A Course in Soil Morphology, Classification, and Survey—Objectives, Methods, and Student Response

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ABSTRACT

The objectives for a course in soil morphology, classification, and survey were written in a manner that stressed learning outcomes. The objectives incorporated an overall goal statement for the course with specific behavioral objectives derived from the steps through which the student must go in order to master the course material. Problem-type quizzes during the indoor sessions coupled with a problem in field survey were used to evaluate the progress of the students in the course. Students responded favorably to the course, the type of student evaluation, and the written objectives.

Additional index words: Student goals, Retesting, Instructional objectives, Cognitive domain, Geomorphology.

Soil morphology, classification, and survey are topics of interest and use to all agronomists. Therefore, many students of agronomy include a course on these topics in their undergraduate or graduate programs. Agronomy 477-877, entitled Soil Morphology, Classification, and Survey, has been taught for many years at the University of Nebraska to meet this need. In 1970 this course was reorganized around certain specific behavioral objectives. It is the purpose of this article to describe these objectives, present the course outline and teaching methods to illustrate how the objectives apply to them, and to present the student response to the course.

Instructional objectives that place emphasis on the student and the goals he is to attain have found increasing use in college courses during the past 10 years (Elson, 1972). Courses in the College of Agriculture at the University of Nebraska have followed this trend, and it has been required that all courses be revised to show the behavioral objectives that a course sets forth. Arnold (1972) described a course in Food Science and Technology at Nebraska written according to these specifications.

Methods of writing instructional objectives have been proposed by Mager (1962) and Gronlund (1970). Those proposed by Mager involve considerable detail, and in courses that require the student to reach the higher levels of the cognitive domain (Bloom, 1956), a very large number of instructional objectives are necessary. The technique described by Gronlund makes use of an overall goal statement for the course. This goal statement is oriented toward the future ability of the student in the course, in future courses, and in the real world. The general behavioral objectives are then derived from the goal statement and are clarified by listing the specific behavior required to meet each objective. The general behavioral (instructional) objectives then become goals toward which the student works rather then steps to be learned one by one.

METHODS

The objectives around which Agronomy 477-877, Soil Morphology, Classification, and Survey, is organized are written according to the technique proposed by Gronlund (1970). At the beginning of each term, students are given a handout which shows the major course goal, the general instructional objectives derived from ideas of the steps necessary to attain his goal, and the course outline with quiz times indicated. The goal statement indicates that “it is the objective of this course to help the student attain a satisfactory level of proficiency in the use and understanding of methods that must be used to initiate and carry out a soil survey in the field. The following are goals toward which the student is guided in order that he can meet the objective.”

1. To describe a soil profile using the presently accepted soil horizon nomenclature
1.1 The student will recognize and describe differences in soil texture, structure, color, consistence, horizon boundaries, and mineralogy that are pertinent to the delineation and description of soil horizons.
1.2 The student will assign to the various horizons he separates on the basis of the above proper-
ties, the accepted nomenclature used to describe soil profiles.

2. To classify the soils the student describes and others described for him according to the classification system presently in use

2.1 The student will recognize the name the diagnostic horizons and other differentiating criteria used to place a soil in its proper category in the classification system.

2.2 The student will use the diagnostic criteria he recognizes and names to place the soil with which he is working in its proper category.

3. To recognize the physiographic positions on the landscape and interpret soil patterns on them in terms of soil properties and processes that formed and are forming the soils and landscape

3.1 The student will construct block diagrams that show and name the physiographic positions, the soils on them, and the geologic materials in which the soils formed.

3.2 The student will describe the effect of position on soil development and the geomorphic processes that formed the landscape.

4. To recognize the various geologic materials in which soils have formed and are forming, to describe how these materials were deposited, and to date these materials according to the most recently published Pleistocene nomenclature

4.1 The student will use the physical properties and physiographic position of the soils in the field to judge in what geologic materials the soils formed.

