Relationships between course performance and student backgrounds in an introductory soil science course

D. D. Malo

ABSTRACT

Numerous factors influence undergraduate student performance at college. Instructors and student advisors need to understand student achievement. The objectives of this research were to relate student background to course performance, to develop some recommendations which could aid potential students in their course selection, and to provide a basis for course evaluation.

Final course letter grades of 466 students were related to student background. The student parameters examined were: the ACT (American College Testing Program) scores for (a) English, (b) mathematics, (c) social science, (d) natural science, and (e) the composite; the average grades for high school (a) English, (b) mathematics, (c) social science, and (d) natural science; college class; college enrolled in; college course credit load; sex; prior cumulative university grade point average; current semester grade point average when enrolled in the course; and cumulative university grade point average after taking the course.

Freshmen earned lower course grades when compared to upperclassmen. The range between freshmen and upperclassmen examination scores declined by 50% by the end of the course. Students carrying 14 credit hours per semester or less earned lower grades than those students carrying 17 credit hours or more. There was no significant difference between the performance of male and female students in courses. Students from the colleges of engineering, pharmacy, nursing, and arts and sciences earned higher course grades than students in agriculture and biological sciences or general registration. Prediction equations were developed to estimate student academic success in this course using the parameters studied. High school grades, ACT composite scores, and the prior cumulative university grade point average were reliable predictors of student success.

Highest final course grades were earned by students who had high ACT scores, enrolled in 17 credit hours or more, read well, were upperclassmen, comprehended what they studied, and could solve practical quantitative problems. Because freshmen students with low high school grades, low ACT scores, or minimal academic training in mathematics or natural sciences were below average in the soils class, they should be advised to enroll in this course in their second year of college.

Additional index words: Soils teaching, Academic achievement, Grades, Motivation, Background of student, ACT scores, Advising, Examinations, Predicting academic success of student.

NUMEROUS factors affect student performance in a course. Advisors of undergraduate students should advise them to select the best possible course combinations (Brown, 1965; Darlow, 1965; Scholtes, 1968). Thus advisors need to understand the factors influencing student performance in a college or a university (McKeachie, 1969). Earlier studies found that personal attributes and background helped determine academic performance of students (Peterson, 1965; Warmbrod and Phipps, 1966; Dearing, 1968; Stevens and Herburger, 1971; Schowengerdt, 1971; Scholtes, 1972; Domeier, 1973; Strait, 1973; Burger and Seif, 1975). Factors such as farm experience, high school performance, college class, sex, ACT (American College Testing Program) scores, and many others influence student performance.

The objectives of this study were to relate a number of parameters of student background to course performance, to develop some recommendations for potential enrollees which advisors can use to aid in course selection, and to provide a basis for course evaluation.

METHODS AND MATERIALS

The introductory soil science course at South Dakota State University is a 3-credit-hour semester course which has two lectures and one 2-hour conventional laboratory each week. This course is required by most agriculture and biological science curricula. It is a freshman course with an average enrollment of 150 students each fall and spring semester.

Final course letter grades of 466 students from the fall 1975, spring 1976, and fall 1976 classes were related to student background. Student parameters examined were: the ACT scores for (a) English, (b) mathematics, (c) social science, (d) natural science, and (e) the composite; the average grades for high school (a) English, (b) mathematics, (c) social science and (d) natural science; college class; college enrolled in; college course credit load; sex; prior cumulative...
RESULTS AND DISCUSSION

ACT composite scores had a significant association with final course grade (Fig. 1). The highest percentage of A and B grades were earned by students with ACT composite scores greater than 23. Conversely, the highest percentage of D's and F's were earned by students with ACT composite scores less than 16. The average letter grade earned increased as the ACT composite score increased. All groups, except those with ACT composite scores between 16 and 23, were significantly different from each other. Similar trends have been noted when high school percentile rankings were used (Burger and Seif, 1975).

Aptitude tests such as ACT do not measure cultural background, creative ability, emotional stability, social abilities, or many other personal attributes (Brown and Thornton, 1971). For this reason, they can account for only part of the variance in college student achievement.

