Evaluating two different introductory soils texts by comparing student exam and homework scores

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ABSTRACT

One choice facing introductory soil science instructors at the college level is which textbook to use in their class. The two oldest and more widely used general soils texts are N.C. Brady's The Nature and Properties of Soils and H.D. Foth's Fundamentals of Soil Science. The Brady text is longer, covers each subject area in more detail, and covers more subject areas; the Foth text is shorter and more general, yet equally well written. In the introductory soil science course (Soils 201) at Washington State University, these two texts were evaluated for their relative effectiveness in helping students prepare for examinations and in providing them with soils information for homework and discussion section assignments. For three different semesters, the students of Soils 201 were given the choice of using either the Brady text or the Foth text. The Student's t-test was used to compare the exam and homework scores for the two student book groups. There were no statistically significant differences at the 0.05 level of probability in overall course grades, exams, or homework/quiz scores between the two student book groups. The data suggest that students can perform equally well on exams and homework in Soils 201, whether they use the Brady or Foth text.

Additional index words: Class references, Textbook selection.

ONE CHOICE facing introductory soil science instructors at the college level is which textbook to use in their class. Stucky (13) found that when students evaluated textbooks, they placed major emphasis on how the text related to lecture material, whether or not the text information was presented in a logical manner, and the readability of the book. This author has found through personal experience that a well-written course textbook is a valuable aid to the student in gaining an understanding of soil science.

One of seven general soils texts (3,4,5,6,9,10,14) is commonly used in introductory soil science courses at the college level. Of these seven, Brady's The Nature and Properties of Soils and Foth's Fundamentals of Soil Science are the two oldest and more widely used texts. In the introductory soil science course (Soils 201) at Washington State University, these two textbooks were evaluated for their relative effectiveness in helping students prepare for examinations and in providing them with soils information for homework and discussion section assignments. This evaluation of the two texts was conducted by comparing student exam, quiz, homework, and overall course grade scores between two student groups, one group using the Brady text and the other using the Foth text.

THE BRADY AND FOTH TEXTBOOKS

These two books were chosen for the study because of (i) the consistent high quality of these books and their many previous editions, (ii) their favorable book reviews, (iii) their arrival on the market at the same time, and (iv) their different formats and styles.

The Brady and Foth textbooks have been in use longer than any other introductory soils texts. The Nature and Properties of Soils (9th ed.) is a revised edition of a long series of soil science texts (since 1922) by one or more of the authors T.L. Lyon, H.P. Buckman, and N.C. Brady. Similarly, since 1943, Fundamentals of Soil Science has been through seven editions and was originally written by C.E. Millar and L.M. Turk, who invited H.D. Foth to join them as a co-author for subsequent editions. Both books continue the tradition of presenting clear and effective soils information established in the earlier editions.

The reviews of both books have been very positive (1,2,7,8,11). For example, the Foth text "is very easy to read and convenient to follow" (1), "is a clear, complete introduction to mainly agronomic uses of soils" (7), and stimulates "in us a respect and curiosity about soils" (8). Likewise, the Brady text "is well written and the format is attractive" (11), and "this text does a very complete job of covering the topics in soil science" (2).

In 1984, when this study was initiated, new editions of both texts had just been published. The Brady and Foth texts have contrasting formats and styles. More specifically, the Brady text (3) is longer and covers each subject area in more detail as well as more subject areas; the Foth text (5) is shorter and more general, yet equally well written. Sorenson (11) stated that while the Brady text "is well suited for classes where students have a strong background in basic sciences and agriculture, beginning students with limited scientific preparation, and little or no agricultural background, may need a more general and experience-oriented approach to the study of soil science." (The students in Soils 201 fell into both groups.) On the other hand, both Banwart (1) and Milford (8) found the Foth text to lack the desired depth, particularly in chemistry-related topics. Therefore, one objective of this study was to determine whether the exam performance of students using the Foth text was less in soil chemistry than students using the Brady text.

METHODS

Soils 201 is a lower division introductory soil science course, with one freshman-level general chemistry course as a prerequisite. There are two 1-h lectures and one 1-h discussion/demonstration section each week. The course covers the fundamental physical, chemical, and biological properties of soils, their interrelationships, and their application to practical land use and soil management scenarios (Table 1). Attending lectures and discussion sections and doing the
reading assignments in one of the two texts were necessary for meeting the course objectives.

For three different semesters, the students of Soils 201 were given the choice of using either the Brady text or the Foth text to conduct their reading and homework assignments and to assist them in studying for the quizzes and exams. To help them decide on which text to buy, the students were told beforehand the following:

1. The Brady text was longer (750 pages), covering each subject area in more detail, while the Foth text was shorter (435 pages) and more general;
2. Both texts were equally well written;
3. The difference in the price of the texts was one dollar (Foth cost $32.95 and Brady cost $33.95); and
4. The reading assignments were about the same length and only covered a portion of each textbook (Table 2).

