science TAKS than the rural and smaller districts for all students tested. Economically disadvantaged students had similar results to the scores of all students, and the larger school districts had higher student scores than their rural and smaller school counterparts.

Little comprehensive research has been done to determine the reason for a gap in performance between rural students and their suburban counterparts (Khattri, Riley, & Kane, 1997). Much like urban schools, staffing issues continue to plague rural schools particularly as related to finding highly qualified faculty and experienced leadership (Browne-Ferrigno & Allen, 2006). Issues such as these coupled with the need to provide a comprehensive and rigorous curriculum with limited means and resources, often places students in rural and small schools at a disadvantage compared to their urban school counterparts.

Literature Review

The Struggle for Equity in Large and Small Schools

The struggle for equity and equality in education is a major concern for educators. Today, more than ever before, educators are scrambling to fill the achievement gap between students' socioeconomic status. Students who are economically disadvantaged are especially at risk of dropping out. To resolve this issue, there was a bi-partisan effort to ratify the No Child Left Behind (NCLB) Act of 2001 which provides strict accountability measures for states to follow. At the forefront of the discussion, small school districts vs. conglomerate school districts are debated in order to determine which system is more adept to close the achievement gap.

There are many variables that come into play in debating whether a small school or large school is conducive to student achievement. Some variables may vary and could be based on the location of the school district, financial assistance, qualified administrators and teachers, crime rates, as well as many more factors. The general consensus amongst researchers manifests insomuch that small, rural—schools enjoy more success due to a reduction in number from the teacher-to-student ratio even in poverty stricken areas of the United States. In one study of a small school district in the state of Alaska, Diaz (2008) states, "Essentially, disadvantaged students performed better in smaller schools in Alaska and worse in larger schools and districts" (p. 31). Researchers seem to be concerned about the conglomerate mega-schools (3000 plus students) and the achievement of minorities and economically disadvantaged students. Since minorities are more likely to live in urban areas where schools are more susceptible to overcrowding, researchers suggest that minorities are especially at risk dropping out due to educational deficiencies in the current system.

The problem further extends to the point that districts are continuing to grow larger and classrooms are facing severe overcrowding issues. The overcrowding is especially problematic when large schools have large populations of students of low socioeconomic status. Small districts seem to have higher achieving students (Abbott, Joireman, & Stroh, 2002).

In 1999 researchers collaborated on the Matthew Project, a study of school size and poverty and how students are affected by it. Through a nationwide comparative analysis of Texas, Ohio, Georgia, and Montana, researchers determined that there was a negative effect of poverty and student achievement. "It was further noted that most high schools in the four states studied were too large to maximize achievement among the economically disadvantaged populations" (Stewart, 2009, p. 21). Cotton (1996) also suggested that economically disadvantaged students seem to do better in small schools rather than large ones. Though this is not inclusive for all situations that may or may not affect economically disadvantaged students in urban settings, researchers of the Matthew Project concur that in the case of education and socioeconomic status, smaller is better.

Texas elementary students do not perform well on science exams at the national level. Texas fourth graders (75%) scored below proficiency levels in science, and 86% of the Hispanic students tested did not meet proficiency either (National Assessment of Educational Progress, 2005). There is not a single answer to this problem, but rather there is a combination of issues. Since 2001 and No Child Left Behind (NCLB), which primarily targets mathematics and reading, there has been a 32% decrease nation-wide on the amount of minutes in school spent on other subjects, science included (McMurrer, 2008). Unfortunately, research has also indicated that even not even that much time is spent on elementary science (Fulp, 2002a). In 2007, a California survey found that while 80% of elementary teachers reported spending 60 minutes or less per week on science, some teachers reported they did not teach any science (Dorph, Goldstein, Lee, Lepori, Schnieder, & Venkatesan, 2007). Contrast this to the statement adopted by the National Science Teachers Association (NSTA) board of directors in July 2002 which suggested that students should do hands-on science daily.

