

**RELATIONSHIP OF SCHOOL DENSITY AND
ACADEMIC PERFORMANCE**

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This paper is in response to a Board member's question regarding the relationship between API performance and school density. The following research questions were developed:

- 1) What is the definition of school density?
- 2) What is the relationship between school density and academic performance?

What is the Definition of School Density?

School density can be operationally defined as the ratio between the number of pupils in a school and the number of acres in the school. While this definition seems simple enough, density calculations will differ depending upon how the number of students and the acreage of a school are determined. In this analysis, the number of pupils in a school is determined in three ways: total enrollment, on-track enrollment, and average daily attendance. In density calculations, total enrollment may be misleading. One of the responses to high student enrollments and limited real estate has been the use of year-round, multi-track school configurations. These schools have dealt with limited space by extending the school year into the summer and partitioning students into tracks, thereby reducing the number of students on campus at the same time. In three-track and four-track schools, respectively, only $\frac{2}{3}$ and $\frac{3}{4}$ of the enrolled population attends school at the same time. In order to make comparisons to single-track schools, an on-track student enrollment is more accurate. Additionally, the number of students on campus may wax and wane throughout the school year based upon student mobility and differing attendance rates. This phenomenon is recognized in state funding calculations for local schools, which are determined by the average daily student attendance. For this reason, average daily attendance might be the most accurate measure of the number of students in a school.

Determination of school acreage is also subject to differential interpretation. Total site acreage can be defined as the footprint of the school property, including building and playground space. Site acreage does not take into account the additional classroom and playground acreage provided by multiple story buildings. Additionally, playground acreage may be decreased by the installation of portable classrooms. While these issues may result in imperfect measurements of school acreage, no centralized record of these phenomena was available at the time of this analysis, and thus, the total site acreage is used in all density ratios.

Table 1 presents data on variables related to student density by schooling level. The number of pupils enrolled is the average number of students per school as of spring 2003 norm day. This is

the largest number of students used in density calculations, and thus represents the most general density calculation. The next two density calculations are more refined and more discrete. The number of pupils on-track was calculated by dividing the number of students enrolled by the number of tracks of students on campus at any one time. The number of pupils attending was calculated by multiplying the number of pupils on-track by a school's attendance rate. The site acreage is the total number of acres of a school's campus, including playground and classrooms. The final three density figures are the respective enrollment figures divided by the site acreage.

Table 1. Descriptive Statistics on Measures of Density

Level	Variables	N Schools	Min	Max	Mean	Std. Dev.
Elementary	N Pupils Enrolled	449	150.0	3031.0	881.4	455.6
	N Pupils On-Track	441	150.0	2020.7	729.7	290.2
	N Pupils Attending	438	199.8	1910.9	697.8	277.1
	Site Acreage	443	1.3	16.8	5.5	1.8
	Pupils / Acre	443	22.7	566.8	176.3	93.1
	On-Track Pupils / Acre	441	22.7	409.1	144.7	62.3
	Attending Pupils / Acre	438	21.3	400.1	138.4	59.7
Middle	N Pupils Enrolled	79	160.0	4279.0	2093.6	782.0
	N Pupils On-Track	74	538.0	2852.7	1945.7	435.9
	N Pupils Attending	74	516.1	2714.6	1810.1	412.7
	Site Acreage	74	3.9	27.1	16.5	5.4
	Pupils / Acre	74	49.4	402.4	154.5	79.8
	On-Track Pupils / Acre	74	49.4	268.2	132.6	53.4
	Attending Pupils / Acre	74	46.6	246.9	123.3	50.0
Senior	N Pupils Enrolled	56	104.0	5089.0	3237.2	1133.2
	N Pupils On-Track	55	572.0	3876.0	2793.9	682.5
	N Pupils Attending	55	544.9	3654.7	2498.8	625.3
	Site Acreage	54	2.9	64.8	25.4	10.1
	Pupils / Acre	54	53.6	451.3	149.5	75.2
	On-Track Pupils / Acre	54	53.6	451.3	125.7	58.3
	Attending Pupils / Acre	54	48.8	430.0	112.8	55.1

What is the Relationship between School Density and Academic Performance?

All measures of student achievement used in this paper come from or are calculated using the 2002 to 2003 Academic Performance Index (API) growth data. API scores and growth calculations are a good measure of overall school performance. In this paper, the specific API variables analyzed are the 2003 growth API scores, 2002 to 2003 API growth, and whether or not a school met its schoolwide and comparable improvement growth targets. In addition to the API growth variables available in the state Academic Performance Index data file, the percentage of the schoolwide growth target attained was calculated. This is the amount of API points attained by a school divided by the schoolwide growth target, as established by the state. If a

school met or exceeded its growth target, the percent of target attained would be 100% or higher. Schools that demonstrated positive growth yet did not meet their growth target would have percentages between 0% and 100%. The percent of growth target attainment for schools that made negative growth would be less than 0%. Since many schools met or exceeded their targets in 2003, the percent attainment was often 100% or higher.

