A LONGITUDINAL STUDY OF ENGINEERING STUDENT PERFORMANCE AND RETENTION. II. DIFFERENCES BETWEEN STUDENTS FROM RURAL AND URBAN BACKGROUNDS*

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ABSTRACT

A cohort of chemical engineering students has been taught in an experimental sequence of five chemical engineering courses, beginning with the introductory course in the Fall 1990 semester. Differences in academic performance have been observed between students from rural and small town backgrounds ("rural students," N=55) and students from urban and suburban backgrounds ("urban students," N=65), with the urban students doing better on almost every measure investigated. In the introductory course, 80% of the urban students and 55% of the rural students passed with a grade of C or better, with average grades of 2.63 for the urban students and 1.80 for the rural students (A=4.0). The urban group continued to earn higher grades in subsequent chemical engineering courses. After four years, 79% of the urban students and 64% of the rural students had graduated or were still enrolled in chemical engineering; the others had either transferred out of engineering or were no longer attending the university. This paper presents data on the students' home and school backgrounds and speculates on possible causes of observed performance differences between the two populations.

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INTRODUCTION

In the fall of 1990 a longitudinal study was undertaken of students then enrolled in the introductory chemical engineering course at N.C. State University (CHE 205). One of us (RMF) taught these students a sequence of five chemical engineering courses in consecutive semesters, using a variety of instructional methods including cooperative (team-based) learning and routine assignment of open-ended problems and problem formulation exercises. The hypothesis is that the students participating in this program will remain in engineering through graduation to a greater extent, earn higher grade point averages in engineering, and develop more positive attitudes about engineering and about their own capabilities than do students who go through the traditionally-taught curriculum. Details about the methodology and preliminary results of the study are given by Felder *et al*.[1]

During the first semester of the study 120 students responded to a questionnaire that included the item:

> "My home community (where I attended high school) is best described as **(a)** rural; **(b)** small town; **(c)** suburban; **(d)** urban."

For statistical analyses, students in the rural and small town categories were combined into a single group, as were those in the suburban and urban categories. Students in the two groups are collectively referred to as "rural" students and "urban" students, respectively. The urban group dramatically outperformed the rural group in CHE 205: 80% of the 65 urban students and 55% of the 55 rural students passed the course with a C or better, and the average grades for the urban and rural students were 2.63 and 1.80, respectively (A=4.0). Urban students generally continued to get higher grades in chemical engineering courses in subsequent semesters. At the end of the sixth semester of the study (which would translate to the fourth year of college for most of the students), 79% of the urban students and 64% of the rural students had either graduated or were still enrolled in chemical engineering; the others had either transferred to non-engineering curricula or were no longer attending the university.

The finding that urban students enjoy greater academic success than rural students is not unprecedented, although no previous studies have dealt specifically with students in technical curricula. Brown[2] observes that rural students are more likely to drop out of college than urban students, citing studies supporting this conclusion by Anderson[3] and Aylesworth and Bloom.[4] Brown also cites evidence for a variety of potential causes of the relatively poor showing of rural students, including lower social pressure to attend college, lower levels of parental education, and limited high school course offerings.

These observations prompted an investigation of differences between rural and urban students in the longitudinal study that might account for their performance differences in chemical engineering courses. This paper summarizes and discusses the results.

STUDENT BACKGROUNDS

Most of the students in this study come from North Carolina, a state in which rural communities tend to lag well behind cities and suburbs in public school funding levels and average SAT and achievement test scores. Of the students enrolled in CHE 205 in the Fall 1990 semester, 89% were either straight chemical engineering majors or enrolled in a chemical engineering/pulp and paper technology (PPT) dual degree program, and 11% were majors in other fields who may or may not have intended to switch to chemical engineering.

Background data for the participating students include categorical variables, such as percentages of students whose parents had college degrees, and continuous variables, such as SAT scores. Between-group comparisons of categorical variables were performed with the 1-tailed Fisher's exact test,[5] which uses the exact hypergeometric distribution rather than the chi-square distribution. Continuous variables were classified as normal or non-normal and were analyzed using 1-tailed t-tests (parametric) or Wilcoxon's rank sum tests (nonparametric). A significance level of .1 was used for all tests, a value recommended for exploratory educational research.[6] The principal results follow.