Effective, high quality professional development should provide an ongoing support system of school-based coaching through a mentoring system of science teacher leader visits to the classroom, because specific follow-up has been shown to be critical in assisting teachers with the incorporation of new knowledge and skills directly to classroom practice (Guskey, 2000). Additionally, professional networking through an online forum can assist with the creation of a collaborative professional community (Wei, Darling-Hammond, Andree, Ruchardsion, and Orphanos, 2009)

Improvement in the quality science teaching is essential, according the recent report, *Before It's Too Late*, of The National Commission on Mathematics and Science Teaching for the 21st Century. Included were valuable suggestions for establishing an ongoing, high-quality system of improvement for teaching and support for the notion that focusing teacher preparation and professional development as a system would improve instruction (Glenn, 2000).

Barriers to the Teaching of Science in Elementary Classrooms

The fact that less time is being spent on elementary science is troubling when more closely examined from two additional perspectives: elementary teacher preparation and elementary teacher confidence to teach science. The current science courses required for elementary teachers often do not have content aligned with the national and state science standards. Four year college courses are problematic, yet two-year colleges are even less likely to be aligned with science content standards (Bechtel, 2010).

In fact, according to a study by the National Science Foundation (2006), less than 15% of Texas high school graduates have enough mathematics and science to even pursue scientific/technical degrees in college. This lack of preparation across the board for science education helps explain why elementary teachers may be uneasy when it comes to their levels of confidence for teaching science in the classroom, which is by no means a recent notion (Brickhouse, 1990). Fulp, (2002b) addressed the need for forward thinking and planning for science curriculum at the elementary and middle school levels and suggested that elementary science teachers should have an understanding of science concepts. The 2000 report, *Inquiry and the National Science Education Standards,* suggests that fundamental understandings of inquiry in grades K-4, scientific investigations involve comparing student answers to questions with what scientists already know. As part of the Biological Sciences Curriculum Study (BSCS), researchers found the 5-E Instructional Model is an effective way to engage students in learning (Bybee, Taylor, Garnder, Van Scotter, Powell, Westbrook, & Landes, 2010). This model is extremely valuable to understand for the delivery of elementary science instruction when the key idea is that hands-on, authentic engagement is conducive to any high-quality elementary student learning environment.

The purpose of this study was to determine whether a relationship exists between school district size and student achievement as measured by 2009 5^{th} grade science Texas Assessment of Knowledge and Skills (TAKS). The study analyzed the size of the school districts across Texas to determine if there is a relationship between school achievement and student TAKS scores and to determine whether those scores are reflective of local, state, or federal programs. In addition, the study explored whether conglomerate districts have more access to programs, resources, and personnel that readily assist, whereas very small school districts tend to have less programs, personnel, and resources, and how this may impact student achievement.

The research questions utilized for this study were: 1. Is there a relationship between school district enrollment size and student achievement measured by the 5^{th} grade Science Texas Assessment of Knowledge and Skills? 2. Is there a relationship between economically disadvantaged student achievement as measured by the 5^{th} grade Science Texas Assessment of Knowledge and Skills and school district enrollment size?

Method

The population for this study was all independent school districts in Texas that reported fifth grade Texas Assessment of Knowledge and Skills Science test in 2009. The Texas Education Agency reported 1135 school districts with 5^{th} grade Science TAKS results, and school district enrollments ranging from 202,773 students in the Houston Independent School District to 23 students in the San Vicente Independent School District. The school districts were distributed into four categories by size. Small school districts ranged from 23 students to 550 students, medium school districts ranged in size from 551 students to 1500 students, large school districts ranged from 1501 students to 6000 students, and mega school districts were 6001 to 202,773 students.

School districts were divided into four categories based on their overall enrollment and the districts' average passing scores for the 5^{th} grade Science TAKS test were analyzed. Each district had additional sub-categories reported to indicate performance of different groups within the testing population of 5^{th} grade students beyond the total district passing percentage. These indicators included gender and economically disadvantaged groups.

The data were retrieved from the Texas Education Agency website and a data file was created from all Texas school districts reporting 5^{th} grade science Texas Assessment of Knowledge and Skills (TAKS) scores. The data were analyzed using SPSS statistical software using the appropriate techniques and treatments to evaluate the data. A one-way ANOVA was performed to evaluate the effects of school district enrollment size on student achievement levels as measured by the 5^{th} grade Texas Assessment of Knowledge and Skills (TAKS) science test. The independent variable was the district enrollment size, which included four different levels of enrollment. The dependent variable was the 2009 5^{th} grade science TAKS scores.