The final course grade average with varying credit hour loads is shown in Fig. 2. As the load increased, the average grade earned increased significantly, with the largest increase occurring at 15 semester credit hours. The highest percentage of A and B grades were earned by students with greater than 17 semester credit hours. On the other hand, the highest percentage of D's and F's were earned by students taking 14 semester credit hours or less.

The full course load range at South Dakota State University is 16 or 17 credit hours per semester; more than 18 hours are overloads; less than 15 are underloads. A full course load may cause students to make more efficient use of their time. Those students taking heavier loads tended to be upperclassmen or fast learners. The underload student may have personal problems, may be a slower learner, or may have a part-time job (Burger and Seif, 1975). Any or all of these reasons may, in part, help explain why underloaded students do not earn as high grades in this beginning soil science course.

The final course grade average for students from various colleges is shown in Fig. 3. Those students which had a strong mathematics and natural science background tended to earn significantly higher final course grades and were enrolled in engineering, pharmacy, nursing, or arts and sciences. Often these students were upperclassmen, and they probably took this course as an elective. Those students without this background generally did not earn high course grades and often were enrolled in the colleges of general registration or agriculture and biological sciences. Similar trends were noted earlier (Brown, 1965; Pond, 1967). Most of the students from the colleges of agriculture and biological sciences and general registration were freshmen, and this was a required course for most of them.

The final course grade average for the four college classes are shown in Fig. 4. Freshmen earned the highest percentage of C's, D's, and F's when compared to all other students. These data suggest that college experience and maturity were impor-
Fig. 3. The final course grade average for students from various colleges (AG & BIO = Agriculture and Biological Sciences, GR = General Registration, ENGR = Engineering, OTHERS = Pharmacy, Nursing, and Arts and Sciences). * sample means followed by the same letter are significantly different at the 5% level according to Duncan’s new multiple range test.

Important factors in predicting student success. Upperclassmen were a more select group because potential enrollees had been eliminated from the sophomore, junior, and senior classes by having failed in other disciplines (Burger and Seif, 1975). In addition, the upperclassmen often had had a mathematics or a natural science course, which may improve their performance in soils. The significantly lower freshmen grades would indicate that freshmen students with low high school grades, low ACT scores, or minimal academic training in mathematics or natural sciences should be advised to delay enrolling in the beginning soil science course until their sophomore year. No significant differences in course performance were found between male and female students. These results are similar to the findings of Burger and Seif (1975).

Lecture examination grades for the four college classes are shown in Fig. 5. As shown in Fig. 4 and by others (Burger and Seif, 1975), freshmen had significantly lower final course grades, and they had significantly lower scores in all the examinations when compared to upperclassmen (Duncan’s new multiple range test at 0.05 level). However, the range between the upperclass scores and freshmen scores was reduced 50% by the end of the semester. It would appear that freshmen were adjusting to the college environment and the challenges of this soil science course by the end of the semester. Transfer students reacted initially in much the same way as freshmen. However, they were upperclassmen and their final grades were not significantly different from other upperclass scores. These results are similar to the findings of others (Strait, 1973; Burger and Seif, 1975).

Final examination scores declined significantly (Duncan’s new multiple range test at 0.05 level), when compared to the other three examination scores. Possibly student motivation for the final examination was less in two of the three semesters studied because the final examination was given on the next-to-last or the last day of final examination week. Senior examination averages decreased most rapidly from the third to the final examination. All graduating seniors were required to take the final examination after graduation exercises, which may have caused a poorer performance on the final examination.

