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This study is concerned with educational growth during the first two years of college, as measured by the American College Testing Program. Students from five colleges were pretested during the senior year of high school and post-tested after the sophomore year of college. Factor analysis and t-tests showed general gains in the four subtests: mathematics, English, natural sciences, and social studies. Sex differences in gain patterns occurred. Institutional differences influenced growth in specific subjects. The educational growth of a student was unrelated to his major. Both initially high and low scoring students regressed the the mean on the re-test. A study of the students in one college on the following aspects is also reported: (1) the effect of taking a specific college course, (2) the influence of a student's major, (3) the gain at the end of the freshman year, and (4) the results of the Sequential Tests of Educational Progress and the School and College Ability Tests. The total study is considered preliminary due to problems such as regression, ceiling, content, and reliability effects. (NG)

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Student Educational Growth During the First Two Years of College[1]

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The purpose of education is the growth of students. Students should change for the better, or "grow," as a result of their educational experience. But how, exactly, should students change? Few people would quarrel with the notion that, among other objectives, students should grow "educationally"; i.e., as a result of college experience, students should demonstrate a greater knowledge of subject matter, more skill in use of language, and increased reading ability--to read with comprehension, to apply their readings to new situations, and to recognize writers' styles and biases. Further, they should be able to analyze and solve problems, to make inferences, and to think critically. These are abilities measured by the ACT tests.

Using ACT Tests to Measure Growth

The ACT tests, we therefore believe, may be useful for measuring the educational growth of college students. Designed for college admissions, the ACT tests are usually administered to college-bound students in the senior year of high school. The tests are generalized measures of educational development in the subject matter areas of English, mathematics, social studies, and natural sciences. As such

[1]Paper prepared for the symposium College Student Growth and Development presented at the 1968 annual meeting of the American Educational Research Association, February 7, 1968, Chicago, Illinois.

the tests are more curriculum-oriented than scholastic aptitude tests that yield two highly generalized scores, one verbal and one mathematics, but less curriculum-oriented than some tests available at the secondary school level. This is necessary because a college admissions test cannot be so curriculum-oriented that it gives a systematic advantage to students using a specific textbook or who are in a particular curriculum. The more curriculum-oriented a test, the more we would expect it to be sensitive to instruction and to specific student growth. Because the ACT tests are somewhat curriculum-oriented and are at least moderately correlated with academic success in college, we could logically try measuring change with such instruments. Consequently, our concern here is with the measurement of educational growth during the first two years of college and the usefulness of the ACT tests for this kind of assessment.

Problems in Measuring Student's Growth

An obvious way to measure change would be to administer retests after the first and/or second year of college to see if there is any gain. But few areas of educational research have been troubled with as many statistical design problems as the analysis of student change.[2] We can do little more here than list some of these difficulties to alert us to potential problems. These difficulties are regression effect, ceiling effect, content effect, and reliability effect.

Regression effect refers to the fact that on retest students tend to go back or regress to the mean for the student sample. A student

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[2] In a useful book on this subject, Harris (1963) edited a series of papers on the measurement of change. Researchers interested in this area are encouraged to study this book.

with a high initial score will tend to make a lower score (regress to the mean) on retest. Similarly, a student with a low initial score will tend to make a higher score (regress to the mean) on retest. If we desire, then, to compare mean change for two groups of students (e.g., those who had a math course and those who did not), it would be appropriate to adjust the retest scores across the two groups by the initial scores. Otherwise, since the more able students would likely be taking math and the less able would not, regression effect might lead us to conclude the less able ones with no math course made the bigger gain when, in fact, there was no true difference in gain between the two groups.

Ceiling effect means that a student with a high score on a test has little room to go up, in comparison to a student with a low score.

Content effect refers not to general statistical problems but to the content of college admissions tests being more closely parallel to that of college courses for average and below average students. College admissions tests are built to be suitable for a wide range of talent, with item difficulties and test content appropriate for college-bound high school seniors. Such tests may not adequately cover college course work in honors programs. For example, a college may section in English; and the ACT English test, with its emphasis on grammar and detecting bad writing, would be appropriate for average and below average sections. But the upper sections may study literature. Literature is not covered in the ACT tests. On retest the students who were initially low and average would be expected to show gain because they had just been studying this material. In contrast, the initially high students would show little or no gain and perhaps even regress.