Demographics. 22% of the rural students and 34% of the urban students were female. Both populations were heavily white (rural—87%, urban—78%), with the balance African-Americans (rural—4%, urban—8%), Asian-Americans (rural—2%, urban—8%), Native Americans (rural—7%, urban—0%), and other ethnic groups (rural—0%, urban—6%).

Transfer Status. 82% of the rural students and 97% of the urban students enrolled as first-year students at NCSU. The remaining students in each population transferred to NCSU later in their programs.

Parental education (Table 1)**.** Substantially smaller percentages of the fathers of the rural students had undergraduate degrees (rural—50%, urban—77%) and advanced degrees (rural—12%, urban—33%), and a greater percentage of the rural fathers had no more than a high school education (rural—29%, urban—14%). A slightly lower percentage of mothers of rural students had college degrees (rural—50%, urban—53%). The percentage of rural mothers with advanced degrees was much lower (8% vs. 22%) and the percentage with no more than a high school education was much higher (37% vs. 20%).

In the fall of 1991, participating students taking the junior course in fluid dynamics and heat transfer (CHE 311) were asked if either or both of their parents had training in science or technology. Those responding affirmatively included 64% of 22 rural students and 73% of 40 urban students. The implication is that the rural students were less likely than the urban students to have parents who could serve as academic role models by virtue of having attended college and/or being trained in science or technology.

Parental attitudes toward college attendance. The sophomores were asked whether they felt that their parents (a) assumed they would go to college and would have been troubled if they had chosen not to go; (b) expected they would go to college but would have been comfortable if they had not; (c) never expected they would go but were pleased about it; (d) never expected they would go and and were not sure it would be worth it. More than 95% of both the rural and urban parents expected their children to attend college (Categories a + b), but a higher percentage of the urban parents (89% vs. 75%) would have been disturbed if their children had chosen not to do so (Category a).

Myers-Briggs Type Indicator Profiles (Table 2). Most students in the study completed Self-Scorable Form G of the *Myers-Briggs Type Indicator*, a widely-used instrument that assesses positions on four scales derived from Carl Jung's theory of psychological types.[7] The results are shown in Table 2, along with data obtained in the 1980's for 4,484 engineering students at a consortium of 10 universities.[8] Results for the NCSU students are close to those for the much larger consortium sample. Relative to the latter group, the NCSU population has an almost identical ratio of extraverts (focused more on the outer world of actions, objects, and people) to introverts (focused more on the inner world of concepts and ideas), a slightly higher ratio of sensors (focused more on immediate, real, practical facts of experience and life) to intuitors (focused more on the possibilities, relationships, and meanings of experiences), and similar ratios of thinkers (tending to make decisions on the basis of impersonal logic) to feelers (tending to make decisions on the basis of personal and social values) and judgers (preferring to live in a decisive and planned way) to perceivers (preferring to live in a flexible and spontaneous way).

The ratio of extraverts to introverts was about the same for both rural and urban populations (48/52). The rural population had a higher ratio of sensors to intuitors (61/39) than did the urban population (55/45), but the difference was not statistically significant; neither was the difference between the judger/perceiver ratios (65/35 for rural students, 59/41 for urban students). The greatest difference between the two populations was found on the thinking/feeling dimension. Majorities of rural males, urban males, and rural females were thinkers, and urban females split evenly between thinkers and feelers. Compared to the engineering consortium averages, the ratio of thinkers to feelers was higher for the rural students of both sexes and lower for the urban students of both sexes. The difference between the thinking/feeling ratios for men (rural—85/15, urban—67/33) was significant at the .1 level; that between the T/F ratios for women (rural—67/33, urban—50/50) was not, due in part to the relatively small number of women in the population.

COLLEGE ENTRANCE CRITERIA

The data include values of three variables used to evaluate applicants to N.C. State: Scholastic Aptitude Test (SAT) math and verbal scores and the Admissions Index (AI), a predictor of first-year performance at NCSU derived from a regression equation containing high school grade point average, converted high school class rank, and SAT scores. These data are available for 103 of the 120 students in the data base; most of the students for whom data are lacking are transfer students. The average AI, SAT-M, and SAT-V scores for the rural and urban populations were compared, with results given in Table 3. The urban students scored significantly higher than the rural students on all three of these measures; the difference of almost 50 points in the mean SAT-M score is significant at the .001 level.