To study the possible relationships between student background and course performance, a correlation matrix was used. The simple correlation coefficients for 15 variables are presented in Table 1. Final course grade was significantly correlated with each of the other 14 variables.
Table 1. Simple correlation of student performance parameters

<table>
<thead>
<tr>
<th>Independent variable</th>
<th>Description</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
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<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
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<tbody>
<tr>
<td>1</td>
<td>Course Grade</td>
<td>0.38</td>
<td>0.41</td>
<td>0.34</td>
<td>0.36</td>
<td>0.46</td>
<td>0.30</td>
<td>0.31</td>
<td>0.37</td>
<td>0.36</td>
<td>0.33</td>
<td>0.45</td>
<td>0.81</td>
<td>0.79</td>
<td>0.63</td>
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<td>2</td>
<td>ACT Score—English</td>
<td>0.47</td>
<td>0.56</td>
<td>0.57</td>
<td>0.76</td>
<td>0.49</td>
<td>0.35</td>
<td>0.41</td>
<td>0.38</td>
<td>0.24</td>
<td>0.21</td>
<td>0.41</td>
<td>0.47</td>
<td>0.43</td>
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<tr>
<td>3</td>
<td>ACT Score—Mathematics</td>
<td>0.45</td>
<td>0.54</td>
<td>0.77</td>
<td>0.28</td>
<td>0.58</td>
<td>0.24</td>
<td>0.36</td>
<td>0.13</td>
<td>0.22</td>
<td>0.37</td>
<td>0.41</td>
<td>0.30</td>
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<tr>
<td>4</td>
<td>ACT Score—Social Science</td>
<td>0.68</td>
<td>0.84</td>
<td>0.33</td>
<td>0.32</td>
<td>0.26</td>
<td>0.27</td>
<td>0.18</td>
<td>0.21</td>
<td>0.37</td>
<td>0.43</td>
<td>0.39</td>
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<tr>
<td>5</td>
<td>ACT Score—Natural Science</td>
<td>0.86</td>
<td>0.34</td>
<td>0.29</td>
<td>0.33</td>
<td>0.36</td>
<td>0.14</td>
<td>0.24</td>
<td>0.36</td>
<td>0.39</td>
<td>0.35</td>
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<tr>
<td>6</td>
<td>ACT Score—Composite</td>
<td>0.43</td>
<td>0.47</td>
<td>0.41</td>
<td>0.41</td>
<td>0.20</td>
<td>0.27</td>
<td>0.47</td>
<td>0.52</td>
<td>0.45</td>
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<td>7</td>
<td>High School English Grade</td>
<td>0.36</td>
<td>0.56</td>
<td>0.42</td>
<td>0.14</td>
<td>0.13</td>
<td>0.30</td>
<td>0.39</td>
<td>0.37</td>
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<td>8</td>
<td>High School Math Grade</td>
<td>0.33</td>
<td>0.44</td>
<td>N.S.</td>
<td>0.16</td>
<td>0.26</td>
<td>0.33</td>
<td>0.32</td>
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<td>9</td>
<td>High School Social Science Grade</td>
<td>0.44</td>
<td>0.17</td>
<td>0.15</td>
<td>0.32</td>
<td>0.37</td>
<td>0.35</td>
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<tr>
<td>10</td>
<td>High School Natural Science Grade</td>
<td>N.S.</td>
<td>0.15</td>
<td>0.36</td>
<td>0.39</td>
<td>0.33</td>
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<td>11</td>
<td>College Class</td>
<td>0.19</td>
<td>0.34</td>
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<td>0.34</td>
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<td>12</td>
<td>College course credit load—hours</td>
<td>0.54</td>
<td>0.53</td>
<td>0.33</td>
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<tr>
<td>13</td>
<td>Current Semester Grade Point Average</td>
<td>0.91</td>
<td>0.66</td>
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<tr>
<td>14</td>
<td>Cumulative Grade Point Average</td>
<td>0.93</td>
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<tr>
<td>15</td>
<td>Prior Grade Point Average</td>
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* *** Significant at the 0.05, 0.01, 0.001 levels respectively. N.S. = not significant at the 0.05 level.

Earlier in the discussion (Fig. 1) comparisons were made between ACT composite scores and course performance. All the high school performance variables examined (variables 1 to 10 in Table 1) fluctuated like the ACT composite score when related to course grade. ACT scores and high school grades or rankings have been used to predict student success in college (Schowengerdt, 1971; Burger and Seif, 1975). High school grades and ACT scores were also useful in predicting student success in this introductory soil science course.