Since they had not been studying the material in college, the test for them would be more one of memory than of English grammar and writing. Following this rationale for the four subtests, more gain would be expected during the freshman than the sophomore year of college, because the test content more closely resembles college freshman courses than the more diverse and advanced sophomore coursework.

Content effect as well as ceiling effect and regression effect favor students with below average initial scores; these students would show the most gain on retest. Many initially high scoring students will make lower scores on retest.

Reliability effect means that two desirable characteristics of college admissions tests produce difference scores between two testings of low reliability. These two characteristics are (1) highly reliable scores and (2) highly correlated test-retest scores obtained within a year or two of each other. In short, the psychometric requirements for a good college admissions test are different from those for a good test to measure change. And the ACT tests are constructed to be good college admissions tests.

We could react in two extreme ways to these difficulties. First, we could decide that the statistical, psychometric, and educational problems in measuring student growth are so great that they preclude educational research in this area. Several researchers have taken this approach and rejected this area for study. Second, we could say the problems are great and unsolvable, so we might as well go ahead and ignore them in our research since we cannot do anything about them anyway. We resolved to do neither, not giving up and not ignoring the inherent problems.

Questions Colleges Have about Student Growth

As a part of their institutional self-study research programs, many colleges and universities have preferred objective measures of student educational development. The following questions typify those asked by college and university administrators:

1. As a result of college experience do students, on the average, learn something, and can they better apply and make use of what they learn? In operational terms, did they make higher scores on retest?
2. Is the pattern of educational growth different for men and women?
3. If a student has completed a course in a certain subject matter area, does he do better on retest in this area than if he had not taken such a course?
4. If a student majors in a certain subject matter area, does he do better on retest in this area than if he does not?
5. Is the average growth during the college sophomore year of the same magnitude as during the college freshman year?
6. How does student growth at our college compare with that at other colleges?
7. How much gain is expected at different initial score levels?
8. Do other related tests measure educational change in college students?

Design

This research was conducted at five institutions located in Arkansas, Iowa, South Dakota, Texas, and Wisconsin. Two institutions were state colleges, one was a private four-year college, one a junior college,

and one a state university. The ACT pretest was written for college admissions purposes, typically during the senior year in high school. The retesting, using a different but parallel ACT test form, occurred after the students had completed two years of college. One college also tested students at the end of one year of college. And one college also had available STEP scores (level 1) on test-retest, while another had SCAT scores (level 1).[3] Institutions indicated student sex, whether or not students had had a relevant course in each subject area of the tests, and the students' educational majors.[4]

To determine whether students on the whole made gains, t tests were conducted on the gain scores, separately for the male and female samples, for each college. Two-factor analysis of covariance, with one factor being sex, and the other being the four ACT posttest scores adjusted by respective initial scores across sex, was used at each college to determine if there were differential gains for men and women (Winer, 1962, pp. 602-618). Two-factor analysis of covariance was also used to determine if gain was different for the college sophomore year than the college freshman year. One factor was year, the other was ACT-posttest scores adjusted across year for initial scores. Covariance was used to adjust for differences between groups (men and women in the first case, freshmen and sophomores in the second) on initial scores so that possible differences between groups on initial scores would not confound the results. One-factor analysis of covariance on posttest

[3]The STEP (Sequential Tests of Educational Progress) and the SCAT (School and College Ability Tests) are published by Educational Testing Service.

[4]The information available varied with institutions. The only data common to all five colleges were sex and ACT test-retest scores.

scores (Cooley and Lohnes, 1962, pp. 63-86) was conducted for each ACT subtest to determine if there were differences between (a) students who had a relevant course or not, and (b) students who were majoring in the relevant curricular area or not. If there were more than two groups being compared, follow-up t tests were used to compare adjusted group means (Snedecor and Cochran, 1967, pp. 429-430, 441) whenever a significant F was obtained. Another procedure involved preparing a table to show average observed gain (or loss) on posttest at the end of two years of college for each initial standard score on each ACT test. And finally, t tests for the available STEP[5] and SCAT scores means, pre and post, were conducted to determine the educational change measured by these instruments over two years of college. STEP and SCAT tests were first administered to college freshmen soon after they arrived on campus and then to the same students after two years of college.

Results

To investigate observed gains on the ACT tests, t tests were conducted for each of the five campuses. Results are shown in Table 1.