Tables 2 through 4 present the correlations between API data and measures of school density. It is important to note that API score is highly correlated with measures of student and school characteristics, such that schools facing less educational challenge (as measured by higher School Characteristic Index (SCI) scores) tend to have higher API scores. At the same time, schools with high enrollment tend to have school characteristics associated with more educational challenge. Thus, it is likely that the API to density relationships may be largely due to student and school characteristics and not due to measures of density. For these reasons, it is important to consider more than a school's 2003 API score when examining the relationship between student achievement and school density.

In elementary schools, density and API score was negatively related, such that lower enrollment and lower density was associated with higher API scores. The relationship was slightly higher for total enrollment and the total number of pupils enrolled per acre and decreased in magnitude with more refined measures of school density, such as on-track pupils per acre. Although smaller in magnitude, the percentage of API growth target attained was also negatively associated with enrollment and the number of pupils per acre. Again, the relationship decreased with more refined density calculations. Other API growth measures, such as 2002 to 2003 API growth, schoolwide and comparable improvement targets met, were positively associated with density, but the magnitudes were small and most relationships were non-significant.

In middle schools, density and API score was negatively related, with significant relationships only in total enrollment, enrolled pupils per acre, and on-track pupils per acre. No middle school API growth measures were associated with density. In senior high schools, density and API score tended to be negatively related, with significant relationships only in total and on-track enrollment. No senior high growth measures were associated with density.

Table 2. Relationship between Performance and Density: Elementary Schools

			SCI 2002	API 2003	N Pupils Enrolled	N Pupils On-Track	N Pupils Attending	Pupils / Acre	On-Track Pupils / Acre	Attending Pupils / Acre
Elementary	SCI 2002	R	1.000	0.885	-0.479	-0.375	-0.372	-0.486	-0.387	-0.382
		Sig.	.	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		N	436	435	436	430	429	432	430	429
	API 2003	R	0.885	1.000	-0.480	-0.390	-0.380	-0.428	-0.326	-0.317
		Sig.	0.00	.	0.00	0.00	0.00	0.00	0.00	0.00
		N	435	446	445	436	436	439	436	436
API Growth	R	-0.338	-0.229	0.106	0.058	0.057	0.122	0.073	0.072	
	Sig.	0.00	0.00	0.03	0.23	0.24	0.01	0.13	0.14	
	N	434	436	436	428	428	431	428	428	
Percent of API Target Attained	R	0.419	0.554	-0.253	-0.218	-0.213	-0.223	-0.180	-0.175	
	Sig.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	N	434	436	436	428	428	431	428	428	
Met Schoolwide Growth Target	R	-0.047	-0.014	0.117	0.100	0.101	0.114	0.092	0.091	
	Sig.	0.33	0.77	0.01	0.04	0.04	0.02	0.06	0.06	
	N	434	438	438	430	430	433	430	430	
Met Comparable Improvement Growth Target	R	-0.048	0.023	0.098	0.078	0.082	0.073	0.050	0.053	
	Sig.	0.32	0.64	0.04	0.10	0.09	0.13	0.30	0.28	
	N	434	438	438	430	430	433	430	430	

Table 3. Relationship between Performance and Density: Middle Schools

			SCI 2002	API 2003	N Pupils Enrolled	N Pupils On-Track	N Pupils Attending	Pupils / Acre	On-Track Pupils / Acre	Attending Pupils / Acre
Middle	SCI 2002	R	1.000	0.920	-0.199	-0.018	0.022	-0.410	-0.313	-0.292
		Sig.	.	0.00	0.09	0.88	0.86	0.00	0.01	0.01
		N	76	75	76	73	73	73	73	73
	API 2003	R	0.920	1.000	-0.317	-0.066	-0.016	-0.350	-0.256	-0.229
		Sig.	0.00	.	0.00	0.58	0.89	0.00	0.03	0.05
		N	75	78	78	73	73	73	73	73
API Growth	R	-0.267	-0.232	0.131	-0.080	-0.064	0.000	-0.086	-0.077	
	Sig.	0.02	0.05	0.27	0.51	0.60	1.00	0.48	0.52	
	N	74	74	74	71	71	71	71	71	
Percent of API Target Attained	R	0.386	0.440	-0.035	-0.020	0.018	-0.217	-0.221	-0.202	
	Sig.	0.00	0.00	0.77	0.87	0.88	0.07	0.06	0.09	
	N	74	74	74	71	71	71	71	71	
Met Schoolwide Growth Target	R	0.055	0.103	0.077	0.087	0.114	-0.042	-0.068	-0.050	
	Sig.	0.64	0.38	0.51	0.47	0.34	0.73	0.57	0.68	
	N	74	74	74	71	71	71	71	71	
Met Comparable Improvement Growth Target	R	0.004	0.139	0.214	0.097	0.131	0.167	0.106	0.130	
	Sig.	0.97	0.24	0.07	0.42	0.27	0.16	0.38	0.28	
	N	74	74	74	71	71	71	71	71	