ADVANCED PLACEMENT CREDIT

Students frequently enter NCSU with advanced placement (AP) credit in one or more of the first-year mathematics, science, and English courses in which satisfactory performance is required to matriculate into an engineering curriculum. The science and mathematics courses required for entry into chemical engineering are Math 141 and 241 (Calculus I and II), Chemistry 101 and 107 (General Chemistry I and II), and Physics 205 (Mechanics).

Substantially more urban students (31%) than rural students (4%) earned AP credit for the introductory calculus course, and slightly higher percentages of the urban students earned AP credit for the remaining required science and mathematics courses. The differences are at least in part attributable to differences in availability of advanced placement courses in rural and urban schools. In a Spring 1992 questionnaire, 92% of the urban students and only 48% of the rural students responding indicated that they had had access to AP science and math courses.

FIRST YEAR OF COLLEGE

Overall first-year grade point averages and grades obtained in first-year science and mathematics courses were tabulated and compared for the two populations. The results are shown in Table 4. The mean GPA was 3.11 for nontransferring rural students and 3.35 for nontransferring urban students. The difference in the means is significant at the .03 level.

In all five of the courses examined, the urban students received higher average grades than the rural students, with the difference being statistically significant at the .1 level in two instances. The differences are conservative estimates of the true differences for the two populations, since greater numbers of (arguably) better students—i.e. those with AP credit—were removed from the urban population before the averages were computed. The only course in which the two averages were nearly equal was the introductory calculus course (MA 141), in which 31% of the urban students and 4% of the rural students had AP credit; in a manner of speaking, the result implies that the lower 69% of the urban population did as well in this course as the lower 96% of the rural population.

MOTIVATION FOR CHOOSING ENGINEERING AS MAJOR FIELD OF STUDY

In the first week of CHE 205, the students were presented with a list of 11 possible reasons for deciding to enroll in engineering and asked to designate up to three of them as having been very important in their decision. The percentages of the rural and urban students who selected each of the specified alternatives are shown in Table 5.

Aptitude in science and mathematics and interest in the field were the predominant choices, each being selected by about 55% of the rural students and 63% of the urban students. Financial reward/job mobility was the next most common choice, being selected by 53% of the rural students but only 43% of the urban students. Twenty-five percent of the rural students and 35% of the urban students were attracted by the possibility of working on socially important problems, and slightly more than 20% of each group were influenced by a role model or a positive experience associated with engineering. Substantially more of the urban students (26% vs. 7% of the rural students) were influenced by a family member, probably reflecting the higher level of parental education and the greater number of scientists and engineers among the urban parents. The rural students were more likely to have been influenced by a high school advisor (15% vs. 2%) or a career day or open house (11% vs. 6%). Fewer than 10% of each group cited a summer engineering program or the influence of a friend or classmate.

EXPECTATIONS AND CONFIDENCE WHEN ENTERING ENGINEERING

On the background questionnaire given in the first week of CHE 205, the students were asked how they rated their academic preparation, what grade they expected to earn in CHE 205 and what grade would minimally satisfy them, and how long they expected to take to graduate. They also completed the Learning and Study Strategies Inventory (LASSI©), a self-administered instrument that provides scores on 10 scales having to do with general attitudes toward learning, motivation to study, time management skills, level of anxiety, and various study skills and strategies. The results follow.

Rating of academic preparation for CHE 205. The students' ratings of their academic preparation differed significantly between the two groups: 50% of the urban students and only 26% of the rural students considered their preparation better than average (*p*=.006 on a Fisher's exact test).

Expected grade in CHE 205. About 93% of the students in each group guessed that their final grade would be B or better. (Their expectations became somewhat more realistic after the first examination in the course.) However, 50% of the urban students guessed that their final grade would be an A, as contrasted with 33% of the rural students (*p*=.05 on a Fisher's exact test).

Requirement for satisfaction with performance in CHE 205. Both groups expressed almost identical satisfaction requirements. Roughly 11% specified a grade of C or better, 54% B or better, 26% A, and 9% creative work beyond the "A" level.