Insert Table 1 about here

There were significant gains ($P \leq .05$) in almost every case for ACT Social Studies, Natural Sciences, and Composite scores. In general, ACT test-retest mean differences were found on most ACT tests at most institutions with especially large gains being noted for Social Studies and Natural Sciences. It is also apparent that there are institutional differences; e.g., the college with the most highly significant mean gain surprisingly had the highest initial means.

[5]Data were available for only five of the STEP tests: Reading, Writing, Mathematics, Social Science, and Science.

Table 2 lists the average observed change for each subtest at each

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Insert Table 2 about here

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initial standard score for the entire group of 972 students who were retested at the end of the sophomore year. As expected, those with high initial test scores had low and negative change on retest, while those with low initial scores had large positive score change. Table 2 demonstrates the need to control for regression effect when between-group comparisons are made.

The remaining results of the study will be summarized briefly and, for simplicity, without reference to tables.[6] A two-factor analysis of covariance was computed at each institution to determine if there were different gain patterns on the four tests for men and women. Posttest scores were adjusted on initial scores in order to avoid giving either men or women a systematic advantage due to regression. At four of the five institutions interaction was found, suggesting that there were different gain patterns for the two sexes. Follow-up tests using one-factor analysis of covariance indicated a sex difference only on the ACT Mathematics scores at three of the institutions and on all subtest scores other than Mathematics at the fourth college. In these cases, where significant difference occurred, males had more gain on ACT Mathematics, Social Studies, and Natural Sciences, and women had more gain on ACT English.

Next, students who had taken a relevant course were compared on the appropriate ACT test with students who had not taken such a course

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[6] A supplement containing all tables for this study is available to interested persons. Address inquires to ACT Research and Development, Box 168, Iowa City, Iowa 52240.

or who had taken fewer such courses. Analysis of covariance was used, with posttest scores adjusted on pretest scores. On every campus, almost all students took English and the aame amount of English coursework during the first two years of college. Consequently, we could not study the effects of an English course on ACT English mean gain.

Three colleges reported data to permit a study of the effect of taking a mathematics course on Mathematics test scores. On all three campuses, students who took a mathematics course made greater gain than those who did not. At two of these colleges, students were divided into three groups-those with no courses, those with one mathematics course, and those with two or more mathematics courses. Consistently, the more mathematics coursework, the greater the mean gain on the ACT Mathematics test.

Few students had not taken a social studies course. Data for only one college permitted sectioning the students into a "no social studies" group. and a "some social studies" group. At another college, data permitted a breakdown into "0-3 semester hours of social studies" and "6 or more semester hours of social studies." No significant mean difference on ACT Social Studies scores was found at either campus.

Three colleges reported data for natural sciences. One college reported whether or not students had had a science course. Students who had a course made a significant gain on retest. Another college found almost all students had had a science course, so students were broken into two groups-those who had from 0 to 5 semester hours of science, and those who had 6 or more hours. There was no significant difference on retest for the two groups. At the third college, groups included students with no science courses, those with one science course,

and those with two or more science courses. There were no significant differences in gain for the three groups.

The effect of educational major on test scores was examined next. Three colleges reported the majors of their students. Taking each of the four ACT tests one at a time, we investigated whether gain on a test was related to educational major. On the Mathematics test on one campus, mathematics and science majors made significantly greater gains than English and language majors, social studies majors, education majors, and business majors. On the other campus, secondary education, business, and liberal arts majors made significantly greater gains on the Mathematics test than elementary education majors. At one college, gain on the Natural Sciences test scores was related to major. Mathematics plus science majors and fine arts plus no-majors made significantly greater gain on the Natural Sciences test than education majors.

Next we compared growth, separately for males and females, during the college sophomore year with that during the freshman year. Data were available from only one college where there had been a retest of one group at the end of the freshman year and of another group at the end of the sophomore year. A two-factor analysis of covariance with a one-factor analysis of covariance follow-up (separately by ACT subtest) was used to determine if the growth pattern was the same for the two groups. The within factor was "ACT subtest" and the between factor was "sex." No significant interaction was found for females, and it was just barely significant at the .05 level for males. Follow-up tests on males revealed no significant differences on specific subtests. Therefore a "year effect" was present for both sexes; most of the gain occurred prior to the sophomore year of college.

One college included SCAT scores, another STEP scores on test-retest. Significant gains were found for the SCAT Verbal and Total scores. For the same sample, significant gains were found for the ACT Social Studies, Natural Sciences, and Composite scores. The college that studied STEP found significant gains on all STEP tests studied: the STEP Reading, Writing, Mathematics, Social Science, and Science scores. This same college found signficant gains on the ACT Mathematics, Social Studies, Natural Sciences, and Composite scores, but not on the English scores.

