

CLASS SIZE IN EARLY ELEMENTARY GRADES: EFFECTS ON STUDENT ACHIEVEMENT IN IOWA

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Abstract—This study examines the class size component of The Iowa Early Intervention Block Grant Program (*Iowa Code 256D*). Using building-level cohort data, the relationship between class size and student achievement (reading and math test scores) in early elementary grades in Iowa is explored with no significant relationship found. However, among a sample limited to buildings with high populations of free or reduced price lunch eligible students, a negative non-linear relationship exists.

Introduction—The Iowa Early Intervention Block Grant Program (*Iowa Code 256D*, funded from July 1, 1999 to June 30, 2012) set a goal of no more than 17 students per teacher in kindergarten through third grade classrooms. This goal is based on the assumption that smaller class sizes will help students achieve a higher level of basic skills, especially reading skills. School districts may use funds from this program in a number of ways to increase the basic skills of students, including: hiring additional licensed instructional staff, before and after school programs, tutoring, implementing all-day kindergarten, and more (*Iowa Code 256D.2*). This study examines the class size component of this program, specifically the relationship between class size and student achievement (reading and math test scores) in early elementary grades in Iowa.

Design and Method—As part of the Iowa Early Intervention Block Grant Program, the number of students and teachers designated to each class (or section) for grades kindergarten through third has been self-reported by schools every year since the 1998-1999 school year as a part of the Basic Educational Data Survey (BEDS). Also, schools submit student Iowa Tests of Basic Skills (ITBS) test scores, along with demographic information for the Adequate Yearly Progress (AYP) report. This study combines data from BEDS and AYP to create building-level cohort comparison groups. (Based on the data available, there is no way to determine which class a particular student belongs to, prohibiting student-level comparisons.)

National standard scores in reading and math for third grade students in the 2007-2008 school year are the dependent variable of interest. These scores are normalized based on the period in which the test is taken (fall, midyear, or spring). Therefore, test scores from different testing periods cannot be accurately compared with each another; separate regressions will be run for each testing period. Class size is the main independent variable of interest. Class size is used instead of building pupil-teacher ratios, as pupil-teacher ratios may be clouded by special education and support staff (Achilles, 2003;

Borland, Howsen, & Trawick, 2005; Wilson, 2002). Furthermore, previous analysis found no correlation between student achievement and pupil-teacher ratios in Iowa. Class size for the year the students took the ITBS are not included in the data, as fall and midyear testing students may have not spent enough time in the classroom to gain any effects from that class size.

Based on previous literature (Achilles, 2003; Biddle & Berliner, 2002), small class sizes may take several years in order to have any effect. Therefore, a three year average class size for building cohorts is included in the primary regression (i.e., class sizes for kindergarten in the 2004-2005 school year, first grade in the 2005-2006 school year, and second grade in the 2006-2007 school year for each building were averaged). Average class size squared is also included, entertaining the possibility that classes may have an optimum size as found by Borland, Howsen, & Trawick (2005). Building average teacher experience of second grade teachers in the 2006-2007 school year is included as a proxy measure of teacher quality. Second grade teachers in the 2006-2007 school year are included instead of 2007-2008 third grade teachers under the assumption that fall and midyear testing students may have not spent enough time in the classroom to gain any effects from the third grade teacher. Teacher experience is divided into two groups: buildings that average five or more years of experience and buildings that average less than five years of experience. This is done with the assumption that teachers not well suited for the profession typically leave the profession in the first few years. Also, after the first few years, teachers see diminished quality benefits from their experience.

Other independent variables included in the regression consist of: gender, special education, talented/gifted, free/reduced price lunch, and English language learner. Reading and math test scores will be the independent variables. Six multiple regressions will be run, once for each reading and math test scores for each testing period of ITBS. The regressions will be run a second time, including only one year class size average for the building cohorts in the previous year (second grade, 2006-2007 school year) in order to compare the effects of a three year class size average to a one year class size average.

