DOCUMENT RESUME

ED 341 717 TM 017 903

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TITLE Using Multiple Regression To Evaluate a Peer Tutoring Program for Undergraduates.
PUB DATE Nov 91
NOTE 19p.; Paper presented at the Annual Meeting of the California Educational Research Association (San Diego, CA, November 14-15, 1991).
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Comparative Analysis; Grade Point Average; Higher Education; *Multiple Regression Analysis; *Peer Teaching; *Predictive Measurement; *Program Evaluation; *Tutoring; *Undergraduate Students
IDENTIFIERS College Board Achievement Tests; *Tutorial Assistance Program CA; University of California Irvine

ABSTRACT

The Tutorial Assistance Program (TAP) of the University of California (Irvine) is described and a new method of evaluation is illustrated through an analysis of the performance of students in six large introductory classes. This approach to evaluation starts with a multiple regression equation for predicting course grades of those not in tutoring and applying the same equation to the TAP students to predict what they would have earned had they not attended tutoring. The multiple regression equation was obtained using: (1) high school grade point average (GPA); (2) Scholastic Aptitude Test mathematics and verbal scores; and (3) scores from the College Board tests in mathematics and English. Comparisons were made for 4,194 non-TAP students and 748 TAP students. Results demonstrate the benefits of TAP, particularly for students considered to be underprepared at college entry. TAP students actually earned higher grades than would have been expected had they not attended TAP. One of the aspects that probably accounts for the efficacy of TAP is that tutors and students attend the same course with the same instructor. Implications of these findings for program improvement are discussed and educational applications of the methodology identified in this paper are suggested. Three tables in the text and five in an appendix present study findings. An eight-item list of references is included. (SLD)

USING MULTIPLE REGRESSION TO EVALUATE A PEER TUTORING PROGRAM FOR UNDERGRADUATES

November 8, 1991

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Paper presented at annual CERA Meeting
November 14-15, 1991
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Introduction

Peer tutoring has become a widely diffused strategy at all levels of education in this country and research has been directed at ascertaining effects of tutoring on tutees and tutors, variations of outcome, and conditions of success. Researchers concur that peer tutoring has a positive effect on tutees' performance in classes where they receive tutoring, that tutors benefit from their experience working with other students, and that structured programs of limited duration produce more favorable outcomes (Ellson, 1976; Cohen, Kulik, & Kulik, 1982; Slavin, 1990).

Nearly all of the extant literature, however, has focused on students at the elementary or secondary levels. Much less attention has been paid to peer tutoring programs for undergraduates despite these programs' often impressive collection of descriptive data and mandated or perceived roles in student retention efforts. Consequently, comparisons of tutorial programs' structures and results at different educational levels are difficult, the potential value of peer tutoring programs to undergraduate education and retention has not been explored adequately, and assessment tools for evaluating tutoring's effects on students continue to be debated.

At the University of California, Irvine, the Tutorial Assistance Program and the Office of Testing, Research, and Evaluation have started modestly to fill this lacuna. Our first steps have confirmed some of the findings about tutoring noted by other researchers, have suggested other areas to investigate, and have led to a new analytical tool. This paper will illustrate the new methodology by analyzing students' performance in six large introductory classes at UCI. We then will discuss the unique features of the peer tutoring program, how results are currently being used in program planning, and how our methodology may be applied to other settings.

Evaluating the Effectiveness of Tutoring

Since 1989 the Tutorial Assistance Program (TAP) and the Office of Testing, Research and Evaluation (TRE) have been conducting a systematic analysis of the effectiveness of TAP's peer tutoring program across the curriculum. This analysis grew out of a major planning project within the Program of Academic Support Services (PASS) to determine the academic needs of undergraduates and to assess the effectiveness of current PASS services, including TAP.

The basic question we wanted to answer was a classic one: "How would these students have done if they had not participated in TAP?" Since the TAP and non-TAP groups were not equivalent, a simple *t*-test between means was not satisfactory. Blocking or matching did not seem to work either; our groups were usually two small for blocking on more than one variable. We also tried an analysis of covariance (ANCOVA) which statistically controls for initial differences. Although ANCOVA is a perfectly acceptable statistical technique,

its results were not very well received by our audience of decision-makers (dean, assistant dean, director of PASS, faculty, academic counselors, and other staff), most of whom were unfamiliar with the technique.

