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**EFFECTIVENESS OF INSTRUCTIONAL MATERIALS  
ALTERED FOR STUDENTS WITH  
VARYING READING ABILITIES**

**A RESEARCH PROJECT OF THE  
DEPARTMENT OF AGRICULTURAL EDUCATION**

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# EFFECTIVENESS OF INSTRUCTIONAL MATERIALS

## ALTERED FOR STUDENTS WITH VARYING

### READING ABILITIES

#### INTRODUCTION

Students learn more and better through active involvement in their own learning. Teachers who utilize learning activities and practices which promote active participation on the part of students tend to be more effective in modifying the behavior of their students. There are numerous approved teaching practices which can be employed to seek active involvement of students in the teaching-learning process.

Printed materials in the form of textbooks, workbooks, bulletins, resource materials, student reference units, etc., are the primary resources used to assist students explore the unknown as they develop new knowledges, skills and attitudes. It is essential that the printed material be understood by the students if optimum learning is to occur.

In recent years, much discussion has been heard and a great deal written about the decline of students' abilities in such basic areas as reading, writing and mathematical calculations. This decline has been illustrated in many different ways at several levels of education. In essence, the decline in students' abilities to read and write has caused national concern among educators, parents and taxpayers.

The National Commission on Excellence in Education report, "A Nation at Risk" (1983) has drawn the attention of educators and non educators alike to the need for dramatically improving the educational system in the United States. The lack of "basic skills" reported by many students and the declining scores on national achievement tests are overwhelming evidence of this need.

As a result of the "Nation at Risk" report and others, there has been a renewed emphasis placed upon the "back to basics" movement, especially at the elementary and secondary levels of public education. Teachers are finding increasing numbers of students in their classrooms who cannot write grammatically accurate or logically complete assigned term papers. Furthermore, many of these students have extreme difficulty in reading textbooks and other assigned readings. Such students, because of reduced reading abilities, are not achieving at the same level of understanding as those students with higher reading competence. Some feel that those students with low reading ability become discouraged and drop out of school.

Estes and Vaughn (1978, 8) pointed out it is not uncommon to find up to fifty percent of the students in upper grade levels who cannot read their textbooks. The use of textbooks under such conditions is not educationally or psychologically sound. Nothing discourages students more than not being

able to read. The statement, "Nothing is so unequal as the equal treatment of unequals," is appropriate to teachers who attempt to use a single textbook with a class containing students of divergent reading abilities.

Ross (1979, 10) stated teachers solve the problem of "poor" readers in one of two ways. The teacher either goes back to "show and tell" type of instruction, or seeks ways to identify reading problems and then implements remedies to alleviate these problems. Unfortunately, the former solution generally contributes further to the students' reading problems or at best does nothing to solve them. Students with "poor" reading ability hamper the concept of individualized self-paced instruction which relies heavily upon the student's ability to read and comprehend what is read.

Reading competency must be assumed to be a prerequisite for academic success in nearly all fields of endeavor. Students enrolled in vocational agriculture programs in Arizona are no exception. Students must be able to understand subject matter content material effectively. A prime requisite for such understanding is that the instructional materials used, including student reference units, are at least written at appropriate reading levels.

Vocational agriculture teachers, like teachers in other subject matter areas, must understand the relationship existing between reading ability of students and content instruction. The teacher must structure the learning environment of students in such a way so (1) students learn both in the light of their abilities and in spite of their reading problems, and (2) simultaneously develop skills and understandings necessary for them to function as literate individuals in a literate society.

Those teachers who teach reading and learning skills along with subject matter content and make provisions in their instruction to accommodate students whose reading ability interferes with their learning tasks are making progress towards the goals mentioned above. To fully employ such a teaching strategy, it would appear teachers must have access to a variety of instructional materials, including student reference units written at different reading levels. If such materials were available, it could be assumed teachers could appropriately "match the materials to the student" on the basis of individual reading ability.

A review of instructional materials available to teachers of vocational agriculture reveals that not one publisher carries identical materials written on more than one reading level. Of more consequence, until recently very few publishers even specified the reading level of the textbook they do offer for sale to teachers as student references.