Researchers (Biddle & Berliner, 2002; Finn & Achilles, 1999; Robinson, 1990; Wenglinsky, 1997) have also found students from disadvantaged backgrounds (i.e., minorities and free/reduced price lunch eligible) to benefit more from smaller class sizes than their white and non-free/reduced price lunch eligible counterparts. (The minority variables are not included in the regressions in this study, as minority is highly correlated with free/reduced price lunch.) Therefore, the regressions will be run again including only buildings that have high numbers of students eligible for free/reduced price lunch (defined as one standard deviation above the mean of free/reduced price lunch for the total sample, or more than 58.7 percent).

Results—Tables 1 and 2 present a descriptive analysis of dependent and independent variables by the three testing periods and aggregate data for all buildings (Table 1) and disadvantaged buildings (Table 2). The descriptive analysis for all buildings includes 567 buildings, while the disadvantaged sample includes 94 buildings.

Table 1—All Buildings: Descriptive Statistics

	Fall (n=207)	Midyear (n=260)	Spring (n=100)	All (n=567)
Class Size: Three year average (K-2 nd grade)	20.04	18.66	20.27	19.44
Class Size: One year average (2 nd grade)	20.64	19.31	20.70	20.05
Reading Score Average (National Standard)	186.90	191.28	192.30	N/A
Math Score Average (National Standard)	184.49	189.93	191.97	N/A
Number of Years Experience (2 nd grade teachers)	16.61	17.77	16.26	17.08
Female (% of bldg)	48.71%	48.07%	49.21%	48.51%
Special Education (% of bldg)	11.52%	11.67%	11.56%	11.59%
Talented/Gifted (% of bldg)	4.86%	6.03 %	7.29%	5.83%
Free/Reduced Lunch (% of bldg)	35.50%	38.27%	44.67%	38.56%
English Language Learner (% of bldg)	4.10%	3.77%	7.84%	4.61%

Source: Iowa Department of Education, Bureau of Planning, Research, Development and Evaluation Services.

Table 2—Disadvantaged Buildings: Descriptive Statistics

	Fall (n=25)	Midyear (n=39)	Spring (n=30)	All (n=94)
Class Size: Three year average (K-2 nd grade)	19.77	18.54	22.25	20.05
Class Size: One year average (2 nd grade)	20.52	19.06	22.80	20.59
Reading Score Average (National Standard)	175.87	184.23	184.55	N/A
Math Score Average (National Standard)	175.06	184.37	186.49	N/A
Number of Years Experience (2 nd grade teachers)	16.25	14.5	15.23	15.20
Female (% of bldg)	48.23%	47.52%	47.54%	47.72%
Special Education (% of bldg)	14.38%	13.03%	13.75%	13.62%
Talented/Gifted (% of bldg)	1.26%	4.82%	9.64%	5.41%
Free/Reduced Lunch (% of bldg)	74.31%	71.57%	73.30%	72.85%
English Language Learner (% of bldg)	16.37%	14.68%	18.52%	16.35%

Source: Iowa Department of Education, Bureau of Planning, Research, Development and Evaluation Services.

Multiple regression results with coefficients are presented in Tables 3 and 4. For variables listed as a percentage of a building (i.e., female, special education, etc.), coefficients represent a relationship to the percentage in decimal form (50% = 0.50). A coefficient of 9.586 for females for fall reading is interpreted as a building with 100 percent female population would average a score of 9.586 higher on fall reading than a building with zero percent female population. (It may be more useful for the reader to break these down into ten percentage points and infer that for each ten percent increase in the female population for a building, the building average fall reading scores increase 0.9586 points.)

According to Table 3, three year average class size is not significantly correlated with national standard reading scores or national standard math scores. Teachers with less than five years experience is negatively related with all test scores, but none of the relationships are statistically significant. Special education is negatively correlated with reading and math test scores in varying testing periods. Talented/gifted is positively correlated with reading and math test scores in the fall and midyear. Across all testing periods, in both math and reading, free/reduced price lunch is negatively related with test scores. English language learner also shows a negative relationship with reading test scores in the fall and midyear.