As a result we developed a multiple regression approach, described below, that predicts how well students in TAP programs would have done if they had not taken tutoring. This approach starts with a multiple regression equation for predicting course grades of those not in tutoring and applying the same equation to the TAP students to predict what they would have obtained if they had not attended tutoring. The difference between the predicted and obtained average course grades of those in tutoring is then an estimate of the effectiveness of tutoring.

Compared to other statistical techniques that we tried, this multiple regression approach was very well received (and understood) by our major audiences. That is, this approach seemed to satisfy both sophisticated as well as non-sophisticated audiences. Decision-makers quickly caught on to the concept and were able to restate the conclusions we found, using some of the same words that we had used to describe the results.

Use of Multiple Regression Analysis (MRA)

Multiple regression analysis (MRA) has been used quite commonly in higher education. For example, at UCI, the Office of Admissions has used MRA to select the top half of students admitted to selective programs such as engineering and computer science. In these cases, multiple regression was used to predict cumulative sophomore gpa based on a linear combination of SAT scores, CEEB Achievement scores in Math and English (both required for admission to UC), and high school gpa. Another example comes from California State Polytechnic University (Pomona) which used MRA to establish an early warning system based on predicted first semester grades. In addition, MRA has been used to determine effectiveness of programs by entering "participation" (1 or 0) into a regression equation and analyzing its position relative to other predictors. However, it has not (to our knowledge) been used to evaluate programs in the manner described below.

Methodology

In this study, a multiple regression approach (MRA) was used to determine how well students in the TAP program would have done if they had not participated in the program. For each course, the technique starts with students not in tutoring. A multiple regression equation was obtained on course grades using the following independent variables: high school gpa (HSGPA), SAT Math (SATM) and Verbal (SATV) scores, and scores from the CEEB Achievement Tests in Math (MATHACH) and English (ENGACH).

The resulting regression equation was then applied to students in the program to predict what their grades would have been if they had not been tutored. These predicted grades represent what the students would have earned if they had not been in tutoring. The mean of the students' predicted grades was then compared

to the mean of their obtained grades and the resulting difference (either positive or negative) can be interpreted as the degree of effectiveness of tutoring.

All statistical analyses were conducted using the SPSS-PC+ REGRESSION procedure with the FORWARD method (the p for entering variables was set at .05). Course grades and student background data were obtained from the Registrar. Letter grades were converted to numbers (A=4.0, A-=3.7, B+=3.3, B=3.0, etc.). For each of the courses, separate regression equations were obtained for all students in tutoring as well as for selected subgroups. Results were combined across instructors within the same course. TAP participation information was obtained from the PASS computerized student data base and was defined by one or more hours in the program.

To illustrate this technique, this paper presents findings from six large introductory courses taught at UCI in fall 1990 (2 courses from biology, 2 from chemistry, 1 from mathematics, and 1 from social sciences). Results are presented below for all students in tutoring, plus selected target groups.

Results

The courses used in this study, the size of the TAP and non-TAP groups, and the median number of hours spent in tutoring are listed in Table 1 below. Course numbers with "A" indicate the first quarter course in a 3- or 5-quarter sequence. Tutoring was offered twice a week, beginning the second week of a 10-week quarter.

Table 1
Courses Used in the Study

Course Number	Title	Non-TAP n	TAP n	Median # of TAP Hours
Biology 90	Diversity of Life	210	42	18.0
Biology 101	Evolutionary Genetics	700	158	18.0
Chemistry 1A	General Chemistry	1167	190	18.0
Chemistry 51A	Organic Chemistry	632	233	19.0
Mathematics 2A	Calculus	735	96	18.0
Psychology 7	Intro to Psychology	750	29	17.0

Table 2 (next page) contains data on course grades, SAT scores, high school GPA, and n's for TAP and non-TAP groups for one of the courses, Biology 90. Results for the rest of the courses are in the Appendix. Table 2 presents results for all TAP and non-TAP students as well as for selected subgroups of students, including SAA[1] students, Special Action[2] students, new freshmen, and Unaffiliated[3] students. All but the new freshman group had been previously identified by PASS as underprepared for general course work at UCI.

