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ABSTRACT

The relationship between test performance and the size of the class in which instruction occurred was studied at Brigham Young University. The classes prepared students for examinations to meet general education graduation requirements. All test scores from 318 sections representing 27 courses from the fall semester, 1980 were analyzed. Section sizes ranged from 13 to 1,008 students. Sixteen content areas were represented. The findings suggest that at the college level, class size may be a much less important influence on student achievement than previously thought. It appears that increasing class size from current levels of 20 to 40 students up to several hundreds of students may not radically affect college student achievement. It is concluded that decisions concerning class size in colleges and universities should be based on issues other than concern about student achievement (e.g., classroom facilities, course budgets, students' demand for classes). Appendices contain summary statistics for the regression analysis results. (SW)

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CLASS SIZE AND ACHIEVEMENT AMONG COLLEGE STUDENTS

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Class size is still an issue in education. Controversy has continued for more than 50 years over the effects of class size on student achievement; the impact of class size on non-cognitive variables such as self esteem, attitudes toward learning, and instruction; and how the costs of education can be reduced. Glass and his colleagues have recently reported research which they believe lays to rest many of the arguments about class size. Using techniques called "meta-analysis" to statistically combine the findings of 77 studies, representing data on nearly 900,000 students, they persuasively argued regarding class size and achievement that:

> A clear and strong relationship between class size and achievement has emerged. The relationship seems slightly stronger at the secondary grades than the elementary grades; but it does not differ especially across different school subjects, levels and pupil IQ, or several other obvious demographic features of classrooms. The relationship is seen most clearly in well-controlled studies in which students were randomly assigned to classes of different sizes . . . . There is little doubt that, other things equal, more is learned in smaller classes. (Glass & Smith, 1979, p. 15)

The relationship Glass and his colleagues have reported between class size and achievement is curvilinear; at about 20 students per teacher, the achievement curve flattens out and appears to remain stable.

The meta-analysis, which required a thorough search and analysis of extant literature on class size, unearthed relatively few studies with class sizes larger than about 40 or with university age populations. Only 3% (20 of 725) of the effect sizes in the meta-analysis were based on performance by students 19 years of age or older (Glass and Smith, 1978, p. 25). The question arises as to whether the meta-analysis findings apply to university settings where classes can be both very large and very small and where most students are 19 or older. Archives of test data at Brigham Young University (BYU) provided an opportunity to study the issue of class size and test performance (achievement) with this age group.

Prior to 1981, students at BYU were required to pass several examinations on a variety of topics to meet general education graduation requirements. Courses designed to prepare students for these exams were taught in sections ranging widely in size. Records of students' performance on the exams were used to estimate the relationship between test performance and the size of the class in which instruction took place. The hypothesis that achievement is higher in smaller classes guided the investigation.

Method

Students' item-level performance on the general education tests, organized by course section, was archived on computer tapes by the BYU Testing Center. All test scores from a sample of 318 sections representing 27 different courses were extracted from the Fall Semester, 1980 archive tape. Courses were selected to reflect the broad variation in section size as well as the diversity in subjects taught. Courses in which students were known not to meet in a regular lecture format were eliminated.

Section sizes ranging from 13 students to 1008 students were included in the study. Sixteen different content areas were represented (accounting, business management, child development and family relations, computer science, communications, economics, english, food science and nutrition, health, physical sciences, physics, psychology, religion, social science, statistics, theatre and cinematic arts). Students' performance on 20,070 tests (usually the final exam in each course) were analyzed.

The "class size" variable was created by calculating the number of non-repeated final exams completed within each section. Hence, a student taking Health 130 in Section 6 for which 25 final exams were recorded, would be assigned a value of 25 for his/her "class size."

The "test performance" variable was created by calculating a standardized score for each student's performance on the final exam, based on the mean and standard deviation of scores obtained by all students taking that exam, independent of section number. Hence, if the mean score on test "A" for all students from sections one through five of Health 130 was 58 and the standard deviation was 12.5 and a student obtained a score of 53, his/her standardized test performance score would be:

$$10 \left(\frac{52-58}{12.5}\right) + 50 = 45.2$$

Glass and Smith (1978) found the relationship between class size and achievement to be nonlinear, best fitted by a logarithmic curve. Therefore, both a polynomial regression analysis of achievement (t-score units) on class size and a linear regression analysis of the log transformations of the achievement scores on class size were run in addition to a simple linear regression of achievement on classsize. These analyses were made across all 27 courses (including course as an element in the model) for varying ranges of class size as well as across all sections within each course.

Results

A summary of the regression analysis results for each model across all courses is presented in Tables 1, 2, and 3. The two alternative models used to account for curvilinearity did not fit the data much better than the simple linear model. Each of the models had some small (based on the small R^2 values) value in predicting achievement, as indicated by the statistical significance of the overall F values. However, the class size variable added little or nothing to the power of the models. What small influence class size may have had was dissipated by the type of course in question (as illustrated by the highly reliable interactions beween size and type of course).

Regression analyses using all three models at the individual course level revealed these same patterns. As summarized in Tables 4, 5 and 6, for only a few of the 27 courses did the models have significant predictive value. Even in those courses, the amount of variance accounted for by the models was small (as indicated by the R^2 values) and the influence of class size was small (as indicated by the beta-weights) and inconsistent (sometimes negative and sometimes positive as indicated by the signs on the beta-weights).

Discussion

Although this was a post hoc analysis, the fact that such a broad range of courses and large numbers of students were involved makes these results quite compelling. They suggest that at the college level, class size may be much less important an influence on student achievement than some educators have thought.

True, these data did not include class sizes smaller than thirteen; and much of the effect due to size in Glass and Smith's (1978) meta-analysis was from classes smaller than thirteen. However, very few undergraduate general education courses are as small as thirteen. It appears that increasing class size from current levels of 20 to 40 up to several hundreds may not radically affect college student achievement.