4.2 The student will describe the geomorphic processes that led to the exposure of once-buried geologic materials at the surface so that soils formed in them.

4.3 The student will place approximate dates in terms of Pleistocene nomenclature on the events that led to the deposition of the geologic materials and the erosion cycles that exhumed those that were buried.

5. To interpret data from soil survey reports of various soil provinces in terms of soil genesis, classification, and land use

5.1 The student will describe how each of the factors of soil formation led to the formation of soils that have properties characteristic of those in each major soil province.

5.2 The student will devise soil suitability charts that include the soils of these regions and the interpretation of their properties in terms of agricultural and nonagricultural uses.

6. To initiate and carry out a soil survey on a given 320-acre tract of land and write a soil survey report of his study of the soils on that land

6.1 The student will include in his report his soil map, soil series and mapping unit descriptions, soil-landscape relationships, and the major chemical and physical properties of the soil series he has mapped.

6.2 The student will also include interpretations of his mapping units in terms of uses related to agriculture and urban land development.

The listed objectives enable the student to see what will be expected of him in the course and indirectly infer how an evaluation of him will be made. They divide the course nicely for testing purposes and establish for the instructor the materials he can include in any tests to determine the proficiency of each student in any phase of the course. The following outline of the course is used to help the student develop the necessary background as they work toward the major course objective.

1. The relationship of soil morphology, classification, and survey to other soil sciences and to science in general

2. Details of soil morphology

2.1 Soil horizon nomenclature; its use and concepts of soil genesis put forth by it

2.2 Soil texture; concepts behind textural class delineations; effect of soil texture on other soil properties and interpretation of soil for various uses

2.3 Soil structure, color, consistence, coarse fragments

3. Writing the soil profile description

4. Soil Classification

4.1 Review of the 1938 system of soil classification and its relationship to the new system

4.2 The most recent system of soil classification (Soil Classification Taxonomy)

4.21 Nomenclature and diagnostic horizons

4.22 Categories in the system

4.3 Relationship of soil classification to soil mapping; relationship of the pedon, poly-pedon, taxonomic unit, and mapping unit

5. Effect of the Pleistocene on environments and soil morphology; polygenesis of soils

6. Relationship of soils to geomorphic surfaces; effects of landscape forming processes on soil morphology

7. Soil drainage; nomenclature and classes

7.1 Soil permeability

7.2 Surface runoff and infiltration rate

7.3 Interpretation of soil drainage classes in terms of agricultural and nonagricultural uses

8. Effect of parent material on soil morphology and soil use

8.1 Soil minerals

8.2 Effect of mineral weathering on various aspects of soil morphology

9. Effects of climate, vegetation, and time on soil morphology

10. Services provided to the soil survey by laboratory facilities (Tour of Regional Soil Conservation Service lab, Lincoln, Nebraska)

11. Preparation for mapping assigned tracts of land

11.1 Landscape control of soils in Lancaster Co., Nebraska (area where student mapping is done)

11.2 Major soils in Lancaster County, Nebraska
11.3 Use of aerial photographs as base maps, use of the stereoscope, map symbols, match lines, inking.

12. Soil interpretations for various uses
   12.1 Soil features that influence the degree of limitation a soil may have for urban uses
   12.2 Conservation farm planning; basis for assignment of soils to various capability units

13. Writing the soil survey report
   13.1 Soil correlation
   13.2 The descriptive part of the report
   13.3 The interpretative part of the report

14. Class field trips
   14.1 Morphological features of soils, landscapes, and parent materials as seen in the field in the mapping area
   14.2 Group mapping of a 160-acre tract of land

15. Independent mapping of a 320-acre tract of land
   15.1 Field review of individual mapping and profile descriptions by the instructor.