## READABILITY MEASUREMENTS

Reading is generally considered one of the most important "basic skills" and has been studied for years. As early as 1923, Lively and Pressley were writing about methods of measuring the readability of textbooks. The accumulation of reading theory and reading research has

developed to the point where specialized training programs are offered by most teacher preparation institutions in the United States.

The reading specialists have worked to enhance the reading ability of students in a variety of ways. One commonly presented procedure has been to select subject matter texts that were not beyond the reading ability of students. Initially, such a recommendation seemed logical and well-advised. Researchers, such as Gunning (1952), Fry (1968) and McLaughlin (1969), have devised formulas by which even "non-experts" in reading can assess the reading levels of written materials.

Tests of readability have been examined by many researchers since the study began. In recent years, some researchers have questioned the validity and reliability of tests of readability.

In 1984, four readability formulas were analyzed to determine the reading grade level equivalence of instructional materials at the middle grades and above (Olson, 1984). The readability formulas analyzed included the Dale-Chall formula, the Gunning-Fog Index, the Flesch Reading Ease Formula, and the McLaughlin SMOG Grading. Olson additionally analyzed the Spache and Wheeler/Smith formula for primary grade materials. Two important findings were that the formulas ignore much of the current knowledge and theoretical bases of the reading process and that they rest on a shaky statistical base. Olson concluded that the readability formulas were based upon unsound criteria, that the correlation research to support the use of other formulas such as strength by association has similar weaknesses, and that the folklore extrapolated from the questionable assumptions places the use of readability formulas in jeopardy.

In a test of readability indexes on such items as income tax materials, Karlinsky and Koch (1983) found standard readability indexes were not useful.

Findings by Fusaro (1988) and Bogert (1985) found conflicting results to the above studies in relation to readability indexes.

Bogert (1985) concluded that readability indexes such as Gunning's Fog index can serve a useful role in the teaching of writing when used as they were intended to be used.

Fusaro (1988) concluded that the Fry readability graph is accurate within one grade level in a paper entitled, "Applying Statistical Rigor to a Validation Study of the Fry Readability Graph."

At the time the readability tests were selected for this study, they were accepted as reliable and valid. While they have been questioned, the research is contradictory. It would appear that applying reading tests as they were intended does give valid results within given boundaries.

The result of the continued emphasis upon "reading formulas" which have placed emphasis upon sentence length and vocabulary has been for publishers to prepare and sell textbooks with prescribed "readability"

levels. Some reading experts have even urged textbook publishers to make available texts at several different reading levels so teachers can match students' reading ability with the readability of their textbooks.

Former Secretary of Education Terral H. Bell, speaking before the American Association of School Administrators in Las Vegas, Nevada on February 25, 1984, labeled such practices as "dumbing down" of textbooks and appealed to educators and textbook publishers to join him in a drive to stop it. Secretary Bell contended that textbooks written for the "bottom of the class" were obstructing the drive to raise school standards in America (Connell, 1984).

Thousands and thousands of dollars are spent annually on printed subject matter reference materials used in vocational agriculture programs in this country. Such instructional materials are provided by a variety of public and private agencies, all of whom are attempting to supply a product which will provide the needed information in a form which will enhance student understanding and which the student can read and comprehend. All of this effort has been largely guided without any basis in research as to "what" or "how".

Readability refers to the success that the average individual has with a book (Dale and Chall, 1948). The primary factors affecting readability are sentence length and vocabulary difficulty. As the readability of instructional materials increases, students with low reading ability would be expected to experience increased difficulty in understanding and comprehending the material.

In summary, there appears to be a growing need for instructional materials in agriculture, particularly student references, written to enhance student understanding. Current student reference units (SRU), referred to as "original", produced by the Department of Agricultural Education at the University of Arizona possess reading levels ranging as high as those written for typical college freshmen. The ten "original" instructional materials, contained in the Two Year Core Curriculum for Vocational Agriculture in Arizona, were intended for use with high school freshmen and sophomore students enrolled in vocational agriculture programs in Arizona.

In an attempt to provide instructional materials with known reading levels, a multi-phased, longitudinal study was undertaken. The ultimate intent of this research project was to assess the effectiveness of selected student reference units (SRU), altered for students with varying reading abilities, on their (students) understanding of agricultural subject matter.