Expected time from college entrance to graduation. 28% of the urban students expected to graduate in four years or less, as contrasted with 15% of the rural students (*p*=.06 on a Fisher's exact test).

Learning and Study Strategies Inventory (Table 6). The higher the score on a scale, the less likely the student will be to experience academic difficulties resulting from inadequacies in the corresponding skill or attitude. On most scales the mean scores for the urban students were slightly higher than those for the rural students, but none of the differences were statistically significant.

EXTERNAL TIME DEMANDS IN THE FIRST SEMESTER OF ENGINEERING

The students were also asked on the background questionnaire to estimate the number of hours per week they spent on an outside job and on extracurricular activities (sports, religious involvement, fraternities/sororities, etc.) The average times spent on outside jobs were almost identical for the two groups, with roughly 80% of each group working 10 hours per week or less and a slightly higher percentage of the rural students working 5 hours per week or less (64% rural, 59% urban).

A greater difference was found between times spent on extracurricular activities. The categories specified in the question and the percentages of students responding in each category were as follows: (a) less than 2 h/wk (22% rural, 12% urban), (b) 2–4 h/wk (38% rural, 28% urban), (c) 5–8 h/wk (22% rural, 33% urban), (d) 9–12 h/wk (9% rural, 22% urban), (e) more than 12 h/wk (9% rural, 5% urban).

PERFORMANCE IN THE FIRST CHEMICAL ENGINEERING COURSE

The introductory chemical engineering course, CHE 205 (Chemical Process Principles), deals with applications of the laws of conservation of mass and energy to chemical processes. The concepts in the course are relatively simple, consisting primarily of the conservation laws and elementary relations from physical chemistry (the ideal gas law, vapor pressure, heat capacity, and heats of fusion, vaporization, and reaction), many of which are already known from high school or first-year college chemistry and physics.

Nevertheless, the course effectively functions as a filter for the chemical engineering curriculum, with attrition rates typically varying from 20% to 40%. One reason is that the type of thinking required for the course is considerably different from anything most of the students have previously been called upon to practice. The emphasis is not on basic concepts but on applications of those concepts to real systems.

Problems are sometimes long and complex, all of the information needed to solve a problem may not be given in the problem statement, and approximations must often be made to arrive at a solution.

All of these course features represent new territory for the sophomores. To do well in the course, they must adopt the systematic approach to problem solving that constitutes a substantial part of the course content. Most college sophomores have never developed systematic problem-solving skills, relying instead on memorization of facts and rote procedures to get by. That strategy no longer works in CHE 205 since the tests are invariably open-book, and students who continue to rely on memorizing generally fail. Students who pass CHE 205 with a C or better have a very good chance of making it through the rest of the curriculum.

Substantial rural/urban differences were found in CHE 205 performance, as shown in Figure 4. The average course grade on a 4-point scale was 1.80 for the rural students and 2.63 for the urban students (p=.002 on a Wilcoxon rank-sum test). Fifty-five percent of the rural students and 80% of the urban students passed the course with a grade of C or better (p=.003 on a Fisher's exact test), which qualified them to proceed to the next chemical engineering course in the curriculum. The difference in the passing frequencies of urban and rural students was substantially greater for men (84% urban pass, 53% rural pass) than for women (73% urban pass, 58% rural pass). A possible interpretation of this result is offered in the Discussion section.

Significant differences were also observed in the letter grade distributions for the two groups (Table 7). The percentage of the rural students who earned A's in CHE 205 (16%) was roughly half of the percentage of urban students doing so (29%), while the percentage of rural students earning F or dropping the course (33%) was approximately double the percentage of urban students doing so (15%).

Several questions were raised when these results were examined. One was the extent to which the performance difference between the rural and urban students in CHE 205 could have been predicted entirely from the differences in their SAT scores or first-year grade-point averages. Another was the extent to which the performance differences might be associated with differences in parental educational level. Finally, certain subgroups of students in CHE 205 were less successful than the class as a whole, notably racial minorities and transfer students: the question was whether an unequal distribution of either or both of these groups between the rural and urban populations might account for the observed performance differences between those populations. Each of these questions was investigated, with the following results.

