Observations from an enrichment study group in plant science

Diana G. Helsel and Judith A. Wells

ABSTRACT

A small enrichment study group was established in the introductory plant science course to: i) specifically determine the academic weaknesses of minority students who were failing and ii) attempt to improve their scholastic performance in the course. At least 3 h each week were devoted to the study group activities of presenting reasoning skills, problem-solving techniques, and test-taking strategies. All these skills were taught within the context of the course material. A major outcome for the study group participants was their development of reasoning skills from a concrete level up to the abstract level by the end of the course. Test-taking performance significantly improved for those who attended regularly. Also, the students' self-image improved as they experienced more success in plant science.

Additional index words: Minorities, Study skills, Test-taking Strategies, Self-image, Problem solving, Disadvantaged students.

MINORITY students from non-agricultural backgrounds have recently been enrolling in Colleges of Agriculture. Retention and grade performance of these individuals has been perceived to be lower than the non-minority, urban student at the University of Missouri. This paper contains observations gleaned from establishing and working with an enrichment study group of seven regularly participating minority students. The strategies described improved the satisfaction and performance of these individuals. Similar techniques may be useful to other instructors in agricultural disciplines.

During the winter semester of 1984, we worked intensively with a group of nine black students enrolled in the introductory course entitled Plant Science. Initially, the group was formed to help these students since they had performed poorly on the first exam. Upon conversing with the group participants, we found many reasons for academic concern:

1. Poor high school preparation in math and science concepts.
2. "Fail syndrome," due in large part to a negative self-image of their abilities and doubt in their eventual scholastic success.
3. Limited study time of 2 to 3 h per week.
4. Thinking exclusively at the concrete level.
5. Poor reasoning and problem-solving skills.
6. Inability to take tests effectively due to test anxiety, poor reading comprehension, and/or poor test-taking strategies.

Students were not utilizing the University's study skills center. To help resolve some of these concerns, we designed an enrichment study group in which we attempted to integrate, as closely and all encompassingly as possible, effective study habits and test-taking strategies within the context of the Plant Science course material.

Students were asked to commit themselves to participating in study sessions totaling 3 h each week. The general design of the study group involved a question and answer format, working from lecture notes. Questions were asked frequently and all students were called, by name, to answer questions. In this way all participants were brought into the discussion. Much positive feedback and reinforcement was given to the participants for trying. The leader of the study group was very aware of not imitating a lecture mode of presentation; the approach was friendly, enthusiastic, helpful, and concerned. This was a deliberate attempt to make the atmosphere relaxed and non-threatening.

The leader of this enrichment study group was a tutor from the University of Missouri-Columbia Learning Center, an academic support unit for undergraduate students. In addition to being a doctoral candidate in Horticulture, this tutor also possessed undergraduate degrees in both Education and Horticulture with many years of teaching experience with both normal and under-achieving students. The Plant Science instructor and the tutor interacted closely through regular meetings designed to focus the learning activities presented in the group. Methods to help the individual students to improve their scholastic performance were also discussed. The class instructor made it a point to attend nearly all of the group meetings; her role was that of a supporting "resource person" to assist with concept clarification and elaboration only.

NOTE TAKING

Within the context of course material, we incorporated discussions of study habit skills. Note taking is an example. As a part of our discussions, we asked students to read from their lecture notes. Thus, we discovered that many students were writing down only what was being shown on the overhead projector. Be-

---

1 Contribution from the Missouri Agric. Exp. Stn. J. Ser. No. 9836 Approved by the Director.
2 Assistant professor and instructor, Dep. of Agronomy, Univ. of Missouri, Columbia MO 65211.
because they were not comprehending the information as they wrote it down, their notes were usually incomplete. In addition, they only vaguely understood which pieces of data were of prime importance and which pieces were of an explanatory, but not vital, nature. As we proceeded through class notes in the study sessions, we encouraged the students to underline, star, or make appropriate notations for items that were especially important to the study of the course. Another useful technique involved asking participants to pencil in potential exam questions or the provided instructional objectives beside the appropriate piece of information. The rationale is that since students use their notes to study for exams, it may be helpful for them to have notes in this “exam” format.