#### PURPOSE OF THE STUDY

This long term research project could be classified as a developmental-evaluative effort. It included both quasi-experimental and

descriptive survey design phases. Independent variables were altered over time to determine their impact independently upon the dependent variable. In essence, the independent variable in each phase of the research was the alteration made to the "original" instructional materials, while the dependent variable--students' understanding--was measured by scores on a posttest covering the subject matter content contained in the student reference being tested.

Each phase of the research dealt with one specific alteration to one of the "original" student reference units. The overall project was of an evolutionary nature. As the results (data) from one phase of research were analyzed relative to the effectiveness of the altered instructional materials upon students' understanding of the agricultural subject matter contained in the specific SRU being tested, the next phase of the research was designed and field tested. The "evolution" phases contained in this longitudinal study were as follows:

- Phase I -- Effect of matched reading ability of students to high or low reading level student reference units
- Phase II -- Effect of high or low reading level student reference units on matched classrooms taught by the same teacher
- Phase III -- Effect of altered format style upon student preference of student reference units
- Phase IV -- Effect of altered format style upon students' reading speed and comprehension of agricultural subject matter contained in a student reference unit
- Phase V -- Effect of high or low reading level student reference units on classroom with no formal instruction (control of teacher influence)
- Phase VI -- Effect of low reading level student reference units with or without illustrations (graphics)

The specific objectives of the study were to answer the following research questions:

1. Will there be a significant difference in student understanding of selected agricultural subject matter, based upon test scores, between classrooms in which students are matched with high or low reading level references according to their measured reading ability and classrooms in which all students use only the high reading level reference?
2. Will there be a significant difference in student understanding of selected agricultural subject matter, based upon test scores, when students were assigned either high reading level or lower reading level student reference units in classrooms taught by the same teacher?
3. Will there be a preference by 9th and 10th grade vocational agriculture students for different format styles (size of print, number of columns per page, and use or non use of outline symbols along page margins)?

4. Will there be a significant difference in readability of altered instructional materials based upon a timed reading speed and comprehension test for difficult format styles?
5. Will there be a significant change in student understanding of selected agricultural subject matter, based upon test scores, between classrooms in which students use either the low reading level or high reading level references but receive no formal instruction?
6. Will there be a significant difference in student understanding of selected agricultural subject matter, based upon test scores, between classrooms in which students use instructional materials containing no illustrations and classrooms where students use instructional materials which contain illustrations?

It should be noted that the terms "student understanding" and "student knowledge" are used synonymously in the bulletin.

#### ASSUMPTION

A basic assumption was made by the researchers as they designed the various phases of this longitudinal study, that being, a correlation exists between the measures of readability on instructional materials and students' reading level as measured by the California Achievement Test (CAT), Level 18, Form D.

#### METHODS AND PROCEDURES

This research involved both a developmental component and an evaluation component. The procedures utilized in each component are presented in the light of each objective of the project.

#### OVERALL DEVELOPMENTAL COMPONENT

The initial developmental phase involved the preparation of selected student references with reading levels of grade 10 or less as measured by recognized readability appraisal procedures. To achieve this portion of the developmental phase, "original" student reference units developed by the Department of Agricultural Education at the University of Arizona were analyzed to assess their reading levels. The student references selected for modification were those contained in the Two Year Core Curriculum for Vocational Agriculture in Arizona published by the Department of Agricultural Education at the University of Arizona. "Original" editions of the student references having readability levels as high as college level were rewritten to reading levels of grade 10 or lower.

Readability was determined through the use of the Fry (1968) and McLaughlin (1969) SMOG formulas. Both formulas are easy to apply and are

highly correlated with the results obtained using the Spache and Dale-Chall formulas (Estes and Vaughn, 1978).

Fry's formula is actually a graph. It consists of plotting a point on a graph where two readability factors coincide, namely, the average number of sentences per 100 words and the average number of syllables per 100 words (Fry, 1968).

The McLaughlin SMOG formula is perhaps the least complicated of all readability formulas. It is based upon the interrelationship of sentence length and vocabulary difficulty. The SMOG formula involves one factor--the number of polysyllabic words in three ten sentence samples.