Three of the 15 variables studied (variables 13 to 15 in Table 1) deal with university grade-point averages. The prior, cumulative, university grade-point average was useful in predicting student success. It was a more accurate predictor of course performance than high school grades or ACT scores if the student was not a first semester freshman or transfer student. The average gave an indication of how well students had met the previous challenges of college and how they might respond to this course.

When the course grade became a part of the variables, current semester grade-point average and cumulative university grade-point average, then the numerical value of the correlation coefficient increased. The current semester grade-point average reflected the greatest influence on the soils grade, while the influence on the cumulative university grade-point average depended on the college class of the student.

The remaining two variables (variables 11 and 12 in Table 1) differ in nature from the other 13 variables studied because they do not directly measure or monitor academic performance. Many of the lowest correlation coefficients listed in Table 1 were associated with these variables, college class or college course credit load. The importance of these two variables, with respect to course performance, has been discussed (Fig. 2 and 4). High school grades had the least association between college class and course load of all the variables studied.

The majority of correlation coefficients appearing in Table 1 are highly significant, and most are numerically quite small. This was caused by the large number of observations and by numerous human and non-human factors which could not be mathematically measured, determined, or described. These non-measurable factors probably had an important influence on student performance.

Regression equations were developed to predict student performance in the introductory soil science course at South Dakota State University. Incoming freshman success was predicted by the equation

\[
CG = 0.163 + 0.035 (ACP) + 0.190 (HNS) + 0.250 (HSS) + 0.020 (AMA)
\]

where
- \( CG \) = final course grade (A = 4.0),
- \( ACP \) = ACT composite score,
- \( HNS \) = average high school natural science grade,
- \( HSS \) = average high school social science grade, and
- \( AMA \) = ACT mathematics score.
The standard error of the final course grade estimate for the multiple regression Eq. [1] was 0.673. The multiple regression coefficient was 0.500, and it was highly significant. The ACT composite score, the average of the four subtests, had the greatest relationship to final course grade of those pre-college variables examined (variables 2 to 10 in Table 1). High school natural science and social science grades also had an important influence on course performance. These courses tend to require large amounts of reading, subject matter comprehension, and problem-solving skills. The significance of these high school grades suggests that the ability to read, to comprehend the subject matter, and to solve problems were important to incoming freshmen success.

The last variable in Eq. [1] which had an important influence was the ACT mathematics score. This exam measures mathematical reasoning ability and emphasizes the solving of practical quantitative problems and the understanding of numerical relationships. The incoming freshmen who received the highest final course grades had high ACT scores, read well, understood the subject matter area, and could solve practical quantitative problems.

Incoming second semester freshmen through senior success was predicted by the equation

\[
CG = -0.663 + 0.651 \times (PGPA) + 0.044 \times (CLH) \\
+ 0.018 \times (AMA) + 0.140 \times (HSS) \\
+ 0.063 \times (CL) + 0.067 \times (HNS)
\]  \hspace{1cm} [2]

where

- \(CG\) = final course grade \((A = 4.0)\),
- \(PGPA\) = prior, cumulative, university grade-point average,
- \(CLH\) = course load in semester hours,
- \(AMA\) = ACT mathematics score,
- \(HSS\) = average high school social science grade,
- \(CL\) = college class (freshmen = 1), and
- \(HNS\) = average high school natural science grade.

The standard error of the final course grade estimate for the multiple regression Eq. [2] was 0.515. The multiple regression coefficient for Eq. [2] was 0.686, and it was highly significant. Previous college performance as measured by the prior, cumulative, grade-point average had the greatest influence on final course grades of all the variables tested (see Table 1). The other five variables in Eq. [2] were considered earlier in Fig. 2 and 4 or in the discussions of Table 1 and Eq. [1]. The incoming second-semester freshmen through senior students receiving the highest final course grades had high prior, cumulative, university grade-point averages; enrolled in 17 credit hours or more; read well; comprehended what they studied; were upperclassmen; and could solve practical quantitative problems.

**LITERATURE CITED**