Table 4. Relationship between Performance and Density: Senior High Schools

			API 2003	SCI 2002	N Pupils Enrolled	N Pupils On-Track	N Pupils Attending	Pupils / Acre	On-Track Pupils / Acre	Attending Pupils / Acre
Senior	SCI 2002	R Sig. N	0.917 0.00 42	1.000 . . 50	-0.472 0.00 49	-0.131 0.37 49	-0.034 0.82 49	-0.314 0.03 48	-0.058 0.70 48	0.002 0.99 48
	API 2003	R Sig. N	1.000 . . 44	0.917 0.00 42	-0.494 0.00 43	-0.318 0.04 42	-0.238 0.13 42	-0.185 0.25 41	0.074 0.64 41	0.128 0.43 41
	API Growth	R Sig. N	0.010 0.95 42	-0.046 0.77 42	0.066 0.68 41	0.071 0.66 41	0.081 0.61 41	-0.039 0.81 40	-0.083 0.61 40	-0.082 0.62 40
	Percent of API Target Attained	R Sig. N	0.507 0.00 42	0.450 0.00 42	-0.199 0.21 41	-0.065 0.69 41	-0.019 0.91 41	-0.162 0.32 40	-0.074 0.65 40	-0.048 0.77 40
	Met Schoolwide Growth Target	R Sig. N	0.179 0.26 42	0.184 0.24 42	-0.140 0.38 41	0.006 0.97 41	0.021 0.90 41	-0.118 0.47 40	-0.021 0.90 40	-0.008 0.96 40
	Met Comparable Improvement Growth Target	R Sig. N	0.217 0.17 42	0.178 0.26 42	-0.136 0.40 41	0.047 0.77 41	0.061 0.70 41	-0.145 0.37 40	-0.021 0.90 40	-0.002 0.99 40

Tables 5 through 7 provide a more descriptive analysis of density and academic performance, with mean API data for each of three roughly equal groups of increasing density. In elementary, schools with higher density have lower API scores, greater API growth, a lower percentage of API growth target attained, and a slightly greater percentage of schools meeting schoolwide and comparable improvement growth targets. For on-track and attending students per acre, higher density was associated with roughly equivalent growth, a lower percentage of API growth target attained, a greater likelihood of meeting schoolwide targets, and no relationship with attainment of comparable improvement. In middle schools, no clear pattern was apparent between density and academic performance. In senior high schools, higher density was associated with a lower percent of API target attained, with no other clear patterns apparent.

Conclusion

Overall, it appears that most measures of school density are not associated with student achievement as measured by the Academic Performance Index. The major exception was the finding that higher density was associated with a lower API score and a lower percent of target attained. These measures, however, are both highly correlated with one another and share a strong relationship with student and school characteristics associated with lower API scores.

Thus, it does not appear that school density alone accounts for much of the variability in student achievement as measured by the Academic Performance Index.

Table 5. Relationship between Performance and Density: Elementary Schools

Density Variables	API Variables	Low Density			Medium Density			High Density		
		N	Mean	Std. Dev.	N	Mean	Std. Dev.	N	Mean	Std. Dev.
Students / Acre	API 2003	144	751	77.5	145	684	86.3	147	646	61.6
	API Growth	144	37	23.8	142	43	21.2	142	45	16.6
	Percent of API Target Attained	144	708%	472.0 %	142	567%	331.6 %	142	495%	261.4%
	Percent of Schools Meeting Schoolwide Target.	144	95%	21.6%	143	95%	21.7%	143	100%	0.0%
	Percent of Schools Meeting Comp. Imp. Target	144	90%	30.7%	143	90%	30.7%	143	93%	25.6%
On-Track Students / Acre	API 2003	142	742	82.0	147	680	82.5	147	659	74.7
	API Growth	142	38	24.4	145	45	19.7	141	42	17.8
	Percent of API Target Attained	142	695%	475.8 %	145	579%	317.2 %	141	497%	282.0%
	Percent of Schools Meeting Schoolwide Target.	142	95%	21.7%	146	97%	18.2%	142	99%	11.8%
	Percent of Schools Meeting Comp. Imp. Target	142	89%	31.7%	146	95%	22.8%	142	89%	31.7%
Attending Students / Acre	API 2003	144	740	81.2	146	680	82.3	145	658	74.6
	API Growth	144	39	24.4	143	44	19.0	140	43	18.6
	Percent of API Target Attained	144	689%	471.6 %	143	576%	319.3 %	140	496%	277.9%
	Percent of Schools Meeting Schoolwide Target.	144	95%	21.6%	144	97%	18.4%	141	99%	11.9%
	Percent of Schools Meeting Comp. Imp. Target	144	89%	31.5%	144	94%	23.0%	141	89%	31.8%