The student earns 4 semester credit hours for this course. There are two 1-hour lecture periods and two 3-hour laboratory periods per week. It is basically a field course, but since it is at present taught during the spring semester, weather keeps the students indoors a large part of the time. Soil cores taken in the fall with a Giddings hydraulic soil coring device and frozen for storage are used in the laboratory to give the students practice in the technique of describing soil profiles. Soil survey reports from various soil and physiographic provinces are used as texts for study in soil genesis as it relates to various aspects of soil morphology. The use of soil survey reports for this purpose was described by Drew and Eikleberry (1965). The indoor sessions are mainly designed to prepare the student to make his soil survey and to write a comprehensive soil survey report.

One half of the grade the student earns is based on his progress as shown on quizzes on the material in the various units outlined by the objectives. There is at least one quiz, and sometimes two, per unit. The quizzes are of the short-answer essay type and are designed to confront the student with a problem situation that might arise in making a soil survey and interpreting data from it. They are so constructed that he can arrive at an answer using the information he has gained up to the time of the quiz. Here the student must apply his information to a situation, analyze it, and synthesize a logical solution. The questions are written so that the steps through which he went to reach his solution are part of the answer. In that way his performance at the various levels of the cognitive domain (Bloom, 1956) can be judged and appropriate credit given. If it is evident that a student has failed to grasp the material covered by a quiz, he is allowed to take a similar quiz and drop the grade on the first. This is done to make certain that every student can cope with as many of the problems that will confront him in the field as possible. In other words, it is not the aim of the quiz to punish the student for not studying, but to help him learn the materials presented. Since he must be able to use the materials over which he is quizzed to make his survey and interpret data from it, lack of comprehension of any point in the course will hurt him in the critical period when he is learning soil survey in the field.

The averages from the quiz grades have been mostly in the A and B range with a few exceptions. This produces a grade distribution without the "typical" distribution curve. However, if a student earns a C, D, or F on a quiz, it means that he has missed some or all of the points of the material studied. It is the aim of the course to give the student command over all of the material included in the course. If he fails to grasp the material at first, it fits the aim of the course much better to allow him to go back and try again until he has gained a satisfactory mastery of the material. Fifty two percent of the students taking the course have retaken one and often several quizzes. Since the tests represent a considerable amount of student time in preparation, they have retaken them only when their initial grade indicated a serious lack of comprehension of the material. A testing procedure such as this tends to produce many high grades and a few low ones with none in the "average" range. A student with a D or F quiz average is not permitted to proceed to the field survey part of the course until his quiz grades indicate that he is adequately prepared to do so. It is worthwhile noting that this procedure makes heavy demands on instructor time. However, since we are working with individuals, it appears to be worthwhile to concentrate some extra effort on the individuals who from time to time need the extra attention.

The other 50% of the grade the student earns is determined by his soil survey and his report. His mapping and soil profile descriptions are reviewed in the field by the instructor or an assistant who has mapped in the field. The judgments the student makes in regard to soil genesis, classification, and land use interpretations along with the accuracy of his mapping unit descriptions and soil-landscape
diagrams constitute the remaining points on which the student is evaluated.

The course meets at its scheduled time until approximately April 1. At this time in most years, field mapping can proceed. After two class field trips to look at profiles and landscapes in the area they will survey and to practice mapping as a group on a 160-acre tract of land near their mapping area, the students pair off, and each pair is assigned a 320-acre tract of land to map. Each pair then meets with the instructor or an assistant once or twice during the mapping period for a field review of their work. A summing up period is scheduled in the lecture room on the last day the class is scheduled to meet. No final exam is given.