Results

The ANOVA was significant, *F* (3, 1134) = 10.652, *p* = .000 and the null hypothesis was rejected. The small district enrollment ranged from 23 total students to 550 total students in the district. The population size for the small districts was 416 districts with a mean science score of 79.195 (*sd* = 17.618). The medium district enrollment ranged from 551 students to 1500 students in the district with a population of 320 total school districts and a mean science score of 81.969 (*sd* = 12.805). The large district enrollment ranged from 1501 students to 6000 students in the district with a population of 250 total school districts and a mean science score of 83.040 (*sd* = 9.387). The mega district enrollment ranged from 6001 students to 202,773 students with a population of 149 total school districts and a mean science score of 86.081 (*sd* = 6.987).

Table 1

Descriptive Statistics 5th Grade Science TAKS Scores for Four District Enrollment Sizes (N = 1135)

Variable	*N*	*M*	*SD*
Small District	416	79.195	17.618
Medium District	320	81.969	12.805
Large District	250	83.040	9.387
Mega District	149	86.081	6.987

Additional tests were conducted to determine differences between groups of school districts based on their enrollment sizes and the science scores. There was a significant difference between the means of the small district science scores and the medium district science scores at the .05 level *p* = .038. There was a significant difference between the means of the small district science scores and the large district science scores at the .05 level *p* = .003. There was significant difference between the means of the small district science scores and the mega district science scores at the .05 level *p* = .000. There was not a significant difference between the means of the medium district science scores and the large district science scores at the .05 level *p* = 1.000. There was a significant difference between the means of the medium district science scores and the mega district science scores at the .05 level *p* = .014. There was not a significant difference between the large district science scores and the mega district science scores at the .05 level *p* = .188 as reported in Table 2.

Table 2

Bonferroni Comparison of School District Enrollment Size and 5th Grade Science Scores

School Size	Mean Score Difference	Std. Error	Significance *p*
Small to Medium	-2.774	1.014	.038*
Small to Large	-3.846	1.091	.003*
Small to Mega	-6.886	1.302	.000*
Medium to Large	-1.071	1.151	1.00
Medium to Mega	-4.112	1.352	.014*
Large to Mega	-3.041	1.411	.188

* The mean difference is significant at the .05 level.

A one-way ANOVA was performed to evaluate the effects of school district enrollment size on economically disadvantaged identified student achievement levels as measured by the 5th grade Texas Assessment of Knowledge and Skills (TAKS) science test. The independent variable is the district enrollment size which included four different levels of enrollment. The dependent variable is the Texas school districts that reported 2009 5th grade science TAKS scores of students that were identified as economically disadvantaged to the Texas Education Agency (TEA). The ANOVA was significant, $F(3, 1131) = 9.981$, $p = .000$ and the null hypothesis was rejected. The enrollment ranges for the small, medium, large and mega school districts were kept consistent throughout the study and for each different analysis of the data. The population size for the small districts was 320 total districts and a mean science score of 72.731 ($sd = 19.559$). The medium district population size was 318 total districts and a mean science score of 76.626 ($sd = 14.551$). The population size for the large districts was 249 total districts and a mean science score of 76.960 ($sd = 11.381$). The mega district population size was 148 total districts and a mean science score of 80.392 ($sd = 6.838$).

Table 3

Descriptive Statistics 5th Grade Science TAKS Scores for Economically Disadvantaged Identified Students for Four District Enrollment Sizes (*N* = 1035)

Variable	N	M	SD
Small District	320	72.731	19.559
Medium District	318	76.626	14.551
Large District	249	76.960	11.381
Mega District	148	80.392	6.838

Supplementary tests were conducted to determine differences between the school district enrollment sizes and economically disadvantaged identified student achievement as measured by the 5th Grade Science TAKS test. There was a significant difference between the means of the small district and the medium district science scores at the .05 level p = .001. The difference in the means of the small district and the large district science scores was significant at the .05 level p = .001. There was a significant difference between the means of the small district and the mega district science scores at the .05 level p = .000. The difference in the means of the medium district and the large district science scores was not significant at the .05 level p = .791. There was a significant difference in the means of the medium district and the mega district at the .05 level p = .011. The difference in the means of the large district and the mega district science scores was significant at the .05 level p = .026 as reported in Table 4.