Table 3—All Buildings: Multiple Regression

	Fall Reading		Fall Math		Midyear Reading		Midyear Math		Spring Reading		Spring Math	
	Coefficient	Standard Error	Coefficient	Standard Error	Coefficient	Standard Error	Coefficient	Standard Error	Coefficient	Standard Error	Coefficient	Standard Error
Three year average class size (K-2)	-0.845	(1.172)	-1.601	(1.130)	1.144	(1.151)	-1.687	(1.048)	1.698	(1.571)	1.632	(1.251)
Three year average class size squared	0.019	(0.029)	0.042	(0.028)	-0.032	(0.0307)	0.047	(0.028)	-0.046	(0.039)	-0.043	(0.031)
Less than 5 years experience (2 nd grade teacher bldg average)	-0.677	(1.319)	-0.596	(1.271)	-1.781	(1.545)	-2.559	(1.408)	-0.374	(2.019)	-0.080	(1.607)
Female (% of bldg)	9.586*	(4.293)	3.039	(4.137)	8.345*	(4.015)	3.616	(3.657)	-11.604	(6.514)	-23.809*	(5.185)
Special Education (% of bldg)	-14.779*	(6.034)	-5.587	(5.815)	-18.945*	(4.913)	-14.129*	(4.476)	-12.905	(10.665)	-20.779*	(8.489)
Talented/Gifted (% of bldg)	11.107*	(4.651)	9.325*	(4.482)	13.100*	(4.024)	13.197*	(3.665)	-0.412	(7.517)	-1.435	(5.983)
Free/Reduced Lunch (% of bldg)	-20.754*	(2.200)	-19.837*	(2.120)	-17.263*	(1.951)	-13.190*	(1.778)	-25.978*	(3.356)	-17.967*	(2.671)
English Language Learner (% of bldg)	-10.103*	(4.663)	-8.352	(4.493)	-7.460*	(3.738)	-5.611	(3.405)	-3.440	(5.756)	-4.178	(4.581)
Multiple R-square	0.542		0.507		0.414		0.362		0.621		0.621	

Source: Iowa Department of Education, Bureau of Planning, Research, Development and Evaluation Services.
 Note: *p<0.05

Among disadvantaged buildings (buildings with over 58.7 percent of students eligible for free/reduced price lunch), three year average class size (and three year average class size squared) has a larger coefficient (compared to the coefficients of all buildings) and is statistically significant for reading test scores among fall and spring testing buildings. Special education is negatively correlated with reading and math test scores for midyear and spring testing buildings. Most other variable coefficients are statistically insignificant.

Table 4—Disadvantaged Buildings: Multiple Regression

	Fall Reading		Fall Math		Midyear Reading		Midyear Math		Spring Reading		Spring Math	
	Coefficient	Standard Error	Coefficient	Standard Error	Coefficient	Standard Error	Coefficient	Standard Error	Coefficient	Standard Error	Coefficient	Standard Error
Three year average class size (K-2)	-9.029*	(4.158)	-6.261	(5.849)	6.372	(6.394)	2.631	(5.066)	-9.612*	(2.172)	-2.941	(2.186)
Three year average class size squared	0.213*	(0.098)	0.147	(0.139)	-0.182	(0.171)	-0.090	(0.136)	0.215*	(0.050)	0.056	(0.050)
Less than 5 years experience (2 nd grade teacher bldg average)	-2.590	(4.822)	0.041	(4.668)	1.155	(5.488)	-3.681	(3.208)	-5.234	(2.784)	-0.841	(2.388)
Female (% of bldg)	18.205	(14.094)	12.157	(19.625)	15.195	(14.942)	4.506	(11.297)	-13.968	(7.282)	-16.208	(8.199)
Special Education (% of bldg)	14.834	(24.471)	22.848	(31.614)	-35.587	(17.612)	-17.476	(13.720)	-30.431*	(11.162)	-31.043*	(11.827)
Talented/Gifted (% of bldg)	-45.389	(33.484)	-14.173	(43.236)	12.454	(21.260)	31.074	(16.583)	21.512	(10.804)	0.316	(11.076)
Free/Reduced Lunch (% of bldg)	-13.301	(10.289)	-25.376	(14.904)	-28.692*	(11.926)	-15.120	(9.407)	-7.164	(6.446)	-6.862	(6.896)
English Language Learner (% of bldg)	-9.025	(6.304)	-5.296	(8.741)	-7.961	(6.034)	-4.770	(4.692)	0.407	(4.563)	-0.032	(4.725)
Multiple R-square	0.496		0.310		0.424		0.523		0.715		0.554	