Results from Biology 90 are typical of the overall findings. For example, students who did not attend TAP had an average course grade of 2.50, while those attending TAP had an average course grade of 1.93 (difference statistically significant). However, such a difference clearly could be a direct result of the lower entering characteristics of the TAP students. They differed significantly from the non-TAP students on: SATV, SATM, and HSGPA. This pattern was also found for new freshmen, SAA students, and Special Action students (although not all of the differences were statistically significant), Only the Unaffiliated students show a different trend in this course; Unaffiliated students using TAP earned a higher average course grade than those not in TAP.

Summarizing these patterns over all six courses, we found that in 5 out of 6 courses, the TAP mean course grade was below that of the non-TAP students. That is, in only one course was the overall TAP mean course grade greater than the non-TAP mean (Chemistry 51A). However, in almost all courses, the TAP students had lower entering characteristics (SAT scores and high school GPA). In several cases, these differences were statistically significant (e.g., see Biology 90). Similar trends were observed for the new freshmen in these courses. Thus, a simple comparison of the TAP and non-TAP means indicated that, overall, the TAP students were not doing as well as those without tutoring.

We found an opposite trend for the underprepared subgroups (SAA, Special Action, and Unaffiliated). In 5 out of 6 courses, both SAA students and Special Action students who attended TAP had higher average course grades than their counterparts not in TAP. For 4 out of 6 courses, the Unaffiliated students in TAP also outperformed other Unaffiliated students not in TAP. Thus, for these subgroups there was a clear benefit to attending TAP that was observable just by comparing the TAP and non-TAP means.

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1 Student Affirmative Action (SAA) students include: American Indians, Blacks, Chicanos, and Latinos.

2 Students who do not meet the normal eligibility requirements of the campus.

3 Students who are in the General Studies Advising Program and have not yet declared a major.

Table 2
Comparison of TAP and No TAP Students
Biology 90, Fall 1990

Group Statistics	No TAP*	TAP	Difference Stat Sig? (p<.05)
All Students			
Course Grade	2.50	1.93	Y
SAT M	570	475	Y
SAT V	465	369	Y
HS GPA	3.77	3.33	Y
n	210	42	
SAA Students			
Course Grade	1.90	1.61	N
SAT M	510	445	N
SAT V	452	379	Y
HS GPA	3.31	3.26	N
n	23	21	
Special Action			
Course Grade	1.57	1.48	N
SAT M	430	411	N
SAT V	393	336	N
HS GPA	2.98	3.16	N
n	3	10	
New Freshmen			
Course Grade	2.42	1.95	Y
SAT M	567	479	Y
SAT V	467	378	Y
HS GPA	3.74	3.26	Y
n	151	35	
Unaffiliated			
Course Grade	2.39	2.70	N
SAT M	588	483	N
SAT V	449	383	N
HS GPA	3.67	--	--
n	17	3	

* Excluding students who attended LSC.

Table 3 (next page) contains the results of the multiple regression analysis described earlier, which predicts how well the TAP students would have done without tutoring. The table contains the obtained gpa for the course and the gpa that was predicted from the non-TAP students. The values of $\underline{R}$ (multiple correlation coefficient) and $\underline{R}^2$ (percent of criterion score variance) are also presented. In the far right-hand column are the variables which entered into the equation ($\underline{p}$ to enter set at .05); they are listed in the order that they entered the equation. Separate regression results were obtained for all students in tutoring as well as for the selected subgroups of SAA students, Special Action students, new freshmen, and Unaffiliated students. Results are presented for statistically significant results only.

In every case where it was possible to predict course grades, the obtained average course grade for students in TAP was larger than the predicted average course grade. That is, the TAP students actually earned higher grades, on average, than what we would have expected if they had not attended TAP. We therefore conclude that TAP tutoring was effective for these groups of students in these six courses, Fall 1990.

Another interesting finding from the regression analyses is that, at least for these courses, the CEEB Mathematics Achievement Test was a powerful predictor of course grades. It was the best predictor of course grade for four of the six courses -- Biology 90, Biology 101, Chemistry 1A, and Mathematics 2A.