(Even though the assigned number of pages was slightly higher in Brady, this was balanced by the fact that the number of words per page was slightly higher in Foth.) From discussions with students, many seemed to buy Brady because they wanted the more detailed explanations and the better reference book; those who bought Foth wanted the simpler, more general explanations. Many also chose their respective books based on their first impression of browsing through the books.

Each book was represented well in the study since approximately half of the class chose each book each semester as follows: for Fall 1984, 48% used Brady and 52% used Foth; for Spring 1985, 60% used Brady and 40% used Foth; for Fall 1985, 41% used Brady and 59% used Foth. Only three students in all three semesters purchased both texts for the course, and they were not included in the study. Only a few students, who were included in the study, used one text at home and read the other one on reserve at the library; however, this had little effect on the experimental results because of the large number of students in the study.

All exams, quizzes, and homework were objective; i.e., single-answer multiple choice, multiple-answer multiple choice, true/false, fill-ins, matching, and calculations. The exams, quizzes, and homework were carefully written so that both books were treated equally; e.g., for homework assignments, when a topic was discussed in only one of the two books, no questions were asked on this topic. Topics had to be covered in both texts to be considered for homework assignment questions. For exams and quizzes, if a topic was discussed in lecture, regardless of its discussion in either book, questions could be asked on this topic. However, exam and quiz questions were usually asked on topics covered simultaneously in both books and not just in lecture. The students had access to old midterm exams but not to old final exams or quizzes; however, the exam questions were always different from semester to semester (as well as throughout the 3 yr of my teaching the course) to reduce their effect on student performances in this study.

The Brady and Foth texts were evaluated for their relative effectiveness as a teaching aid using student exam and homework scores. The grading factors and breakdown in relation to subject matter and reading assignments are listed in Table 2. There were three midterm exams, each worth 15% of the course grade; a comprehensive final exam worth 25%; and quizzes, homework assignments, and discussion section exercises worth 30%. Thus, there were six grading factors to be separately tested: exam no.1, exam no. 2, exam no. 3, final exam, homework/quizzes, and course grade. The Student's t-test was used to test the statistical significance of a difference between the two means of each grading factor for the two student book groups.

The t-test was used to answer the following questions:
1. Does using one book over the other give a student, on the average, a significantly better overall course grade?
2. Do students score significantly higher in specific areas of soil science (e.g., soil chemistry, soil genesis, etc.) by using one book instead of the other?
3. Do students perform differently on homework assignments and quizzes by using one book instead of the other?

During the three semesters, the student enrollments were 106, 52, and 74 students for the Fall 1984, Spring 1985, and Fall 1985 semesters, respectively. The student enrollment by class for each of the three semesters ranged from 3 to 7% freshman, 30 to 45% sophomores, 35 to 45% juniors, 10 to 15% seniors, and 1 to 3% graduate students. Thus, the class was predominantly (about 80%) sophomores and juniors. The class distribution (i.e., freshmen, sophomores, juniors, or seniors) probably had very little effect on the study results because there were approximately equal numbers of each class category using each book.

**RESULTS AND DISCUSSION**

The data in Table 3 show the means and standard deviations of the scores for students using the Brady text vs. the Foth text. Also listed are observed significance levels for the t-tests, each of which indicates the probability of being in error if the means are proclaimed to be different. There are no probabilities less than or equal to 0.05, which indicates that the computed t-values for all grading factors (and thus mean
differences for each grading factor) are not significant at the 0.05 level.

The two overall course grade means were almost identical for both Fall 1984 and Spring 1985. Only for Fall 1985 were they somewhat different but not statistically significant; in addition, there was no letter grade difference assigned to the two course grade means for Fall 1985. The only two means that come close to being significantly different at the 0.05 level are 0.07 for exam no. 1, Spring 1985; and 0.06 for exam no. 2, Fall 1985. The mean exam no. 1 score (Spring 1985) was higher for Foth, and the mean exam no. 2 score (Fall 1985) was higher for Brady. If there would have been a consistency in these mean score differences for each grading factor) are not significant at the 0.05 level.

The data in Table 3 also indicate small and inconsistent differences between the standard deviations of each grading factor. For five of the six grading factors in Spring 1985, the standard deviations were somewhat higher for students with the Foth text; thus, more higher and lower scores with Foth. However, the opposite was the case the following semester with the standard deviations being somewhat higher with the Brady students.

Possible extraneous variables affecting the study results were the quality of the lecture material, the teaching ability of the instructor, and the “cross-pollination” between student groups (i.e., students from the two different groups exchanging ideas or studying together). It is difficult to evaluate two soils texts by comparing student exam and homework scores without considering these variables. The lecture material was based on information from both texts as well as other introductory soils texts, journal articles, and specialized soil texts. The students sometimes received a blend of information from both the Brady and Foth texts, which could have diminished the effect of the individual texts somewhat.