Source: Iowa Department of Education, Bureau of Planning, Research, Development and Evaluation Services.

Note: *p<0.05

The regressions were run a second time, including only one year class size average for the building cohorts in the previous year (second grade, 2006-2007 school year) in order to compare the effects of a three year class size average to a one year class size average. Class size held a statistically insignificant relationship with reading and math test scores for all testing periods for both samples (all buildings and disadvantaged buildings). Coefficients for class size were smaller for the one year average data than the three year average data. This is illustrated in Figures 2-5 in Appendix A. Figures 2-5 also demonstrate the difference in the effect of class size between the sample of all buildings and the sample of disadvantaged buildings.

Discussion—Based on this study, one cannot draw a firm conclusion on the relationship between class size and student achievement. Measuring at the building level, class size is not correlated with reading and math test scores for all buildings in the state of Iowa. However, when looking at only disadvantaged buildings, class size has more of a negative correlation with reading and math test scores. This is in agreement with previous research (Biddle & Berliner, 2002; Finn & Achilles, 1999; Robinson, 1990; Wenglinsky, 1997) which found students from disadvantaged backgrounds to benefit more from small class sizes than their white and non-free/reduced price lunch eligible counterparts.

Other variables of interest that were not included in this study that may be confounding results include: preschool attendance, parental involvement, parental educational attainment, and participation in other initiatives funded by The Iowa Early Intervention Block Grant Program, such as before and after school programs, tutoring, and all day kindergarten (*Iowa Code 256D.2*).

One limitation of this study is the inability to control for students moving in and out of buildings (students may have been exposed to class sizes in one building, and then moved to another building to be tested). Student-level data (instead of building-wide averages) would be much more informative in predicting test scores, as student populations can vary greatly within buildings. Class sizes also vary within buildings, creating limitations as it is not possible to tie students to a given class size.

Teacher quality may be a major influence on student achievement that was not fully taken into account by measuring years of experience at the building level. Factors affecting teacher quality not measured by experience may include educational attainment, professional development, innate teaching ability, and motivation. Also, teacher years of experience can vary highly within buildings. Therefore, knowing the teachers who taught which students would benefit this study.

The relationship between class size, teacher quality, and achievement needs to be thoroughly examined at the student level in the state of Iowa. In a cost-benefit analysis in the state of Florida, Ilon and Normore (2006) found reducing class size to be the least cost-effective option for increasing test scores among several alternatives such as increasing school administration, increasing staff with advanced degrees, and hiring more experienced staff members. In 2005, Rivkins, Hanushek, and Kain found that teacher quality (measured by experience) makes major gains after the first three years of teaching and is strongly related with student achievement. They also found class size to have a modest (yet statistically significant) impact on achievement. Using teacher salary as a proxy for teacher quality in an international study, West and Woessmann (2003) found capable teachers to be able to promote student learning regardless of class size while less capable teachers did not seem to be able to teach large class sizes effectively.