Discussion

At this point let us briefly summarize our findings.

1. In general, students tested at the end of the college sophomore year show gains on the four ACT tests. ACT English scores seem to be the least sensitive to student growth while Social Studies, Natural Sciences, and Composite scores are the most sensitive. On an institutional level, English and Mathematics are the only two that have any negative mean score changes. English and Mathematics are probably more influenced than the other two by content, ceiling, and regression effects.
2. Institutional differences apparently determine growth and the subject matter areas in which it occurs. For example, the college with the highest initial score means had the greatest observed gain by far on ACT Social Studies and Natural Sciences scores. This difference in gain would be even more marked if there were no ceiling and regression effects present. In contrast, this college had less English score gain than did the others, and for females the change was negative. Such

institutional differences may be the result of student input characteristics or of campus atmosphere and instructional characteristics, or of both.

3. Different gain patterns on the tests are found for boys and girls. At three of the five colleges, boys gained significantly more on Mathematics scores than did girls, possibly because more boys take mathematics courses than girls. A fourth college had significant sex differences on the other three subtests, excluding Mathematics.

4. Students who take a college mathematics course show gain on ACT Mathematics test scores. No such growth is detectable for students who take a social studies course. ACT Social Studies scores may reflect such content as generalized reading comprehension which is less related to social studies courses than, for example, Mathematics scores are to mathematics coursework. Semi-technical reading and comprehension skills are emphasized and practiced in the freshman courses of many curricular areas. Social Studies scores have proved to be predictive for a wide range of freshman courses. Thus, we might expect much overall gain on this test for the college population as a whole with little difference generally apparent when mean change comparisons between groups of students are made. The available data did not permit an adequate study of the effect of having a college English or science course, but there would likely be more gain on ACT Natural Sciences scores associated with taking a science course than gain on ACT English scores associated with taking an English course.

5. Generally, student's educational growth is unrelated to his major. Gain on Mathematics test scores do seem to be related to major in some instances, and gain on Natural Sciences tests may be. Little change as a result of major could be due to several factors. Majors have already mastered most of the basic skills covered in that test and thus have much less room for improvement (ceiling effect). And most students may not have decided on a major until shortly before retest and thus have had no additional coursework in their major field. It is also common practice to leave most courses in students' major areas until the junior and senior years of college.
6. Students tested after the sophomore year did not show significantly more gain on any of the subtests than students tested after the freshman year. It has been mentioned that the ACT tests were built to predict first term grades and are more applicable to first year courses. Perhaps the more advanced courses of the sophomore year do not emphasize much of the test content. Sophomore students therefore do not have the opportunity to increase proficiency in such skills. During the freshman year most students may near their peak proficiency on the basic skills emphasized in the tests.
7. Negative gain (or loss) is associated with initially high scoring students while positive gain is associated with initially low scoring students, as expected because of regression effect. Mean gains occurred on Social Studies and Natural Sciences test scores at a much higher initial score level than for English and Mathematics scores, implying the presence of content effect.

8. Gain in scores over two years in college is detected on both the SCAT and STEP tests.

In addition to the problems in measuring change, there are certain other limitations to this study. First, we used gain on the respective subtests to study the effects of courses and majors, when it might have been better to construct variables of "potential" in the four academic areas of the tests, based on the optimal weighting of the tests used routinely for the institutional prediction of college grades. In other words, we used content rather than predictive validity in dealing with educational development in the four areas of the tests. Second, there was no control for maturational effects. ACT-tested students who did not go to college could be re-tested at the end of the same time interval and their changes compared with college students. Third, there was no control for student input on an inetutitional level;[7] this was justified on the theory that institutional differences were not of interest in this study since we were focusing on the educational development of college students in general. Fourth, almost a year of high school experience occurred after the pretests. A study with the pretest given at the beginning of the college freshman year would avoid this problem. Fifth, the motivation to do well on the tests may have been considerably greater when the tests (pretest) were written for college admissions, than when the posttest occurred.

However, this study of the educational growth of college students was intended to be a preliminary one. We consider the ACT tests along

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[7] Stanley (1966) has discussed the problem of controlling for student input in college effects design. For an example of one experimental approach, see Nichols (1964).

with the SCAT and STEP as being of some use in this case.