In rewriting the student reference units, the same technical concepts and objectives were addressed in the "modified" references as were identified in the "original" editions. The only major change between the two references was in readability levels. Reading levels of the ten student references contained in the core curriculum are shown in Table 1 for the "original" and "modified" editions. Mean values were determined by averaging the Fry and SMOG scales.

In addition, criterion-referenced evaluative instruments (CREI) for measuring the relative degree of knowledge of vocational agriculture students for each selected student reference had to be rewritten to the appropriate reading level.

TABLE 1. Reading Level Values (grade) of Original and Modified Student Reference Units.

Student Reference Unit	Original		Modified			
	Fry	SMOG	Mean	Fry	SMOG	Mean
Livestock Selection	13	11	12	6	9	7.5
Livestock Health	11	13	12	10	10	10
Livestock Feeding	13	14	13.5	8	10	9
Livestock Production Management	11	13	12	7.5	10	8.5
Plant Growth and Development	10	12	11	9	10	9.5
Plant Diseases	13	13	13	8.3	9	8.6
Insects	9	12	10.5	9	10	9.5
Weeds	11	13	12	7.3	9	8
Plant Production Management	12	13	12.5	7	9	8
Soils	11	13	12	8	9	8.5



These instruments were used to measure student knowledge of specific subject matter on the posttest. The reliability and difficulty of each instrument used in the study are found in Table 2.

TABLE 2. Test Reliability and Difficulty for Selected Criterion-Referenced Evaluative Instruments.

Criterion-Referenced Evaluative Instrument	Test Reliability*	Difficulty*
Livestock Selection	.82	49.9%
Livestock Feeding	.86	50.7%
Plant Growth and Development	.87	51.98%
Soils	.85	49.97%
Plant Diseases	.74	54.74%

\*A test reliability of .80 or greater is considered "extremely high", while a difficulty factor of 50% is desirable for evaluative instruments of this nature.

It should be pointed out that when the impact of altered format styles of the student references were being evaluated (objectives 3, 4 and 6), the following modifications were employed: (a) size of type (print); (b) number of printed columns per page; (c) use of outline symbols along page margins; and (d) number of illustrations.

#### DEVELOPMENTAL COMPONENT FOR OBJECTIVE 1 (PHASE I)

In order to address objective 1, the student reference unit on Plant Growth and Development was selected since this unit was included in curricula of over ninety percent of the vocational agriculture programs in Arizona. The "original" unit was rewritten at an average reading level of grade 9.5 (Fry-9; SMOG-10). Since both freshmen and sophomore students were involved in this phase of the study, selection of a student reference unit with this reading level was most appropriate.

The criterion-referenced evaluative instrument (CREI) on Plant Growth and Development containing 53 multiple choice questions was likewise rewritten at the 9.5 grade reading level. This measurement device had a test reliability of .87 with a difficulty of 51.98 percent. The test was slightly difficult.

## DEVELOPMENTAL COMPONENT FOR OBJECTIVE 2 (PHASE II)

Two student reference units were utilized to address objective 2. It was necessary to identify those additional instructional units which were included in most vocational agriculture curricula. Therefore, the student reference units on Livestock Selection and Livestock Feeding were selected.

The "original" Livestock Selection student reference unit was written at grade 13 as measured by the Fry formula and grade 11 according to SMOG. This student reference unit was rewritten to an average reading level of grade 7.5 (Fry-6; SMOG-9).

The "original" Livestock Feeding student reference unit was written at grade 13 and 14 as measured by Fry and SMOG formulae, respectively. It was rewritten at grade 9 (average of Fry and SMOG).

The criterion-referenced evaluative instruments for the above two student reference units were likewise revised to reflect comparable reading levels of the SRU's. The CREI on Livestock Selection and Livestock Feeding contained 40 and 48 multiple choice questions, respectively.