Conclusions—In the 2000-2008 fiscal years, \$236.3 million in Early Intervention Block Grant Program funds have been allocated to school districts (*Iowa Code 256D.5*), see Table 5. Fifty percent of the yearly allocation is based on kindergarten through third grade enrollment, while the other 50 percent is based on first through third grade students eligible for free or reduced price lunch (*Iowa Code 256D.4*). With 755 school buildings in Iowa housing kindergarten through third grade students, that averages approximately \$38,742 per building per year (FY 2004-2008). However, that can vary greatly depending on enrollment and free/reduced price lunch population. Most school districts use Early Intervention funds to pay teacher salaries. In the 2007 fiscal year, 99.1 percent of Early Intervention Block Grant Program funds went towards salaries and benefits (Iowa Department of Education, 2008).

Table 5—State Class Size Reduction Allocations for Iowa Public Schools
FY 2000 to FY 2008

FISCAL YEAR	STATE ALLOCATION	CPI ADJUSTED ALLOCATION IN FY 2000 DOLLARS**
FY 2000	\$10 million	\$10.0 million
FY 2001	\$20 million	\$19.5 million
FY 2002	\$30 million	\$28.7 million
FY 2003	\$30 million	\$28.1 million
FY 2004	\$29.3 million*	\$26.7 million
FY 2005	\$29.3 million	\$25.8 million
FY 2006	\$29.3 million	\$25.0 million
FY 2007	\$29.3 million	\$24.3 million
FY 2008	\$29.3 million	\$23.8 million

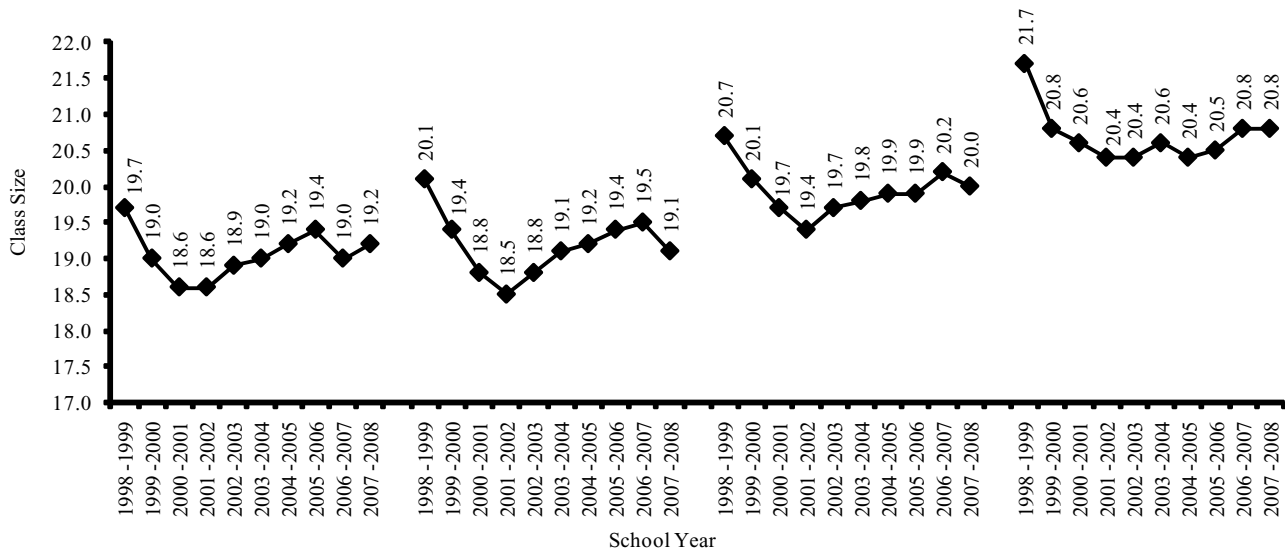
SOURCE: Iowa Department of Education, Bureau of Planning, Research, Development and Evaluation Services, Basic Educational Data Survey.

*The FY 2004 appropriation was reduced as a result of an across-the-board cut after the initial appropriation and then received a partial restoration of funds.