Additional research in college student growth could deal with institutional differences in average student educational growth, student differences in educational growth, interactions of students and institutions on growth, and special applications of our knowledge to assessing growth among culturally and educationally disadvantaged college students.

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TABLE 1

T-TEST OBSERVATIONS OF OVERALL MEAN GAIN FROM ACT PRETEST TO POSTTEST AT 5 COLLEGES

College & Years Attended[a]	MALES Pretest Mean	S.D.	Posttest Mean	S.D.	r	t	FEMALES Pretest Mean	S.D.	Posttest Mean	S.D.	r	t
ACT ENGLISH												
A1	15.22	4.95	16.75	4.32	.68	4.37**	19.00	5.29	20.01	5.38	.82	3.25**
A2	16.64	5.50	17.47	4.87	.66	2.16*	19.17	5.04	20.19	4.04	.75	3.26**
B2	17.95	4.70	18.87	4.31	.75	2.94**	21.40	4.03	21.07	3.94	.76	-1.16
C2	17.06	3.89	17.73	3.75	.61	2.37*	19.59	3.62	19.69	4.06	.65	0.28
D2	17.55	4.97	19.34	3.87	.72	3.43**	21.50	3.66	21.21	4.15	.70	-0.46
E2	19.57	3.43	19.95	3.86	.53	0.97	21.97	3.25	21.63	3.56	.46	-1.19
ACT MATHEMATICS												
A1	16.06	5.59	17.10	5.80	.78	2.95**	16.63	6.04	17.55	6.03	.84	2.77**
A2	17.68	6.25	18.68	5.50	.75	2.66**	14.84	5.31	16.03	5.72	.73	3.12**
B2	21.29	6.40	21.71	5.59	.81	1.14	20.35	6.92	19.57	6.10	.86	-2.15*
C2	18.19	5.26	19.13	4.55	.67	2.78**	16.01	5.04	16.93	4.31	.60	2.00*
D2	18.70	5.75	19.41	5.66	.83	1.42	16.71	5.36	17.13	4.64	.60	0.46
E2	23.47	4.85	24.82	4.61	.71	3.41**	19.61	4.83	20.90	5.05	.65	3.86**
ACT SOCIAL STUDIES												
A1	16.17	5.92	18.84	6.33	.68	5.83**	17.47	6.33	18.88	6.29	.78	3.47**
A2	17.32	5.93	20.71	5.56	.77	9.73**	16.76	4.94	19.04	5.68	.67	5.58**
B2	20.38	5.46	21.81	4.75	.77	4.16**	21.96	5.50	23.77	5.03	.81	5.38**
C2	19.55	4.82	21.43	4.70	.64	5.56**	20.85	5.64	22.24	4.80	.51	2.46*
D2	19.77	5.48	21.59	5.06	.69	2.90**	20.79	5.16	21.17	4.63	.62	0.43
E2	21.78	4.73	25.81	3.84	.66	10.13**	21.82	4.27	25.69	3.68	.59	13.16**
ACT NATURAL SCIENCE												
A1	17.61	5.72	19.90	5.60	.64	5.11**	17.67	6.67	18.91	6.36	.80	3.09**
A2	18.00	6.79	21.89	5.78	.72	9.11**	16.51	5.58	18.93	5.47	.63	5.44**
B2	21.98	5.13	23.02	5.28	.72	2.73**	21.20	5.76	22.39	4.96	.73	2.89**
C2	20.26	4.77	21.86	4.95	.66	4.77**	19.06	4.83	20.15	4.91	.60	2.31*
D2	19.70	5.67	20.20	5.72	.69	0.74	17.92	4.58	20.08	5.25	.65	2.55*
E2	22.93	4.54	24.72	3.95	.55	4.02**	21.09	4.76	23.25	4.08	.44	5.67**
ACT COMPOSITE												
A1	16.38	4.54	18.22	4.40	.79	6.80**	17.82	5.25	18.94	5.30	.89	4.66**
A2	17.53	5.08	19.79	4.41	.85	9.47**	16.96	4.32	18.63	4.28	.85	7.57**
B2	20.52	4.44	21.45	4.13	.89	4.69**	21.40	4.77	21.82	4.27	.92	2.19*
C2	18.86	3.67	20.18	3.52	.77	6.46**	19.04	3.87	19.87	3.55	.76	2.96**
D2	19.07	4.33	20.34	4.28	.85	3.57**	19.42	3.84	20.00	3.86	.80	1.17
E2	22.07	3.30	24.01	3.06	.74	7.67**	21.21	3.15	23.01	2.86	.70	9.50**