**Performance Evaluations**

Students were given periodic, individual performance evaluations so they could clearly see their progress in mastering the course material. This became particularly important when some of the participants began to attend erratically. We were able to make it clear that the more frequently they participated in study group sessions, the higher their exam scores would likely be. This association was proven to be true by the end of the term.

**Concreteness as a Foundation for Abstract Reasoning**

One of the major hindrances to these students was their inability to reason at the abstract level. Because of this problem, they had difficulty comprehending the more complex concepts found in the course material. To remedy this deficiency, concrete examples were introduced to create a framework or foundation for future reasoning. Once this concrete framework was established, students were able to build on it and eventually move to the abstract level of more complex thinking. An example of how we created concreteness could be demonstrated by the topic: “Introduction to Chromosomes.” Students had no visual image of chromosomes; thus it was difficult for them to cognitively comprehend how chromosomal translocations, inversions, or duplications might arise. To provide them with some concrete material, snap-on beads, such as those used in preschool, were utilized. We explained that each differently colored bead represented a gene and that the string of beads was similar to the arrangement of genes on a chromosome. Each student was given two strings of beads (representing two homologous chromosomes) which could be manipulated. Next, the students were asked to take the beads apart and rearrange them to show an inversion, for example. After students had experienced the hands-on manipulation of these snap-on beads, they were able to quickly grasp the concept of chromosomal changes. Most importantly, future review sessions about this concept repeatedly demonstrated that all the students remembered this chromosomal information with 100% accuracy. The learning experienced in this concrete fashion became permanent.

Another situation where we found it necessary to create a concrete foundation for learning was in the area of soil texture and physical properties. For individuals with no first-hand experience on various farm soils, discussions dealing with water infiltration into sandy vs. clay soils were abstractions. Three jars containing 3 cm glass beads, small marbles, and sand served to illustrate the relative soil particle sizes of sand, silt, and clay, respectively. Placing these three samples in sieves and pouring water through each sieve produced a visual, concrete experience that provided us with the foundation from which to build other concepts.

**Calculations**

Step-by-step calculations were one of the emphases of the study group. One of the first suggestions was that the students allow themselves enough room on paper to make the calculations. Many times students tried to do calculations in their heads or without writing down adequate information to reach the correct answer. We also encouraged students to label all their answers with the correct units at each step in the calculation. Many times this eliminated responses from multiple choice exams simply due to the units involved. The final suggestion for calculation questions was to check answers for their reasonableness. In a soil test question, for example, the amount of fertilizer applied must always be greater than the amount of the element required since fertilizers do not contain 100% of the nutrient element involved. At the outset, students tended to have difficulty with numerical relationships, and it was not uncommon for them to be confused as to whether to multiply or divide a number as part of a calculation. The students displayed poor math skills as well as math anxiety. Calculating soil test recommendations presented a situation where step-by-step problem solving was necessary. First, the students were trained to locate the important pieces of data from a soil test printout. Once the important information had been found, the students were asked to insert this data into a specific step-by-step formula for solving the problem.

**Test Taking**

Severe test anxiety characterized this study group. Sample exams given during the study sessions helped familiarize students with the instructor’s test style, and helped the participants to feel more prepared for upcoming exams. In addition, the sample examinations helped to clarify and reinforce student reasoning about Plant Science.

Initially we were surprised at how unaware these students were of different methods of successfully addressing examinations. For example, the students had never taken multiple choice exams using the process of elimination to find the correct answer. It was com-
mon among these students to find them trying to read the entire exam question and all four or five responses as one unit. As a result, the students became confused, frustrated, and overwhelmed. If they did not immediately know the correct answer based on rote memorization, they typically picked an answer at random, then went on to the next question feeling more and more frustrated as time went by. In addition, most students had poor reading comprehension which often resulted in their being unable to retain the content of the exam question long enough to meaningfully read/understand the answer choices. Below is an example of this type of question.