**Calculated from Consumer Price Index (CPI), U.S. Department of Labor, Bureau of Labor Statistics.

The Iowa Early Intervention Block Grant Program sets a goal of no more than 17 students per teacher in kindergarten through third grade classrooms. During the first three years of the program, average class size for grades kindergarten through third decreased. However, in the 2002-2003 school year (FY 2003) class sizes increased and have been on an upward trend since (Figure 1). This may be related with a leveling off of state allocations and the decreasing purchasing power of those allocations every year (according to CPI adjusted allocations in Table 5). Perhaps, the allocation is not large enough to help schools reduce class sizes. The Iowa Early Intervention Block Grant Program has been added to the State Aid formulate for fiscal year 2009 which will allow for it to grow on a per pupil basis. This influx of dollar in the future could help districts move towards the goal of smaller classrooms. Another theory may be that schools have become accustomed to receiving their class size reduction allocation every year and have shifted other funding sources that they previously used for reducing class sizes to other expenses. Nonetheless, the purpose of the funding is to reduce class sizes under the assumption that small class sizes help students achieve a higher level of basic skills.

Figure 1—Iowa Public School District Average Class Size for Grades K-3 1998-1999 to 2007-2008



SOURCE: Iowa Department of Education, Bureau of Planning, Research, Development and Evaluation Services, Basic Educational Data Survey, Class Size Survey files.

Through the life of The Iowa Early Intervention Block Grant Program (July 1, 1999 to June 30, 2012), the Iowa Legislature will allocate \$354 million to Iowa school districts (*Iowa Code 256D.5*). Based on the information that is currently collected from schools, one cannot determine any relationship between class size and student achievement for young Iowa students. An allocation of resources to critically identify which Early Intervention Block Grant Program components/indicators help students achieve higher levels of basic skills is needed for any further analysis.