Although student evaluations for the course and the instructor were high for the three semesters, the influence of the first two variables on the study was reduced by using both texts each semester and by giving only objective homework, quiz, and examination questions. The advantage of using both texts each semester was the two student book groups to the same lectures, discussion sections, exams, quizzes, homework assignments, and mood of the instructor.

Since it was virtually impossible to segregate the two groups of students, “cross-pollination” could not be avoided. However, I question how influential this could have been on student performances on exams and homework, especially since collaboration on homework assignments was discouraged.

Although the exams each of the three semesters had different questions, the exam format and types of questions (i.e., multiple choice, true/false, fill-ins) were the same. Even the material covered on each exam fell into the same topic categories each semester (Table 2). Students consistently scored higher on the first and third exams and lower on the second and final (comprehensive) exams. In fact, the overall mean score for each exam or course grade among the three semesters (Table 3) was generally similar (except for exam no. 1), indicating the uniformity of each test for the three semesters.

The homework questions were directly taken from material in the books. The quiz and exam questions were taken from the material covered in lectures and the books. The lecture material and book contents complemented each other. Some students might have passed the course (“C” or “D”) by only doing the reading and not coming to lecture or by taking good lecture notes and not doing the reading. However, for students to get an “A” or “B” in the course, discussions with the students indicated that taking good lecture notes and doing the reading was necessary.

CONCLUSIONS

The Brady and Foth textbooks were evaluated over three semesters for their relative effectiveness as a teaching aid by comparing student exam and homework scores. There were no statistically significant differences at the 0.05 level of probability in overall course grades or final exam scores between the two student groups, whether they used the Brady text or the Foth text. In addition, there were no statistically significant differences in midterm exam scores between the two

<table>
<thead>
<tr>
<th>Grading factor</th>
<th>Mean Brady</th>
<th>Mean Foth</th>
<th>Overall</th>
<th>Standard deviation Brady</th>
<th>Standard deviation Foth</th>
<th>Observed significance level</th>
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<tbody>
<tr>
<td>Fall 1984 grades: N_{Brady} = 51 students and N_{Foth} = 55 students</td>
<td>Exam no. 1: 80.6</td>
<td>80.6</td>
<td>80.6</td>
<td>10.1</td>
<td>9.7</td>
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<td></td>
<td>Exam no. 2: 68.4</td>
<td>67.2</td>
<td>67.8</td>
<td>17.6</td>
<td>19.9</td>
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<td>Exam no. 3: 83.5</td>
<td>82.8</td>
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<td>8.2</td>
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<td>Final exam: 72.8</td>
<td>71.9</td>
<td>72.3</td>
<td>11.8</td>
<td>14.9</td>
<td>0.75</td>
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<td></td>
<td>Homework/quiz: 88.5</td>
<td>90.6</td>
<td>89.5</td>
<td>15.4</td>
<td>13.3</td>
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<td>Course grade: 79.8</td>
<td>79.8</td>
<td>79.7</td>
<td>9.7</td>
<td>10.4</td>
<td>0.94</td>
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<td>Spring 1985 grades: N_{Brady} = 31 students and N_{Foth} = 21 students</td>
<td>Exam no. 1: 72.9</td>
<td>78.2</td>
<td>75.0</td>
<td>10.4</td>
<td>9.8</td>
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<td>Exam no. 2: 67.1</td>
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<td>68.4</td>
<td>13.8</td>
<td>16.0</td>
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<td>81.6</td>
<td>5.3</td>
<td>21.9</td>
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<td>Final exam: 71.6</td>
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<td>8.0</td>
<td>8.7</td>
<td>0.57</td>
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<td>Homework/quiz: 86.1</td>
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<td>84.5</td>
<td>11.5</td>
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<td>Fall 1985 grades: N_{Brady} = 30 students and N_{Foth} = 44 students</td>
<td>Exam no. 1: 85.5</td>
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<td>Final exam: 75.1</td>
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<td>10.2</td>
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<td>9.6</td>
<td>10.6</td>
<td>0.14</td>
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<td>78.2</td>
<td>8.6</td>
<td>7.8</td>
<td>0.16</td>
</tr>
</tbody>
</table>

1 Since variances were unequal, the value of \( t = (w_1 t_1 + w_2 t_2)/(w_1 + w_2) \), where \( w_i = s_i^2/n_i \), \( w_i = s_i^2/n_i \), and \( t_i \) are the values of Student's \( t \) for \( n_i - 1 \) and \( n_i - 1 \) df, respectively, at the chosen level of significance (12).
student groups, which indicated similar performances and understanding of the specific areas tested (e.g., soil chemistry, soil genesis, etc.) regardless of which book was used. Furthermore, the student groups did not have significantly different homework and quiz scores based on which textbook they used.

The data do not suggest that any introductory soils textbook could be used with equal exam and homework results. The data only suggest similar test and homework scores for the Brady and Foth texts, two books that are well written and have a long history of classroom use.

REFERENCES