Table 3
Obtained and Predicted Course Grades for TAP Students

Course Group	Obtained GPA	Predicted GPA	R	R^2	Variables in Equation
Biology 90					
All TAP	1.93	1.84	.57	.33	MATHACH
New Freshmen	1.95	1.75	.51	.26	MATHACH
Biology 101					
All TAP	2.30	2.17	.43	.19	MATHACH, HSGPA, SATV
SAA	2.17	1.94	.63	.40	MATHACH
Spec Action	2.25	1.46	.84	.71	SATM
Chemistry 1A					
All TAP	2.28	1.80	.58	.33	MATHACH, HSGPA
SAA	1.61	1.16	.63	.40	ENGACH, SATV, MATHACH
Spec Action	1.74	-0.19	.83	.69	SATM
New Freshmen	2.42	1.99	.60	.36	MATHACH, HSGPA
Unaffiliated	2.21	1.48	.60	.36	MATHACH, HSGPA, ENGACH
Chemistry 51A					
All TAP	2.48	2.28	.33	.11	SATM, HSGPA
Math 2A					
All TAP	2.30	1.83	.60	.36	MATHACH, HSGPA, SATV
SAA	2.01	1.18	.54	.29	MATHACH
New Freshmen	2.64	1.92	.63	.39	MATHACH, HSGPA, ENGACH, SATM
Unaffiliated	2.35	1.67	.59	.34	MATHACH
Psychology 7					
All TAP	2.61	2.24	.37	.14	HSGPA, SATM, SATV
SAA	2.23	2.10	.41	.17	HSGPA, SATM

Discussion of Results

1. Unique Features of TAP's Peer Tutoring Program

That students benefitted so clearly from TAP tutorials should not be surprising since this program contains a number of elements researchers have identified as characteristic of effective tutoring programs at all educational levels. According to the research literature, the ideal-type of an effective tutoring program may be described as a well structured program offered outside of and in addition to regular classroom instruction, of limited duration, targeted at local criteria of competence, using experienced students to tutor small groups of students in the class, and whose tutors practice active teaching skills (Ellson, 1976; Cohen, Kulik, & Kulik, 1982; McKellar, 1986; Lidren, Meier, & Brigham, 1991).

To this description we may compare UCI's Tutorial Assistance Program. First, TAP -- unlike many tutoring programs studied by researchers -- is an academic support unit operating under the aegis of the Dean of Undergraduate Studies (part of Academic Affairs) and having professional and clerical as well as student staff. Training and monitoring of tutors, tutorial formats, policies concerning tutees' attendance and other responsibilities, and liaison with academic departments are well established. Second, tutoring is an option students may choose apart from the required discussion sections. Tutorials meet for two hours per week during the quarter and focus on the courses' lectures and readings. Third, TAP selects undergraduates to tutor courses they have done well in; undergraduates are selected on the basis of their overall GPA, their grade in the course, recommendations by faculty, and an interview with program staff. Fourth, tutors receive training in teaching and tutoring techniques during their first quarter with the program (4 units of workload credit through the Department of Teacher Education) and are observed and evaluated every quarter by professional staff.

Thus comprehending many of the elements most often cited by researchers as effective, TAP would seem to illustrate the general setting of a peer tutoring program for undergraduates. However, TAP also has several features that are unusual and that contribute to the program's effectiveness. (Some of these have been cited by researchers but agreement about their importance has not been reached. See, for example, House and Wohlt (1990) and Levin and Levin (1991)).

First, tutees choose tutorials by course and by instructor; tutorials consist of students and a tutor all of whom attend the same lecture. Second, within the groups students display heterogeneous levels of skills and motivation due to the random selection of tutorials. In fact, TAP attracts about as many high-achieving students as low-achieving students. Third, TAP enforces a strict attendance policy; two or more absences may cause a student to be dropped from the tutorial group. The consequences of these three conditions seem to be that students in tutoring are integrated more easily with their peers in large lecture courses, that regular attendance forces students to keep pace with the course, and that students perhaps may benefit more from heterogeneous groups than from homogeneous groups.

Two other unusual features of UCI's tutoring program likewise deserve notice: its charging a fee and its high rate of use. The program charges a user fee of

$50 per course per quarter; approximately one half of students pay for tutoring on their own and one half have tutoring paid for by the Financial Aid Office or another on campus sponsor. During any given quarter ten to fifteen per cent (10%-15%) of all undergraduates participate in TAP's tutorials, the majority of them in lower division (introductory) courses. It should be pointed out that these features reflect students' perception of the program as useful and worth an extra investment in time and money. Moreover, tutees' evaluations of the program consistently rate its services positively. Students' expectations about tutoring's benefits surely play an important if as yet unquantified part in their performance in their courses particularly since students participate voluntarily in tutoring and hence may have greater than average motivation to succeed.