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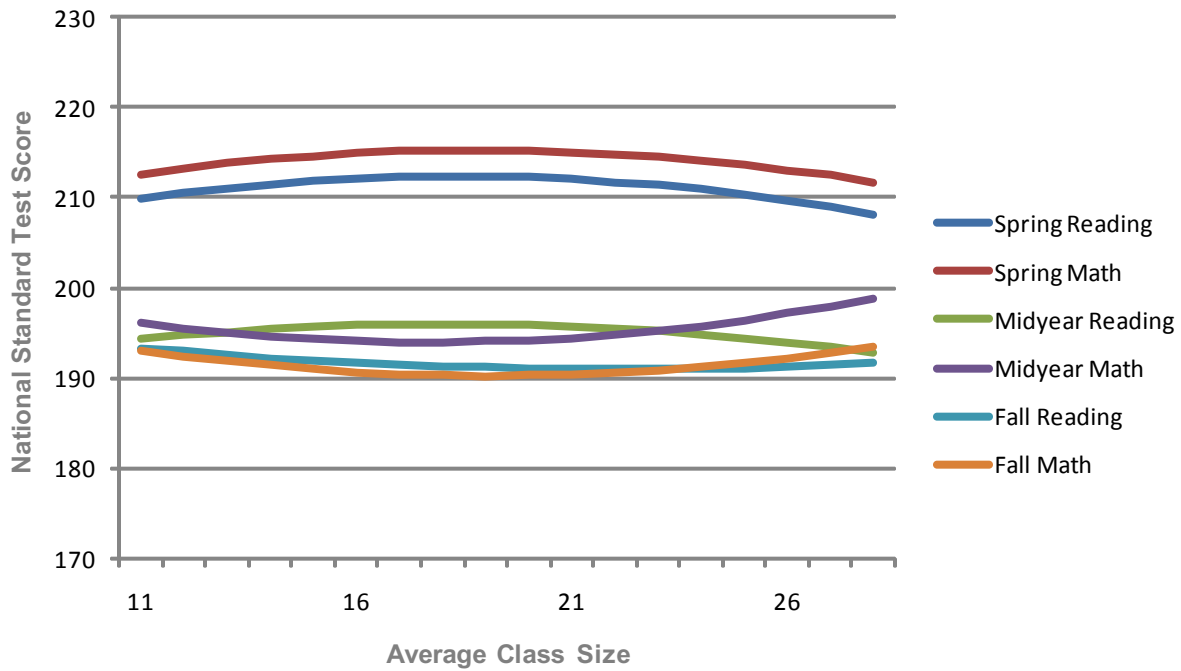
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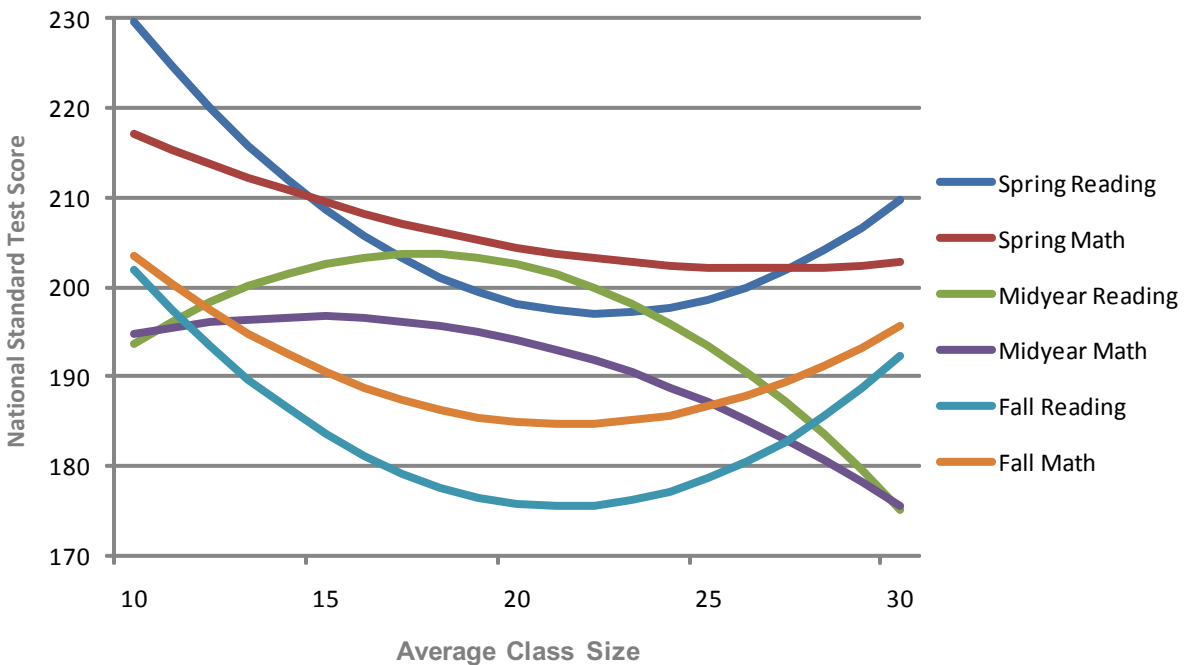
APPENDIX A