## DEVELOPMENTAL COMPONENT FOR OBJECTIVE 3 (PHASE III)

To accomplish objective 3 of this study, the student reference on Plant Diseases was selected for two reasons. First, this unit was not widely included in the curriculum of most vocational agriculture programs in Arizona. Although a critical management concern exists in Arizona relative to the prevention and control of plant diseases, only a limited number of copies of this resource unit had been disseminated. Second, due to the above, it was assumed there would be less subject matter contamination regarding plant diseases than with other student references contained in the core curriculum.

To determine student preferences concerning the size of print, number of columns per page and use or non use of outline symbols along page margins, three different samples of the Plant Diseases student reference unit were developed. Sample A was reproduced using pica (large) type and a single column format. Elite (small) type and a single column format was used to reproduce sample B. Sample C was reproduced using elite type and a double column format. It should be pointed out that each sample (A, B, C) contained the same subject matter content on plant diseases as contained in the "original" reference unit.

To collect data for the achievement of objective 3, a format preference survey was developed. Likewise, each student's reading ability was determined from the reading vocabulary and reading comprehension portions of the California Achievement Test, level 18, form D.

#### DEVELOPMENTAL COMPONENT FOR OBJECTIVE 4 (PHASE IV)

Phase IV of this study was to determine which of the three sample format styles for the Plant Diseases SRU were easiest for students to read and comprehend. Thus, the three sample styles developed for objective 3 were utilized to collect data essential to accomplish objective 4.

The "Reading Comprehension Test" instrument consisting of thirty multiple choice questions with four distractors was developed to measure the average comprehension of randomly assigned students for each of the three sample format styles. The test questions were organized sequentially to parallel the flow of information presented in the three format styles. Face and content validity of this instrument were assessed by faculty and graduate students in the department.

#### DEVELOPMENTAL COMPONENT FOR OBJECTIVE 5 (PHASE V)

The influence of the teacher on student understanding of selected agricultural subject matter was the major concern of objective 5. The student reference unit on Soils for the core curriculum was selected for use in this phase of the research project. The "original" Soils SRU was written with a readability of grade 13 as measured by SMOG. This SRU was rewritten to grade 9 readability (SMOG).

Likewise, the criterion-reference evaluative instrument (CREI) containing 40 multiple choice questions was rewritten to approximate the reading level of the revised Soils SRU.

#### DEVELOPMENTAL COMPONENT FOR OBJECTIVE 6 (PHASE VI)

The Plant Diseases SRU was selected for use to address objective 6. The "modified" edition (lower reading level) of this reference was rewritten at grade 8.6 reading level. The lower reading level version was modified further by (1) adding two to three illustrations per printed page to demonstrate visually the concept/principle being presented, and (2) utilizing a two column format style to accommodate the effective use of the illustrations.

The two references used in this phase of the study were the lower reading level Plant Diseases SRU with no illustrations and the lower reading level Plant Diseases SRU with illustrations.

#### OVERALL EVALUATION COMPONENT

The evaluation component of this research employed, when required, a quasi-experimental, non equivalent control group design. The sampling units used in all phases except for phases III and IV were individual vocational agriculture classrooms.

The subjects used in this study were 9th and 10th grade high school students studying vocational agriculture in Arizona high schools during the 1980-81 to 1987-88 school years.

Student performance data in the form of posttest scores, referred to as "student understanding", were the primary dependent variables. All classes used were directed by teachers who had volunteered to participate in each phase of the study. The term "student understanding" as used in this research is synonymous with "student knowledge". The alterations (modifications) made in the instructional materials became the independent variables.

The "original" student reference units were developed for use in the Two Year Core Curriculum in Vocational Agriculture. The core curriculum is taught in the first two years of vocational agriculture in Arizona.

At the beginning of each phase of the study, with the exception of phase VI, each individual student's reading ability was determined through the administration of the reading vocabulary and reading comprehension section of the California Achievement Test (CAT), level 18, form D. Level 18 of the CAT is recommended for use with grade range 7.6 to 9.9. Within this range, this form of the CAT yields the most accurate results. A percentile rank was determined for each student involved in the various phases of the study. It should be noted percentile ranks 49 and 50 correspond respectively to the approximate reading grade equivalents 9.2 and 9.3.