2. How Results Are Being Used in Program Planning

As mentioned earlier, these results were produced as part of a major planning project which we called the Academic Needs Assessment Project. In that project, we have looked at courses identified by the academic counselors as being difficult for UCI students. For each course, we have studied patterns of course grades for various target groups (such as those in this study) and where they are offered, we have evaluated the effectiveness of our PASS services, including TAP. As we complete the data analyses for each major school on campus (e.g., Biological Sciences, Social Sciences), we are meeting with the associate dean and senior academic counselor in that school to identify areas where additional services might be needed.

By focusing on the data analyses in these meetings, we have reached several conclusions. First, we have noted that results for any one quarter may not generalize to other quarters since the instructors (and their grading standards) may change over quarters. Second, we have confirmed some suspicions about our students and disconfirmed others. For example, we have confirmed that in general our SAA and Special Action students do not perform as well as other students, and that majors perform slightly better than non-majors. But we disconfirmed the notion that transfer students are having trouble in UCI courses. Instead, we found that in general transfer students are performing on par with other students. Third, not all the courses identified as "difficult" were actually difficult in terms of their average course grade. In fact, some of these courses had passing rates (grades of C or better) as high as 98%.

In addition, we have found several trends related to students in the peer tutoring program. First, TAP students attend tutoring sessions regularly; the average number of hours is approximately 15-17 hours per 10-week quarter. Second, there is a small but positive relationship between hours spent in tutoring and grade in the course. Third, the average course grade of students in TAP is in general slightly lower than that for non-TAP students; however, the TAP students start with lower entering characteristics such as high school gpa and SAT scores. However, when we predict how well these students would have done without tutoring, in general we find that the obtained gpa is higher than the predicted gpa. And finally, in many courses there is a positive benefit for SAA students and Special Action students attending TAP.

In terms of planning new programs, the results of this project have been very valuable in identifying courses which need new or additional support services.

We have also found that some PASS services were ineffective; as a result, some of these services have been dropped or redesigned. The good news about the general effectiveness of TAP tutoring has been used in various outreach efforts to encourage students to use tutoring.

3. Suggested Applications

The methodology identified in this paper has several educational applications. The most obvious one is its application to other similar tutorial programs at other colleges and universities. Instead of crying "it can't be done", managers of such programs could use this methodology to evaluate the effectiveness of similar academic support services. Similarly, it could be used to evaluate compensatory education programs at the elementary and secondary level, such as Head Start and Chapter I programs. This methodology helps to solve the problem of nonequivalent groups in quasi-experimental designs (Campbell & Stanley, 1963).

Another application lies in assisting the campus's efforts to inform high schools as well as the campus community more fully about our introductory courses' real level of difficulty, the elements in high school students' academic preparation that best predict success in these courses, and the effectiveness of campus academic support programs. As we noted earlier, the results of the analysis described here were understood and accepted more readily by our campus audience than were the results of other analyses used previously. We think it likely that a broader audience would find this analysis useful, particularly if it were tied in to the overall performance of graduates from specific districts.

Finally, this methodology and its results suggest other areas of investigation. A longitudinal study, for example, of the effects of tutoring on students' academic achievement could examine the long term as well as short term gains in student performance at the undergraduate level.

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Appendix

Table A1
Comparison of TAP and No TAP Students
Biology 101, Fall 1990

Group Statistics	No TAP*	TAP	Difference Stat Sig? (p<.05)
All Students			
Course Grade	2.51	2.30	Y
SAT M	589	542	Y
SAT V	458	399	Y
HS GPA	3.89	3.81	N
n	700	158	
SAA Students			
Course Grade	2.06	2.17	N
SAT M	497	485	N
SAT V	448	445	N
HS GPA	3.64	3.65	N
n	77	19	
Special Action			
Course Grade	1.73	2.25	N
SAT M	505	450	N
SAT V	402	295	N
HS GPA	3.25	3.09	N
n	18	4	
New Freshmen			
Course Grade	2.88	2.08	N
SAT M	629	573	N
SAT V	492	465	N
HS GPA	3.64	3.78	N
n	55	4	
Unaffiliated			
Course Grade	2.27	2.25	N
SAT M	574	561	N
SAT V	440	380	N
HS GPA	3.73	3.76	N
n	56	8	

* Excluding students who attended LSC.