Some of the larger classes in the analysis employed smaller "lab" sections taught by teacher assistants and a variety of media aides to supplement the large group lectures. These methods may have provided all the support system that students needed to achieve well in large classes. But perhaps these supplements are not critical to learning in large classes. Future researchers should employ well controlled methods to investigate the ideal class size for college students and the role of labs and media in large group college instruction.

In summary, the major implication of this analysis is that pending further research, decisions about class size in colleges and universities should be based on issues other than concern about student achievement (e.g., classroom facilities, course budgets, convenience in testing and grading, students' demand for classes, students' attitudes toward the subject taught and college generally, faculty attitudes, etc.).

References

Glass, Gene V and Smith, Mary Lee. Meta-analysis of research on the relationship of class-size and achievement. Boulder: Laboratory of Educational Research, University of Colorado, September, 1978.

Glass, Gene V and Smith, Mary Lee. Meta-analysis of research on class size and achievement. Educational Evaluation and Policy Analysis, 1979, 1(1), 2-16.

Table I

Results of Simple Linear Regression Analysis
(Model I[1])

Class size Range	Number of Courses	N of Tests	F values for overall model and each element: Overall	C_1	S_1	Interaction C_1-S_1	R^2
13-20	11	1543	2.67**	.91	.76	5.03**	.03
13-30	12	6244	1.34	.34	1.75	2.19*	.005
13-40	13	7125	1.52*	.53	.85	2.47**	.005
20-40	13	6122	1.48	.59	1.12	2.27**	.006
30-40	10	911	2.24**	2.15*	.05	2.72*	.04
30-1008	24	13854	1.95**	.59	.59	3.50**	.006
40-1008	20	13025	1.89**	.25	.61	3.81**	.005
13-1008	27	20070	1.52**	.00	.87	3.12**	.004

* = $p < .05$

** = $p < .01$

[1]Model I: $Y = B_o + B_1C_1 + B_2S_1 + B_3C_1S_1 + e$

Where: C_1 = Course type.
S_1 = Class Size

Table 2

Results of Linear Regression Analysis of Log Transformations Model II[1]

Class size Range	Number of Courses	N of Tests	F values for overall model and each element: Overall	C_1	S_1	Interaction $C_1 - S_1$	R^2
13-20	11	1543	2.87**	.84	.70	5.62**	.03
13-30	12	6244	1.33	.38	2.78	1.97*	.005
13-40	13	7125	1.44	.61	.88	2.24**	.005
20-40	13	6122	1.33	.67	.41	2.02*	.005
30-40	10	911	2.15**	2.22*	.004	2.39*	.04
40-1008	20	13025	2.03**	.23	.52	4.15**	.006
13-1008	27	20070	1.60**	.11	.70	3.18**	.004

* = $p < .05$

** = $p < .01$

[1]Model II: $\text{Log } Y = B_o + B_1 C_1 + B_2 S_1 + B_3 C_1 S_1 + e$

Where: C_1 = Course Type
S_1 = Class Size

Table 3

Results of Polynomial Regression Analysis
(Model III[1])

Class Size Range	Overall	F Values for Overall Model and Each Element C_1	S_1	S_1^2	Interaction $C_1 - S_1$	Interaction $C_1 - S_1^2$	R^2
13-20	2.31**	.91	.76	1.91	5.04**	1.05	.04
13-30	2.05**	.34	2.30	16.50**	1.60	1.70	.01
13-40	1.70**	.53	.68	.27	3.08**	1.65	.009
20-40	2.20**	.60	.87	.83	2.94**	3.15**	.013
30-40	1.97**	2.15*	.08	10.1	1.76	.61	.04
30-1008	1.91**	.59	.60	1.86	3.48**	1.70	.008
40-1008	1.90**	.25	.61	1.55	3.79**	1.87	.007
13-1008	1.70**	.00	.86	1.09	3.14**	2.20**	.006

* = $p < .05$

** = $p < .01$

[1]Model III: $Y = B_o + B_1C_1 + B_2S_1 + B_3S_1^2 + B_4C_1S_1 + B_5C_1S_1^2 + e$

Where: C_1 = Course Type
S_1 = Class Size.

Table 4

Critical Statistics for Classes Having Statistically Significant F Values Using Model I[1] to Predict Achievement from Class Size

Class	B_1	F	R^2
English 115	-.27**	15.05**	.004
Health 129	-.10**	24.98**	.018
Religion 121	+1.60**	10.17**	.104
Stat 221	+.08**	8.53**	.048

* = $p < .05$

** = $p < .01$

[1]Model I: $Y = B_0 + B_1 S_1 + e$
S_1 = Class Size

Table 5

Critical Statistics for Classes Having Statistically Significant F Values Using Model II[1] to Predict Achievement from Class Size

Class	B_1	F	R^2
Comm 102	+.009*	3.96*	.008
English 115	-.006**	17.14**	.005
Health 129	-.002**	28.32**	.021
Religion 121	+.035**	9.41**	.097
Social Science 100	-.0003*	4.33*	.002
Statistics 221	+.002**	9.27**	.052

* = $p < .05$

** = $p < .01$

[1]Model II: $\text{Log } Y = B_o + B_1 S_1 + e$
S_1 = Class Size

Table 6

Critical Statistics for Classes Having Statistically Significant F Values Using Model III[1] to Predict Achievement from Class Size

Class	B_1	B_2	F	R^2
English 115	2.00*	-.04**	11.32**	.006
Health 129	.23*	-.003**	17.50**	.026

* = $p < .05$

** = $p < .01$

[1]Model III: $Y = B_o + B_1 S_1 + B_2 S^2 + e$

S_1 = Class Size