Randomly assigned classroom units in which students were provided altered or unaltered student reference units were utilized as either treatment or control. For phases I, II, V and VI, classrooms were the sampling units and classroom average posttest scores, not individual student scores, were used for analysis purposes. Within each classroom unit were an array of student reading abilities (levels). Random selection of classroom units helped to control for average differences in reading ability between various classes. The one exception was that classroom units were not utilized for objectives 3 and 4.

Analysis of results involved a comparison of test scores (average number of correct responses) from treatment and control groups. An analysis of covariance (SPSS, ANOVA) was run on resulting test scores using the number of correct responses as the criterion variable and the two treatment levels (high and low reading level references) as the factors with the reading index (CAT score) as the covariant.

#### EVALUATION COMPONENT FOR OBJECTIVE 1

This facet of the study employed a quasi-experimental design. All criteria for a true experimental design were met, with the exception of random selection. The teachers participating in this phase of the study volunteered to do so. The student reference on Plant Growth and Development was tested in 11 high schools consisting of 21 classroom units (11 treatment; 10 control) involving 353 9th and 10th grade high school students

studying vocational agriculture in Arizona. The random block design was employed with students blocked by natural occurring classroom assignments. Of the 353, 331 students completed the posttest.

Classroom units were randomly assigned to either treatment or control groups. Students whose classrooms were assigned to the treatment group were given one of two references on Plant Growth and Development depending upon their measured reading ability. These are referred to as "two-reference classroom units". Students in the treatment group with high reading ability (percentile rank of 50 or above) were provided with the "original" student reference unit having a readability of approximately grade 11. Students in the treatment group with medium to low reading ability (percentile rank of 49 or below) were given the "modified" Plant Growth and Development SRU with a readability of approximately grade 9.5. Students in the classrooms assigned to the control group were all provided the "original" references (readability of grade 11) and are referred to as "one-reference classroom units".

All other factors such as size of print, concepts contained, type of covers, color of covers, binding, etc., were held constant in all references used in this phase of the study.

Following the assignment of treatment group students to the appropriate reference, students in both treatment and control groups were taught a unit on plant growth and development. As reported by teachers participating, an average of 12 classroom periods was devoted to teaching the Plant Growth and Development unit. The student-teacher interaction process was utilized by all teachers while teaching this unit. On the day following completion of teaching the unit, students in both treatment and control group classrooms were administered the criterion-referenced evaluative instrument as a posttest. This instrument contained 53 multiple choice questions. As reported earlier, this test had a test reliability of .87 and a difficulty of 51.98 percent.

The computer program used to analyze the data provided breakdowns for treatment and control groups by ninth grade, tenth grade, low reading ability and medium reading ability in terms of mean reading scores and mean correct responses on the posttest. The program also computed t-values for all breakdowns between treatment and control groups. Scattergrams were plotted to aid in analyzing the data.

#### EVALUATION COMPONENT FOR OBJECTIVE 2

The second phase of this longitudinal research project, employing a quasi-experimental design, was to attempt to control for the relative effectiveness of the teacher's teaching ability. In order to address objective 2, it was necessary to identify Arizona vocational agriculture teachers who taught two classes of freshmen or two classes of sophomore students. Only those teachers who volunteered to participate in this study and who taught two classes of freshmen or two classes of sophomore vocational agriculture students were utilized.

For this phase, the student reference units on Livestock Selection and Livestock Feeding were tested in 9 Arizona high schools using 18 classroom units involving 529 high school students enrolled in 9th or 10th grade vocational agriculture programs.

Each of the two SRU's consisted of a high reading level (original) reference and a lower reading level (modified) edition. These references were used in paired classes (teachers with two classes of freshmen or sophomore students) to nullify or control the influence of the teachers' teaching ability. One of the two classes taught by the same teacher used the higher reading level reference, while the other used the lower reading level reference. Classrooms were randomly assigned to treatment or control groups.

At the completion of instruction using either the Livestock Selection or the Livestock Feeding SRU, a criterion-referenced evaluative instrument (CREI) on the specific subject matter taught was administered to students in both treatment and control groups. The CREI on Livestock Selection contained 40 multiple choice questions, while the CREI on Livestock Feeding contained 48.