Transfer students. There were 12 transfer students in CHE 205, of whom 10 were rural and two were urban. The average course grade of the transfer students was 1.42, well below the 2.25 average grade for all students. If the transfer students are taken out of the populations, the average grade for the remaining rural students is 1.87 (up from 1.80); for the remaining urban students the average is 2.68 (up from 2.63), still a significant difference (p=.004).

Minority students. Ethnic minority students on the average earned substantially lower grades than white students.[1] The rural population included 13% minority students and the urban population 22%; if the minorities are removed, the performance disparities between rural and urban students become even greater.

Parental education. Rural-urban academic performance differences are often attributed to differences in family socioeconomic status (SES). The background variable in this study that provides the most relevant measure of SES is parental educational level. (Limited data on family income levels are highly correlated with parental educational data.) Multiple regressions were carried out for the weighted average CHE 205 grade versus three dichotomous variables:

x_1 = 1 if father attended college, = 2 if father never attended college
x_2 = 1 if mother attended college, = 2 if mother never attended college
x_3 = 1 for rural, = 2 for urban

The father's educational level accounted for 10.8% of the variability in the average 205 grade; the model is significant at p=.0007. If the mother's educational level is added to the model, the variability accounted for is 11.3%, but the contribution of the new variable to the model is not significant at the .1 level. If the rural/urban variable is added to the first two, the variability accounted for is 17.9% and the model is significant at p=.0002. The contribution of the rural/urban variable is significant at p=.0058, suggesting that parental education alone does not completely account for the performance differences between the rural and urban students.

SAT scores. To determine whether the rural/urban difference merely served as a proxy for SAT scores in determining CHE 205 performance, a multiple regression was carried out. The dependent variable was the weighted average test grade in CHE 205 and the independent variables were the SAT-V and SAT-M scores and a dichotomous variable equal to 1 for rural students and 2 for urban students. SAT-V and SAT-M alone account for 13.5% of the variability in the weighted average CHE 205 grade, and the three independent variables as a group account for 17.3% of the variability; the latter model is significant at p=.0005. The addition of the rural/urban variable thus explains an additional 3.8% of the total variability, a statistically significant contribution (p=.04).

SAT scores + parental education. A multiple regression was also carried out including all of the preceding variables—SAT-M, SAT-V, the two parental education variables, and the rural/urban variable. The first four variables account for 21% of the variability in the weighted average CHE 205 grade, with a model significance p=.0005. Including the rural/urban variable in the model accounts for an additional 2% of the variability, a contribution not significant at the .1 level.

First-year GPA. The first-year GPA has been found to be an excellent predictor of performance in CHE 205[1] and more generally of success in the engineering curriculum.[9] Another multiple regression was performed with the weighted average test grade in CHE 205 as the dependent variable and the first-year GPA and the dichotomous rural/urban variable as independent variables. For the students for whom the GPA could be computed, the two independent variables as a group account for 42.6% of the variability in the weighted average CHE 205 grade; the model is significant at p<.0001. GPA alone accounts for 40.1%; the addition of the rural/urban variable explains an additional 2.5% of the total variability, a statistically significant contribution (p=.05).

PERFORMANCE IN SUBSEQUENT CHE COURSES IN THE STUDY

Four chemical engineering courses followed CHE 205 in the longitudinal study:

1. **CHE 225—Chemical Process Systems.** Process statistics, process variable measurement methods, and computer simulation of chemical processes.

2. **CHE 311—Transport Processes I.** Fluid dynamics and heat transfer.
3. **CHE 312—Transport Processes II.** Mass transfer and staged operations.
4. **CHE 446—Chemical Reactor Design and Analysis.**

CHE 225 emphasizes applications rather than theory and is not generally found very difficult by students who understand the material in CHE 205. CHE 311 is far more rigorous and conceptually difficult than either of the previous two courses, and CHE 312 and CHE 446 are somewhere between CHE 205 and CHE 311 in conceptual difficulty.