*$p \leq .05$

**$p \leq .01$

[a] The capital letter identifies the college and the numeral denotes how many years the group had attended this college at the time of the retest. Sample sizes are as follows:

	Males	Females
A1	115	106
A2	126	114
B2	105	95
C2	143	85
D2	44	24
E2	83	153

TABLE 2

DISTRIBUTION ACCORDING TO STANDARD SCORE ON THE PRETEST OF ACT TEST-RETEST MEAN CHANGE[a]

Pretest Standard Score[b]	ACT English Freq	ACT English Mean Change	ACT Math Freq	ACT Math Mean Change	ACT Soc St Freq	ACT Soc St Mean Change	ACT N Sci Freq	ACT N Sci Mean Change	ACT Compos Freq	ACT Compos Mean Change	Pretest Standard Score
36											36
35			4	-2.00							35
34			3	-2.33							34
33			4	-4.00	1	-2.00	5	-2.40			33
32			6	-3.33	8	-0.50	3	-1.00			32
31			11	-1.18	10	-1.80	4	-1.50	2	-1.00	31
30	1	-5.00	7	-2.14	17	-1.59	14	-1.29	4	-0.50	30
29	5	-2.20	19	-1.84	16	0.06	18	-1.39	6	-0.50	29
28	11	-1.64	22	-1.73	24	-0.75	37	-0.89	20	-0.35	28
27	20	-1.85	36	-0.83	26	-0.54	39	0.10	26	-0.04	27
26	36	-1.72	38	-0.18	43	0.58	61	-0.49	29	-0.07	26
25	40	-2.05	42	-0.36	74	1.68	34	0.21	37	0.27	25
24	57	-1.16	35	-0.94	58	1.90	69	0.29	65	0.52	24
23	68	-0.66	62	-0.32	70	1.33	71	1.17	56	0.95	23
22	67	-0.66	31	0.55	49	1.35	49	0.86	85	1.07	22
21	79	0.11	39	0.15	64	2.03	74	0.76	91	0.89	21
20	88	-0.11	50	-0.36	80	2.26	66	1.30	87	1.06	20
19	92	0.04	58	0.17	53	3.43	55	1.62	79	1.48	19
18	93	1.32	77	0.29	58	2.34	71	2.65	92	1.84	18
17	74	1.39	59	1.08	55	4.05	42	3.55	73	2.19	17
16	58	0.76	67	1.42	59	3.24	42	3.12	46	1.91	16
15	44	1.30	67	1.43	41	4.90	43	4.72	49	2.14	15
14	32	2.00	46	1.26	46	4.76	45	4.02	34	2.26	14
13	28	2.93	46	1.80	39	4.00	28	5.14	26	3.54	13
12	15	2.20	40	3.12	14	4.36	32	5.03	25	2.84	12
11	17	1.65	23	2.91	19	4.68	16	4.37	12	3.17	11
10	10	3.50	18	4.11	14	4.36	9	4.89	14	3.93	10
9	12	4.00	20	5.85	6	8.17	12	6.25	6	3.83	9
8	8	5.87	6	4.50	13	5.23	14	6.14	3	2.67	8
7	1	7.00	17	4.47	7	9.29	5	8.40	2	4.50	7
6	7	7.00	7	4.86	6	7.17	7	9.29	2	8.00	6
5	1	6.00	7	9.86	1	4.00	3	10.33			5
4	1	13.00	1	5.00			2	5.50			4
3	4	10.75	2	5.50			1	16.00	1	5.00	3
2	2	9.50	2	7.00	1	16.00	1	6.00			2
1	1	10.00									1

Statistics for the entire group of students (972 students from 5 colleges):

	English	Mathematics	Social Studies	Natural Science	Composite
Pretest mean	19.11	18.75	19.96	19.98	19.58
Mean change	0.46	0.82	2.48	1.92	1.42
r_{12}	.70	.77	.71	.67	.84

[a]All students in the sample had attended two years of college prior to the posttest.

[b]ACT tests have a standard score range of 1-36, with the scale being the same for the four tests and composite. National college bound norms for the ACT tests show means and standard deviations of approximately 20 and 5 respectively.