**STUDENT RESPONSE AND DISCUSSION**

Soil Morphology, Classification, and Survey has been offered following the previously discussed objectives and outline for 2 years (one semester per year). During this time, 50 students have taken the course. Of this number, 13 have been graduate students, 6 have been juniors, and 31 have been seniors. A questionnaire was given to the students at the end of each semester. It was hoped that the answers to these questions would show student reaction to the course and help the instructor better fit the course to student preferences in future semesters. The students were asked the following questions:

1) Do you feel that the course was logically presented and the materials explained clearly? If not, suggest a means to improve on these aspects of the course.
2) Do you feel that the testing system was fair, adequate, and helpful in the learning process? Would you have preferred hour exams and/or a final? Were the type of questions asked satisfactory to you?
3) Was there anything that you hoped to get from the course that was not covered?
4) Was the experience of practice mapping as a group prior to independent mapping useful to you?
5) Do you feel that the field survey part of the course is useful? If not, with what would you replace it?
6) Any other comments, negative or positive, about the course, instructor, your fellow students, classroom facilities, the political situation... anything?

The answer to question number 1 was unanimous in the affirmative. The only student to respond in a manner other than "yes" or "I think it was logically presented" indicated that it was the only course he had taken that he could not think of a thing to change.

In answer to question number 2, all but 3 of the 50 students said they were satisfied with the quizzes as they were given, and were in favor of the testing procedure and types of questions used. The vast majority took the time to state that they could see no use in a final exam (a point on which their instructor is certainly in agreement) and that they approved of the lack of stress on memorized feedback in the course. Of the three that expressed reservations about the testing system, one indicated that he would have preferred a final in addition to the quizzes, and two felt that it was not fair to those who passed the quizzes to allow a student to have another chance if he missed the point of the material covered on the quiz the first time around. Several students expressed a positive reaction to knowing what materials were to be emphasized on the exams, and three actually took the trouble to write that they enjoyed the quizzes.

The majority of the students felt that the course covered most of the topics they had hoped to study during the semester. One indicated that he could answer the question better in 4 or 5 years after he had worked for a while. Several felt that we had limited our outlook on soils by confining the soils studied to those in the continental United States, and one felt that we extended ourselves too greatly by studying soils in regions other than Nebraska.

Everyone seemed to think that group practice in mapping the 160-acre tract of land prior to going to the field to map independently was beneficial to them. During the first semester that this was incorporated in the course, a period of rainy weather reduced our field time to the point where not enough time was available to complete the practice session. The weather favored the group during the next semester and the practice session went as scheduled. Field reviews of the mapping during the time following the practice session showed vastly superior work compared to those where the practice session was rained out. It therefore appears to be a very worthwhile procedure.

All felt that the field mapping was useful, and no one indicated that it should be replaced with some other form of exercise. Most indicated that it was the most useful part of the course. Here they could immediately apply the work in the classroom to a project in the field, giving them a sense of accomplishment which one student stated was seldom felt in courses he had completed at the University. One student seemed to feel that writing the soil survey report was too time consuming, but he admitted that he had "learned a lot" from it.
There were many different responses to question number 6. Most took it seriously, and several wrote on the back of the questionnaire to complete it. There were no negative responses to the course or instructor, and several were decidedly positive. Most students had a favorable response to the type of exam questions that allowed them to see the application of the quiz questions toward the goals of the course. Several were specific in noting that they could tell what the exams would be like and how they fit with the course objectives. Most also seemed to approve of a lack of memorized feedback and of being able to use what they had learned to reach a solution to what one student called “practical problems”.

The aim of supplying the students with objectives in the form shown is to help them learn not only the basic knowledge necessary to making and understanding a soil survey, but to help them see how this knowledge is applied in the survey. Probably all the levels of the cognitive domain are approached in the course. To go from the definitions of horizon nomenclature through application of this nomenclature to a soil profile being described to the evaluation and interpretation of soils and landscapes in terms of soil genesis and/or land use requires that the student apply acquired knowledge to a situation which he must evaluate and synthesize some conclusion based on his knowledge. The stated objectives lead him in this direction and the problem-type exam coupled with a comprehensive field problem allows him to complete the process. In this way the thinking of the student at the various levels of the cognitive domain can be evaluated, and the course objectives remain oriented toward learning outcomes rather than the learning process.