Comparing percentages of rural and urban students passing these courses with C's or better (as was done for CHE 205) does not provide particularly useful information since the passing rates are in the 80-100% range for both groups. More revealing is the comparison of average grades shown in Table 8 (in CHE 205, a drop is counted as an F). In the relatively easy and highly applied CHE 225, the average grades of the rural and urban students were almost the same, with the rural grade being marginally higher. However, in the more challenging transport courses, the average grades for the urban students were half a letter grade higher than those for the rural students: 2.93 vs. 2.40 in CHE 311 (p=.03) and 3.44 vs. 2.86 in CHE 312 (p=.003). The difference was much smaller in CHE 446, primarily due to a decline in the average grade of the urban students.

A marked difference also exists between the performance levels of the two populations at the top of the grade spectrum. Table 9 shows the percentages of each population earning A's in the five courses. Higher percentages of urban students earned A's in each course, with the differences being most pronounced in CHE 205, 311, and 312. The sharp decline in the percentage of urban students earning A's from CHE 312 (54%) to CHE 446 (34%) may be attributable to a form of "senioritis." Our hypothesis (partially confirmed in personal interviews) is that some of the seniors in CHE 446, increasingly concerned with post-graduation prospects and plans, decided that getting one more A was not worth the time and trouble it would take. Many of the urban students who had earned A's in CHE 312 therefore opted to settle for B's in CHE 446, thereby lowering both the average course grade (Table 8) and the percentage receiving A's (Table 9).

ACADEMIC STATUS AFTER SIX SEMESTERS OF THE STUDY

Following the Spring 1993 semester, 86 of the 120 students enrolled in CHE 205 in the fall of 1990 had either graduated or were still actively enrolled in chemical engineering; the remainder were either in some other curriculum, on academic suspension, or out of school.

Table 10 shows the status of the rural and urban students in June 1993. Students in the category "CHE—On schedule" are either dual-degree candidates or voluntarily took lighter loads and so extended their residencies, but will almost certainly graduate with chemical engineering degrees in the coming academic year, as will the students in the co-op program. Students who are "behind schedule" failed to pass one or more chemical engineering courses with grades of C or better and may or may not successfully complete their degree programs. Those "never in CHE" either failed to achieve the necessary overall GPA to be formally admitted to the CHE degree program or did not intend to matriculate in chemical engineering when they took CHE 205.

At the conclusion of the Spring 1993 semester, 29% of the rural students and 40% of the urban students received degrees in chemical engineering, 53% of the rural students and 70% of the urban students were in good standing in chemical engineering (graduated, on schedule, or in the co-op program), and 64% of the rural students and 79% of the urban students had not left chemical engineering. Higher percentages of rural students than of urban students had gotten into academic difficulty in chemical engineering (11% vs. 9%), were never admitted to chemical engineering and so only took the first course in the sequence (13% vs. 8%), or left school or were suspended (15% vs. 3%). In short, the performance advantage enjoyed by the urban students in CHE 205 continued to manifest itself through the remainder of the curriculum.

SUMMARY, DISCUSSION, AND CONCLUSIONS

One hundred twenty students enrolled in the introductory chemical engineering course in the fall of 1990 have been tracked through six semesters. Students from rural and small town backgrounds ("rural students"—N=55) have been compared with students from urban and suburban backgrounds ("urban students"—N=65) on a variety of measures. In almost every measure of scholastic aptitude or achievement examined, urban students surpassed rural students. The urban students had higher scores on standardized college entrance examinations, placed out of more first-year college courses, earned better grades in first-year science and mathematics courses and in three out of four subsequent chemical engineering courses included in the study, and were less likely to drop out of engineering or out of college.

Several differences between the populations were identified that might account in part for the observed academic performance differences. Higher percentages of the urban students' parents had college degrees and training in science or technology, and significantly higher percentages had advanced college degrees. Most of the parents expected their children to attend college, but a higher percentage of urban parents would have been disturbed if their children had chosen not to do so. Many more urban students had access to advanced placement courses in their high schools and took advantage of that access, and it is likely that the teaching quality in advanced science and mathematics courses was better in the urban schools than in the few rural schools that offered such courses. These results are consistent with the assertion of Brown[2] that the relatively poor showing of rural students is attributable in part to lower social pressure to attend college, lower levels of parental education, and limited high school course offerings.