Table 4

Bonferroni Comparison of School District Enrollment Size and 5th Grade Science Scores for Economically Disadvantaged Identified Students

School Size	Mean Score	Std. Error	Significance *p*
Small to Medium	-3.895	1.178	.001*
Small to Large	-4.229	1.257	.001*
Small to Mega	-7.661	1.479	.000*
Medium to Large	-.334	1.259	.791
Medium to Mega	-3.766	1.480	.011*
Large to Mega	-3.432	1.544	.026*

* The mean difference is significant at the .05 level.

Results

The data analysis indicated that a relationship does exist between student achievement as measured by the 5th grade Science TAKS test and district enrollment size. This relationship is significant between the different levels of district enrollment from small district size of 500 students and less to the mega districts of over 6000 students. Each Texas school district had their 5th grade student scores from the Science TAKS test averaged and these averages were analyzed using an analysis of variances (ANOVA) to determine if a relationship existed. Every school district in Texas that reported 5th grade Science TAKS tests from the 2009 school year were included within this study and all data were reflected within these reported scores. The enrollment size classifications of the school districts were determined by the authors and these classifications were viewed as natural points of separation using a pre-determined criterion. This criterion was developed to ensure that school district groups had similar resource levels for both financial and personnel. Small school districts with less than 500 students will have only one elementary school with typically only one or two teachers per grade level and limited district science curriculum staff development at the elementary level. Medium school districts with less 1500 students would have typically one elementary school (5 to 6 teacher per grade level) and have limited central office support for science curriculum at the elementary level. Large school districts with less than 6000 students would have multiple elementary schools with central office supported elementary science curriculum resources. Mega school districts with more than 6000 students have many elementary schools with designated elementary science curriculum specialists and in-district science staff development and curriculum resources.

The data indicates that smaller schools do not perform as well on the 5th grade science TAKS test as the medium, large and mega districts. This data follows what the review of the literature reports. Huysman (2008) elaborates,

> Rural schools operate under the same laws and with comparable expectations and goals as their urban and suburban counterparts, but without the quantity or quality of support and resources available from a school's central organization or the local community. Ultimately, it remains a rural school district's responsibility to provide a quality and appropriate education to the youth of their community. (p. 31)

The results from this study indicate that this statement is true and the scores on the science achievement as measured by the 5th grade science TAKS scores of all students are subjected to school district size. School districts in urban and suburban areas in Texas have higher percentages of passing the 5th grade science TAKS test than rural and small school districts.

The averages of students were compared and analyzed in the differences in the averages were significant between all, but two groups. The only two groups that did not show a significant difference was between the medium and large school districts and large and mega school districts. All the other comparisons reported in Table 2 show a significant difference in the averages between the school district enrollment groups at the .05 level. The first research question the answer is yes there is a relationship between school district enrollment size and student achievement measured by the 5th grade Science Texas Assessment of Knowledge and Skills.

The data analysis indicated that a relationship does exist between economically disadvantaged student achievement as measured by the 5th grade Science Texas Assessment of Knowledge and Skills and school district enrollment size. The same parameters were used to analyze the data for all students and students that were identified economically disadvantaged. The school district enrollment sizes were identical, however the number of school districts varied from one data collection to the other. Only school districts that had an economically disadvantaged group of 50 students had this sub-group reported. This reduced the number of small school districts from 416 to 320 a loss of 96 school districts. The absence of these scores could have artificially skewed these results; however the scores are consistent with the reported scores from the other school districts and with the scores from all students.

The results from the comparison of school district sizes were significant for all groups, but one. The only group that was not significant was between medium to large school districts. All the other comparisons were reported in Table 4 show a significant difference in the averages between economically disadvantaged identified student's scores on the 5th grade science TAKS test and between school district enrollment sizes at the .05 level. The second research question is yes there is a relationship between economically disadvantaged student achievement as measured by the 5th grade Science Texas Assessment of Knowledge and Skills and school district enrollment size.