Table 6. Relationship between Performance and Density: Middle Schools

Density Variables	API Variables	Low Density			Medium Density			High Density		
		N	Mean	Std. Dev.	N	Mean	Std. Dev.	N	Mean	Std. Dev.
Students / Acre	API 2003	24	618	73.7	25	607	93.2	24	549	54.6
	API Growth	24	24	13.2	24	27	17.3	23	24	12.4
	Percent of API Target Attained	24	233%	137.1 %	24	274%	203.7 %	23	170%	70.0%
	Percent of Schools Meeting Schoolwide Target.	24	92%	28.2%	24	79%	41.5%	23	78%	42.2%
	Percent of Schools Meeting Comp. Imp. Target	24	71%	46.4%	24	75%	44.2%	23	87%	34.4%
On-Track Students / Acre	API 2003	24	620	69.9	24	596	102.2	24	559	55.4
	API Growth	24	24	13.6	23	28	15.1	23	24	14.8
	Percent of API Target Attained	24	237%	136.3 %	23	271%	189.7 %	23	175%	113.1%
	Percent of Schools Meeting Schoolwide Target.	24	92%	28.2%	23	78%	42.2%	23	78%	42.2%
	Percent of Schools Meeting Comp. Imp. Target	24	75%	44.2%	23	74%	44.9%	23	83%	38.8%
Attending Students / Acre	API 2003	22	623	72.5	26	590	101.1	23	564	53.9
	API Growth	22	23	13.6	25	26	15.3	22	25	14.5
	Percent of API Target Attained	22	233%	140.0 %	25	254%	189.5 %	22	187%	112.6%
	Percent of Schools Meeting Schoolwide Target.	22	91%	29.4%	25	76%	43.6%	22	82%	39.5%
	Percent of Schools Meeting Comp. Imp. Target	22	73%	45.6%	25	76%	43.6%	22	82%	39.5%

Table 7. Relationship between Performance and Density: Senior High Schools

Density Variables	API Variables	Low Density			Medium Density			High Density		
		N	Mean	Std. Dev.	N	Mean	Std. Dev.	N	Mean	Std. Dev.
Students / Acre	API 2003	15	630	78.2	10	631	111.2	15	542	55.7
	API Growth	15	25	11.6	9	17	17.1	15	24	18.2
	Percent of API Target Attained	15	294%	201.2 %	9	235%	366.0 %	15	178%	135.4%
	Percent of Schools Meeting Schoolwide Target.	15	100%	0.0%	9	56%	52.7%	15	73%	45.8%
	Percent of Schools Meeting Comp. Imp. Target	15	67%	48.8%	9	44%	52.7%	15	47%	51.6%
On-Track Students / Acre	API 2003	13	625	86.2	14	608	97.7	13	558	75.8
	API Growth	13	21	10.0	13	22	18.0	13	27	18.1
	Percent of API Target Attained	13	264%	222.8 %	13	200%	196.3 %	13	244%	275.4%
	Percent of Schools Meeting Schoolwide Target.	13	92%	27.7%	13	69%	48.0%	13	77%	43.9%
	Percent of Schools Meeting Comp. Imp. Target	13	54%	51.9%	13	62%	50.6%	13	46%	51.9%
Attending Students / Acre	API 2003	12	627	89.8	14	583	89.3	13	585	94.0
	API Growth	12	21	10.3	13	26	18.6	13	22	17.6
	Percent of API Target Attained	12	273%	230.0 %	13	234%	170.4 %	13	210%	293.3%
	Percent of Schools Meeting Schoolwide Target.	12	92%	28.9%	13	77%	43.9%	13	69%	48.0%
	Percent of Schools Meeting Comp. Imp. Target	12	50%	52.2%	13	62%	50.6%	13	46%	51.9%