Other factors for which no direct evidence is provided by this study undoubtedly contribute to the observed rural student/urban student performance disparities. As a consequence of the differences in their home and school backgrounds, rural students receive less intellectual stimulation from parents or peers and have access to fewer potential role models. They are subject to lower academic standards and less expert career counseling in high school, and are therefore more likely to misjudge their aptitude for engineering; given good advice, some of them would probably have made better curriculum choices.[10] They are also more likely to experience anxiety or depression over the difficulty of adjusting to college life, coupled with a reluctance to seek counseling.[4] Another observation in the literature is that rural females are more likely than urban females to restrict their career choices to traditionally female occupations.[2] Rural females who choose to go into engineering might therefore be unusually strongly motivated and/or more self-confident than their male counterparts, which could account for the higher success rates observed in this study for the rural females.

Whatever the causes may be, it is clear that engineering students from rural and small town backgrounds are academically disadvantaged relative to urban and suburban students. (This conclusion does not account for underprivileged inner city students, whose presence was negligible in this study). Correcting the disparity on a long-term basis will require dramatic changes in the allocation of human and material resources to public schools, and possibly efforts to change the attitudes and expectations of many parents regarding their children's education; unfortunately, such changes are not likely to be made in a period short enough to benefit prospective engineering students in the decade to come. To help these students, remedial and supportive measures in college teaching and advising programs will be required.

Aylesworth and Bloom[4] propose an outreach program for students from rural backgrounds that might include such features as sensitizing advising staff to the problems and needs of these students, designing special orientation programs, and creating peer support groups. However, Brown[2] points out that such programs cannot be effectively designed until the controlling academic and/or social origins of the rural students' performance and retention problems can be identified from the broad list of possible causes. For example, the rural students in this study report lower expectations for success than their urban peers: tutoring programs that label rural students as at-risk for academic failure could have negative repercussions if they increase these students' anxiety or lack of confidence. Interventions that involve exposure to successful rural students could be helpful.[10]

A final point. The experimental course sequence involved a great deal of active, cooperative learning, which educational psychology research indicates should support enhanced motivation to learn, problem-solving skills, and depth of understanding of the course material relative to standard instructor-centered lecture-based methods. Although the rural/urban differences observed in the study are real and significant, the extent to which both groups were differently affected by the methods used in the experimental courses will not be known until data are obtained for a comparison group that proceeds through the curriculum as normally taught. These data are currently being collected.

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TABLE 1. PARENTAL EDUCATIONAL LEVELS

	Father		Mother	
Educational Level	**Rural (N=48)**	**Urban (N=60)**	**Rural (N=48)**	**Urban (N=60)**
Advanced degree	12%	33%	8%	22%
Bachelor's degree	38%	44%	42%	31%
Some college	21%	8%	12%	27%
High school grad.	19%	11%	33%	20%
Not high school grad.	10%	3%	4%	0%
p†	.02		.02	

†Fisher's exact test

TABLE 2. MYERS-BRIGGS TYPE INDICATOR PROFILES

MBTI Scale	**Engr.† (N=4484)**	**Rural (N=51)**	**Urban (N=64)**	**p‡**
Extraversion (E) – Introversion (I)	E I 45% 55%	E I 47% 53%	E I 48% 52%	NS
Sensing (S) – Intuition (N)	S N 52% 48%	S N 61% 39%	S N 55% 45%	NS
Thinking (T) – Feeling (F) (Females)	T F 61% 39% (N=698)	T F 67% 33% (N=12)	T F 50% 50% (N=22)	NS
Thinking (T) – Feeling (F) (Males)	T F 75% 25% (N=3786)	T F 85% 15% (N=39)	T F 67% 33% (N=42)	.08
Judging (J) – Perceiving (P)	J P 59% 41%	J P 65% 35%	J P 59% 41%	NS

†Data for a 10-school consortium.[8]

‡ Fisher's exact test

TABLE 3. SAT SCORES AND ADMISSION INDEX

Measure	**Rural (N=43)**	**Urban (N=60)**	**p‡**
SAT-M (Std. Dev.)	602 (81)	651 (72)	.001
SAT-V (SD)	496 (81)	540 (77)	.003
AI (SD)	2.80 (0.39)	2.94 (0.38)	.04