"The main idea behind cation exchange capacity is that soil particles have the ability to:
1. Attract, retain, and exchange negatively charged ions.
2. Attract, retain, and exchange positively charged clay particles.
3. Attract, retain, and exchange fertilizers.
4. Attract, retain, and exchange positively charged ions."

We taught them that if they did not know the right answer immediately, they could read through the multiple choice responses and systematically eliminate obviously incorrect responses. This was a major revelation to all the study group participants.

The importance of identifying the keywords in the exam questions before going on to reading the responses was stressed. We simply told students to underline or circle the two or three words in an exam question that were crucial to understanding it. In writing exams, instructors may help by underlining keywords (i.e., "except," "but," "different," "smaller," "larger," "not," etc.) in exam questions. This procedure helps alert students to search for exceptions. For example:

"Which of the following cropping practices increases the opportunities for soil erosion?
1. Fallowing.
2. Relay cropping.
3. Intercropping.
4. Double cropping."

Students also were taught to break exam question responses into component parts and to consider one part at a time. An example is this two-part question, which was unsolvable for many on the first exam:

"In the process of double fertilization, one sperm unites with the egg to form the _______ while the other sperm unites with the two polar nuclei to form the _______.
1. Endosperm; embryo.
2. Endosperm; synergids.
3. Embryo; endosperm.
4. Embryo; synergids."

After instructing them to consider one component of the answer each time (and use the process of elimination, if needed), they were able to successfully reason through the question.

Another very important test-taking strategy that must come in advance of exam time is concentrating on complete learning via elaboration, rather than simply rote memorization. Many students will memorize information for exams by simply repeating definitions over and over again to themselves. This often results in incomplete learning. If students study by elaborating on the definition and facts and placing them in context or imagining them in practical applications, learning is much more complete. Exam performance is enhanced as well. Reasoning out loud is also a good technique to teach students; thus, knowledge deficits or gaps are revealed. At all times students must be encouraged to use their reasoning skills.

Another test-taking strategy new to these students was to look for commonality in answers. The following provides an example of the type of commonality for which we encouraged them to search.

"On which crop would you find intercalary meristems at the base of the stem internodes and basal meristems on the leaves?
1. Corn.
2. Soybeans.
3. Alfalfa.
4. Lespedeza."

Even if the students did not know the correct response, they could readily note that three of the four answers represented dicots; the only remaining answer was a monocot. It was therefore likely that the monocot was the correct answer. This commonality technique also helped students to integrate various pieces of information and utilize classification schemes in problem-solving as well as in test-taking.

We suggested that when taking an exam, the students read through each question and answer those they were sure of immediately, marking off these questions with a check mark. For those more difficult and time-consuming (but answerable) questions, we suggested that the students mark a plus sign next to them. Upon first reading, those questions seen as impossible were marked with a minus sign. After answering the easy questions (marked with a check), we instructed them to tackle the question with plus sign markings. When completed, the students continued by addressing questions marked with minuses. Finally, students were asked to double-check that they had marked a response to every exam question.

Another test-taking strategy used with some of these students was the administration of verbal exams. One leader would read aloud the exam question and possible answers to the student, who would read along silently. Then the student provided an answer verbally. The study group leaders were thus allowed to closely observe the reasoning processes and calculation strategies used by these students. Learning deficiencies were also noted. We were able to provide feedback on appropriate pronunciation and word clarification, if necessary. We had found reading speed to be slow and that the students frequently misread.
words; for example, transpiration vs. translocation. Consequently, this resulted in them incorrectly answering exam questions. This pitfall was avoided by verbally reading the exam questions. Verbal exams also gave us the opportunity to encourage the students to talk through the reasoning process they used in arriving at their answers. By encouraging them to talk through their answers, we were making them more aware of whether or not they were using logical reasoning. We continually reminded the students to ask “Does my reasoning make sense?” and “Does my answer appear reasonable?” Eventually, this reasoning process became a standard procedure for the students as they worked through, developed, and ultimately internalized a logical and valid reasoning process of their own.