It is interesting to note that teachers in the control group spent an average of 17.5 class periods teaching the Livestock Selection SRU with a range of 8 to 25 periods, while those teachers in the treatment classrooms taught an average of 18.1 periods, ranging from a minimum of 8 class periods to a maximum of 25. Teachers in either control or treatment groups spent approximately the same amount of instructional time teaching the Livestock Selection unit.

For the Livestock Feeding SRU, teachers in both control and treatment groups taught this unit for an average of 18.86 class periods. The range in classroom periods taught varied from a minimum of 13 to a maximum of 28. Students in either the control or treatment group received the same amount of instructional time for this unit.

It can be inferred from the above data that the amount of instructional time devoted to teaching these two SRU's was not a factor in students' performance as measured by posttest scores whether they were in control or treatment groups.

Data were analyzed to determine if a difference in student understanding, as measured by the average number of correct responses, existed between classroom units assigned high or low reading level student reference units.

### EVALUATION COMPONENT FOR OBJECTIVE 3

To determine if the format style of student reference units had any effect upon student preference, phase 3 of this study was designed to test three different format styles. This phase involved 248 freshmen and sophomore vocational agriculture students in nine high schools.

The study was conducted to determine students' preferences concerning the size of print, number of columns per page and use or non use of outline symbols along the page margins for the student resource unit on Plant Diseases.

The accessible population of this study was restricted to students who had not yet studied the Plant Diseases SRU in their vocational agriculture classes and to classrooms volunteered by their teacher. The twelve teachers who had participated in phase II of the research were asked to volunteer their students again for this study. Of these teachers, nine were able and agreed to participate. All freshmen and sophomore students in attendance in these nine classes on the day of testing comprised the sample. It should be noted that in this phase of the research individual students were the sampling units, not classrooms, as was the case in phase I and II. Thus, this might be considered a cluster sampling technique (blocking) with the cluster being volunteered classrooms and the sampling units individual students in each classroom.

This phase of the study was descriptive in nature. It was designed to determine students' preference for the printed format style of the Plant Diseases SRU. To assist with planning for future production of instructional materials, it was desirable to determine student preferences concerning the size of print, number of columns per page and use or non use of outline symbols along page margins for SRU's. This was accomplished using various samples of the Plant Diseases unit and looseleaf supplemental pages which varied from one another only in format style. The "Format Preference Survey" instrument was used for students to record their preferences.

On the day of testing, students were provided specific instruction for completing the preference survey instrument followed by the distribution of the three sample format styles of the Plant Diseases SRU in a planned sequence. Prior to distribution, the samples had been randomly arranged to assure no one sample unit was more frequently opened up first by students. After all students had received their sample, they answered the questions on the "Format Preference Survey".

Data were analyzed to ascertain students' format style preferences.

#### EVALUATION COMPONENT FOR OBJECTIVE 4

The same three format style Plant Diseases SRU's used to address objective 3 were utilized in this phase of the study. Likewise, the same 248 freshmen and sophomore vocational agriculture students involved in the format style preference study (phase III) were utilized in this phase. It should be noted that the data collected from two students were unusable.

This phase was quasi-experimental in nature. Students blocked in classrooms were randomly assigned to one of three groups. It was designed to assess which of the three sample SRU format styles tested were actually easier for students to read and comprehend. Classroom testing, using the

"Reading Comprehension Test" instrument immediately followed students' completion of the format preference survey.

The relative reading ease of each format style was determined through the use of a timed reading speed test. This test measured the average reading speeds (number of words read per minute) of randomly assigned students for each of the three sample format styles. The relative comprehensibility of each format style was determined through the use of a closed book paper and pencil test. This test was designed to measure the average comprehension of students for each of the three sample format styles.

During the actual testing, students were told to (1) read through their assigned unit at a normal speed, (2) read for three minutes when instructed to start reading, and (3) circle in pencil the last word they had read when it was announced the three minute timed reading period was finished.

At the conclusion of the timed reading test, students completed the "Reading Comprehension Test" instrument consisting of 30 multiple choice questions organized sequentially to parallel the flow of information presented in the three sample format styles. Organizing the comprehension test questions in this manner allowed the researchers to later adjust students' comprehension test scores based upon how far each student had read through the assigned sample unit. Adjusting students' comprehension score assessment in this manner prevented the penalizing of slow reading students' comprehension on the multiple choice test, or the comparative inflation of fast reading students' comprehension scores.