‡Fisher's exact test

TABLE 4. FIRST-YEAR GPA AND COURSE GRADES

Course	Rural (N)	Urban (N)	p[‡]
GPA[†]	3.11 (43)	3.35 (59)	.03
Math 141[*]	2.85 (41)	2.90 (42)	NS
Math 241[*]	2.77 (45)	3.08 (59)	NS
Chem 101[*]	3.23 (43)	3.57 (60)	.06
Chem 107[*]	3.16 (43)	3.28 (60)	NS
Phys 205[*]	2.47 (44)	2.86 (58)	.04

[†]Nontransfer students only

[‡]Wilcoxon rank sum test

[*]Students with AP credit deleted

TABLE 5. MOTIVATION FOR CHOOSING ENGINEERING[†]

Reason	Rural (N=55)	Urban (N=65)
Aptitude in science and math	56%	63%
Interest in field	55%	63%
Job mobility/financial rewards	53%	43%
Work on socially important problems	25%	35%
Role model/positive experience	20%	23%
High school advisor	15%	2%
Open house/career day	11%	6%
Summer program	7%	5%
Friend or classmate	7%	5%
Family member	7%	26%
Other	7%	14%

[†] Students could choose up to three reasons

TABLE 6. LEARNING AND STUDY STRATEGIES INVENTORY (LASSI©) SCORES

LASSI Scale[†]	Rural (N=49)	Urban (N=65)	p[‡]
ATT	31.4	33.2	.1
MOT	32.0	32.0	NS
TMT	25.2	26.0	NS
ANX	25.0	26.0	NS
CON	27.1	27.2	NS
INP	27.6	28.9	NS
SMI	19.0	19.5	NS
STA	25.1	24.6	NS
SFT	25.7	26.5	NS
TST	29.6	31.0	NS

[‡] t-test

[†]Scale definitions:

- ATT = Attitude and interest in school
- MOT = Motivation, diligence, self-discipline, willingness to work hard
- TMT = Use of time management principles for academic tasks
- ANX = Anxiety about school performance (high score=low anxiety)
- CON = Concentration and attention to academic tasks
- INP = Information processing (ability to supply meaning and organization to new information)
- SMI = Selecting main ideas and recognizing important information
- STA = Use of study aids (highlighting, underlining, writing summaries,...)
- SFT = Self-testing, reviewing, preparing for classes
- TST = Test-taking strategies and preparing for tests

TABLE 7. PERFORMANCE IN CHE 205

Performance Measure	**Rural (N=55)**	**Urban (N=65)**	**p**
Mean grade (A=4.0)	1.84	2.63	.003†
% passing (A, B, C)	55%	80%	.003‡
% A	16%	29%	.04‡
% B	25%	40%	
% C	13%	11%	
% D	13%	5%	
% F/drop	33%	15%	

† Wilcoxon rank sum test

‡ Fisher's exact test

TABLE 8. GRADES IN LONGITUDINAL STUDY COURSES.

Course	**Rural (N)**	**Urban (N)**	**p‡**
CHE 205	1.8 (55)	2.6 (65)	.002
CHE 225	3.2 (27)	3.1 (44)	NS
CHE 311	2.4 (25)	2.9 (42)	.03
CHE 312	2.9 (22)	3.4 (39)	.003
CHE 446	3.1 (17)	3.1 (38)	NS

‡Wilcoxon rank sum test

TABLE 9. PERCENTAGES EARNING A's IN LONGITUDINAL STUDY COURSES

Course	**Rural (N)**	**Urban (N)**	**p‡**
CHE 205	16% (55)	29% (65)	.07
CHE 225	33% (27)	43% (44)	NS
CHE 311	20% (25)	33% (42)	NS
CHE 312	23% (22)	54% (39)	.02
CHE 446	24% (17)	34% (38)	NS

‡ Fisher's exact test

TABLE 10. STATUS OF STUDENTS AFTER FOUR YEARS

Status	**Rural (N=55)**	**Urban (N=65)**
Graduated	29%	40%
ChE – On schedule	11%	22%
ChE Co-op	13%	8%
ChE – Behind schedule	11%	9%
Switched curricula	9%	11%
Never in ChE	13%	8%
Suspended/dropped out	15%	3%