Figure 2—Three Year Average Class Size, All Buildings



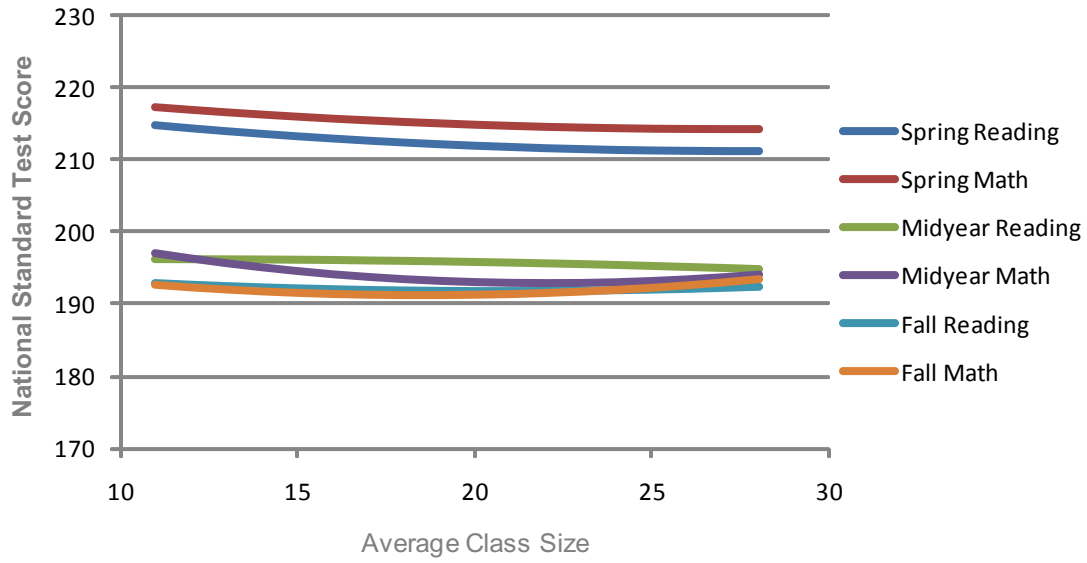
SOURCE: Iowa Department of Education, Bureau of Planning, Research, Development and Evaluation Services.

Figure 3—Three Year Average Class Size, Disadvantaged Buildings



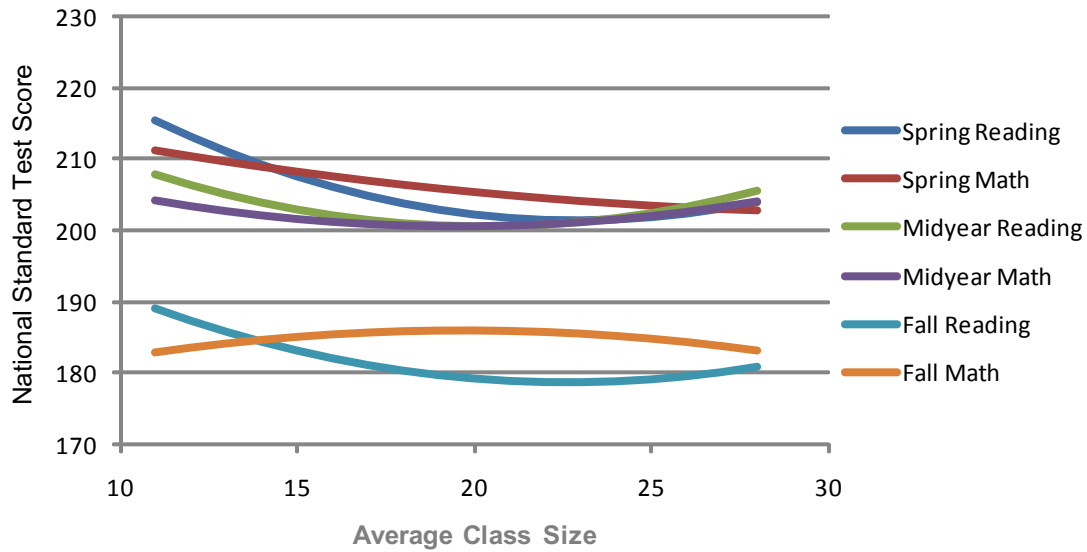
SOURCE: Iowa Department of Education, Bureau of Planning, Research, Development and Evaluation Services

Figure 4—One Year Average Class Size, All Buildings



SOURCE: Iowa Department of Education, Bureau of Planning, Research, Development and Evaluation Services.

Figure 5—One Year Average Class Size, Disadvantaged Buildings



SOURCE: Iowa Department of Education, Bureau of Planning, Research, Development and Evaluation Services.