Table A2
Comparison of TAP and No TAP Students
Chemistry 1A, Fall 1990

Group Statistics	No TAP*	TAP	Difference Stat Sig? (p<.05)
All Students			
Course Grade	2.36	2.28	N
SAT M	600	548	Y
SAT V	462	436	Y
HS GPA	3.75	3.56	Y
n	1167	190	
SAA Students			
Course Grade	1.47	1.61	N
SAT M	526	463	Y
SAT V	449	399	Y
HS GPA	3.49	3.21	Y
n	118	44	
Special Action			
Course Grade	1.38	1.74	N
SAT M	540	439	Y
SAT V	428	354	Y
HS GPA	3.10	2.95	N
n	24	18	
New Freshmen			
Course Grade	2.42	2.42	N
SAT M	607	572	Y
SAT V	468	444	Y
HS GPA	3.76	3.65	N
n	800	118	
Unaffiliated			
Course Grade	1.97	2.21	N
SAT M	586	565	N
SAT V	456	402	Y
HS GPA	3.60	3.34	N
n	161	37	

* Excluding students who attended LSC.

Table A3
Comparison of TAP and No TAP Students
Chemistry 51A, Fall 1990

Group Statistics	No TAP*	TAP	Difference Stat Sig? (p<.05)
All Students			
Course Grade	2.26	2.48	Y
SAT M	585	569	Y
SAT V	448	420	Y
HS GPA	3.89	3.89	N
n	632	233	
SAA Students			
Course Grade	1.85	2.37	N
SAT M	505	491	N
SAT V	452	406	N
HS GPA	3.58	3.71	N
n	46	26	
Special Action			
Course Grade	1.47	2.72	Y
SAT M	487	576	N
SAT V	395	418	N
HS GPA	3.12	3.50	N
n	15	5	
New Freshmen			
Course Grade	2.34	--	--
SAT M	650	--	--
SAT V	443	--	--
HS GPA	3.60	--	--
n	5	0	
Unaffiliated			
Course Grade	1.91	2.15	N
SAT M	585	560	N
SAT V	441	425	N
HS GPA	3.79	3.56	N
n	30	11	

* Excluding students who attended LSC.

Table A4
Comparison of TAP and No TAP Students
Mathematics 2A, Fall 1990

Group Statistics	No TAP*	TAP	Difference Stat Sig? (p<.05)
All Students			
Course Grade	2.53	2.30	N
SAT M	601	541	Y
SAT V	457	441	N
HS GPA	3.72	3.61	N
n	735	96	
SAA Students			
Course Grade	1.74	2.01	N
SAT M	525	495	N
SAT V	442	413	N
HS GPA	3.52	3.55	N
n	77	19	
Special Action			
Course Grade	1.43	2.50	N
SAT M	503	530	N
SAT V	398	325	N
HS GPA	3.15	3.07	N
n	22	2	
New Freshmen			
Course Grade	2.70	2.64	N
SAT M	616	560	Y
SAT V	456	439	N
HS GPA	3.73	3.59	N
n	543	55	
Unaffiliated			
Course Grade	2.44	2.35	N
SAT M	613	540	Y
SAT V	457	429	N
HS GPA	3.64	3.56	N
n	114	17	

* Excluding students who attended LSC.

Table A5
Comparison of TAP and No TAP Students
Psychology 7, Fall 1990

Group Statistics	No TAP*	TAP	Difference Stat Sig? (p<.05)
All Students			
Course Grade	2.79	2.61	N
SAT M	567	459	Y
SAT V	457	364	Y
HS GPA	3.74	3.30	Y
n	750	29	
SAA Students			
Course Grade	2.18	2.23	N
SAT M	469	398	Y
SAT V	428	[illegible]50	Y
HS GPA	3.36	3.17	N
n	99	16	
Special Action			
Course Grade	2.03	2.27	N
SAT M	470	400	N
SAT V	402	340	N
HS GPA	3.01	2.90	N
n	34	6	
New Freshmen			
Course Grade	2.74	2.54	N
SAT M	560	442	Y
SAT V	458	366	Y
HS GPA	3.59	3.24	Y
n	438	25	
Unaffiliated			
Course Grade	2.63	3.00	N
SAT M	546	453	N
SAT V	445	310	Y
HS GPA	3.55	--	
n	109	3	

* Excluding students who attended LSC.