OUTCOMES

Study group students eventually became scholastically self-motivating. They became enthusiastic about plant science to the extent that they would organize their own extra study group sessions, especially prior to examinations. Some students who began the semester with a failing grade on the first exam were able to attain an A by the end of the semester (Table 1). Another significant result of the study group is that the participants have developed a much greater enthusiasm/appreciation for learning about plant science and agriculture. The feedback from this study group was so positive that the University’s Learning Center has sought to model some features of this technique.

<table>
<thead>
<tr>
<th>Group</th>
<th>Exams</th>
<th>Prior to study group</th>
<th>Study group operating</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Exam 1</td>
<td>Exam 2</td>
<td>Exam 3</td>
</tr>
<tr>
<td>Participants</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>38</td>
<td>46</td>
<td>66</td>
</tr>
<tr>
<td>B</td>
<td>44</td>
<td>44</td>
<td>46</td>
</tr>
<tr>
<td>C</td>
<td>48</td>
<td>82</td>
<td>72</td>
</tr>
<tr>
<td>D</td>
<td>40</td>
<td>82</td>
<td>96</td>
</tr>
<tr>
<td>E</td>
<td>40</td>
<td>64</td>
<td>90</td>
</tr>
<tr>
<td>F</td>
<td>60</td>
<td>80</td>
<td>92</td>
</tr>
<tr>
<td>G</td>
<td>56</td>
<td>72</td>
<td>94</td>
</tr>
<tr>
<td>Non-participants</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>56</td>
<td>-</td>
<td>62</td>
</tr>
<tr>
<td>I</td>
<td>48</td>
<td>62</td>
<td>46</td>
</tr>
</tbody>
</table>

Table 2. Grade point averages for study group participants.

<table>
<thead>
<tr>
<th>Group</th>
<th>Cumulative GPA prior to term of two terms</th>
<th>Cumulative GPA after study group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>1.000</td>
<td>2.000</td>
</tr>
<tr>
<td>B</td>
<td>1.611</td>
<td>0.857</td>
</tr>
<tr>
<td>C</td>
<td>1.667</td>
<td>2.800</td>
</tr>
<tr>
<td>D</td>
<td>1.842</td>
<td>3.538</td>
</tr>
<tr>
<td>E</td>
<td>-</td>
<td>3.000</td>
</tr>
<tr>
<td>F</td>
<td>2.636</td>
<td>3.786</td>
</tr>
<tr>
<td>G</td>
<td>1.971</td>
<td>1.500</td>
</tr>
<tr>
<td>Non-participants</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>1.455</td>
<td>0.385</td>
</tr>
<tr>
<td>I</td>
<td>1.575</td>
<td>2.291</td>
</tr>
</tbody>
</table>

Since the end of our first study group, we have found that many of the members have extended or generalized these improved study attitudes and skills, using them in other classes, and leading to improved cumulative grade point averages (Table 2). These results may be due, in large part, to the improved self-image of these students after they significantly improved their grades. Unfortunately, some students allowed extracurricular activities (social and athletics) to hamper their academic performance.

As study group leaders, we have become much more aware of weaknesses that can be found in many of the students involved in the plant science course. Consequently, we have been able to identify where some of our presentations may be weak and have been able to improve the course presentations for all as a result. Finally, we found that combination of course content and study habit improvement is much more effective than providing information on study strategies alone. The immediate application of the test-taking strategies to course content helps clarify, solidify, and make a permanent change in the student’s thinking and approach to taking exams.

The design of this study group works well with small groups of minority students. It also may be used with an entire class, as an optional, outside-of-class component. The review, drill and practice, and personalization of the study group design may improve confidence and test scores of even above-average students. Both approaches have been tried. However, minority group participation drops precipitously when they must become part of a larger, heterogeneous group. Thus, if the objective is to promote minority student participation and competency, use of a small, homogeneous group appears necessary.