Conclusions

Rural and small school student achievement as measured by the 5th grade science TAKS test averages are significantly below the averages of the larger school districts in Texas. The economically disadvantaged student scores from rural and small schools were lower as well in almost the exact proportions as data including all student scores. The performance gap between rural and small school students exists in the elementary level between the more suburban and urban school districts in Texas. The results from this study could equip the Texas Education Agency to target more resources and focus to rural and small school elementary science curriculum. This could possibly be accomplished through the Texas Educational Region Service Centers Further research could potentially isolate these barriers to rural and small school achievement and increase student achievement in elementary science. Additional research projects could examine math or reading scores and determine if these findings are science specific or part of a larger rural and small school student performance gap.

References

Abbott, M., Joireman, J., & Stroh, H. (2002). *The influence of district size, school size and socioeconomic status on student achievement in Washington: A replication study using Hierarchical Linear Modeling* (Tech. Rep. No. 3). Seattle, WA: Seattle Pacific University, Washington State Research Center. Retrieved from http://www.spu.edu/wsrc

Bechtel, S. (2010). *The preparation of elementary school teachers to teach science in California: Challenges and opportunities impacting teaching and learning in science*. Sacramento, CA: California Council on Science and Technology.

Brickhouse, N.W. (1990). Teacher beliefs about the nature of science and their relationship to classroom practices. *Journal of Teacher Education, 41*(3).

Browne-Ferrigno, T., & Allen, L. W. (2006). Preparing principal for high-need rural schools: A central office perspective about collaborative efforts to transform school leadership. *Journal of Research in Rural Education, 21*(1). Retrieved from http://jrre.psu.edu/articles/21-1.pdf

Bybee, R., Taylor, J.A., Garnder, A., Van Scotter, P., Powell, J.C., Westbrook, A., & Landes, N. (2010). *The BSCS 5-E instruction model: Origins, effectiveness, and applications*. Colorado Springs, CO: BSCS. Retrieved from http://www.smcm.edu/educationstudies/pdf/rising-tide/volume-3/chris-madrigal-rachel-clement-mrp.pdf

Cotton, K. (1996). *Affective and social benefits of small scale schooling*. Charleston, WV: ERIC Clearinghouse on Rural Education and Small Schools. (ERIC Document Reproduction service No. ED401088)

Diaz, V. (2008). Relationships between district size, socioeconomics, expenditures, and student achievement in Washington. *The Rural Educator*. Seattle Pacific University.

Dorph, R., Goldstein, D., Lee, S., Lepori, K., Schneider, S., & Venkatesan, S. (2007). The status of science education in the Bay Area: Research brief. *Lawrence Hall of Science University of California*. Berkeley.

Fulp, S. (2002a). *2000 National survey of science and mathematics education: Status of elementary school science teaching.* Chapel Hill, NC: Horizon Research.

Fulp, S. (2002b). *Status of elementary school science teaching*. NC: Horizon Research.

Glenn, J. (2000). *Before it's too late: A report to the nation from the National Commission on Mathematics and Science Teaching for the 21st Century*. Washington, DC.

Huysman, J. (2008). Rural teacher satisfaction: An analysis of beliefs and attitudes of rural teachers' job satisfaction. *The Rural Educator*, *29(2)*. Retrieved from http://www.ruraleducator.net/archive/31-1/Lucas%202009.pdf

Khattri, N., Riley, K., & Kane, M. (1997). Students at risk in poor, rural areas: A review of the research. *Journal of Research in Rural Education*, *13(2)*. Retrieved from http://www.jrre.psu.edu/articles/v13,n2,p79-100,Khattri.pdf

McMurrer, J. (2008). Instructional times in elementary schools: A closer look at changes for specific subjects. *Center on Education Policy.*

National Assessment of Educational Progress. *Average fourth-grade NAEP science scores and percentage of students in each achievement level in 2005, by state*. Retrieved from http://nationsreportcard.gov/science_2005/s0106.asp

National Science Foundation. (2006). *Science and Engineering Indicators*. Retrieved November from http://www.nsf.gov/statistics/seind06/pdf/c02.pdf

Stewart, L. (2009). Achievement differences between large and small schools in Texas. *The Rural Educator*, *30(2)*, 20-28.

Wei, R.C., Darling-Hammond, L., Andree, A., Ruchardsion, N., & Orphanos, S. (2009). *Professional learning in the learning profession: A status report on teacher development in the United States and abroad*. Stanford, CA: National Staff Development Council.