Data were analyzed to determine the relationships between the different variables examined in this phase of the study.

#### EVALUATION COMPONENT FOR OBJECTIVE 5

This phase of the study involved the quasi determination of the effect on student understanding of the Soils SRU written at two different reading levels controlling for both teacher influence (teacher interaction with students) and student reading ability. The intent of this phase of the study was to measure the effect of the readability of written instructional materials controlling interactive teacher influences and students' reading ability. It involved 12 high schools comprising 19 classroom units consisting of 222 students studying vocational agriculture in Arizona.

A randomized block design was employed with students blocked by natural occurring classroom assignments. Only classrooms situated in secondary schools offering two classes of either freshmen or sophomore vocational agriculture students taught by the same teacher were included in this phase of the study. It should be pointed out, however, that those teachers participating in this phase of the study were not the same teachers who participated in phases I, II, III or IV.



The classrooms were randomly assigned to treatment and control groups. The classes in the control group used the original Soils SRU written at the 12th grade level as measured by the average of the Fry and SMOG scales, while the treatment group used the modified SRU written at the 8.5 grade level as measured by the same scales. To arrive at individual student's reading level, all students in both classroom groups completed the reading portion of the California Achievement Test (CAT) level 18, form D.

In order to control teacher influences, each day for four consecutive classes (days), students were assigned specific pages to read in the Soils SRU in 25 minutes. Following each reading period, students were allowed 20 minutes to answer prepared study questions. On the 5th day, a posttest on Soils was administered. During the four-day testing period, teachers provided no instruction other than telling students what pages to read.

Analysis of data was undertaken to ascertain whether controlling student-teacher interaction resulted in differences in student understanding.

#### EVALUATION COMPONENT FOR OBJECTIVE 6

The final phase of this study was to determine the effects of altered graphics (illustrations) on student understanding. The Plant Diseases SRU was used in this effort. A randomized block design was again employed with students blocked by naturally occurring classroom assignments. Only classrooms offering 9th and 10th grades of vocational agriculture taught by the same teacher were utilized. All classrooms were again volunteered by their teachers for this phase of the study. Different teachers participated in this phase of the study than did in the other phases. There were 148 ninth and tenth grade vocational agriculture students who participated in this phase blocked into ten classroom units from four high schools.

The classrooms were randomly assigned to treatment and control groups. The classes assigned to the control group utilized the Plant Diseases SRU written at the 8.6 grade level and containing no illustrations. The treatment group was provided the same lower reading level Plant Diseases SRU (8.6 grade level) which contained at least two illustrations per printed page.

Based upon previous findings, the researchers concluded that it was not essential to determine the students' reading ability (CAT) in this phase of the study. This decision resulted in a large savings of money and professional time. It was based upon the fact that controlling students' reading ability in the previous phases of this study revealed no statistically significant relationship to the various independent variables being tested.

Data were analyzed to ascertain whether student understanding, as measured by test scores, was affected by instructional materials containing illustrations.

## RESULTS AND ANALYSIS

The primary intent of this multi-phased research project was to assess the effectiveness of selected student reference units (instructional materials), altered for students with varying reading abilities, on their understanding of agricultural subject matter. The major concern was to determine whether there would be a statistically significant change (.05 alpha level) in student understanding as measured by mean correct posttest scores. In addition, it was desirable to determine students' preferences for various format styles in an attempt to identify guidelines which might impact upon the production of future student reference materials developed by the Department of Agricultural Education at the University of Arizona. Determining the reading indices of students enrolled in 9th and 10th grade vocational agriculture programs in Arizona was also considered to be a desired outcome of this study.

### PHASE I - EFFECT OF MATCHED READING ABILITY TO READABILITY OF INSTRUCTIONAL MATERIALS

As a means to assess the effectiveness of matching student reference units of different reading difficulty with students according to their measured reading ability, a comparison of treatment and control groups posttest mean correct responses was made.

The treatment group was comprised of classrooms in which students were matched with "original" and "modified" Plant Growth and Development SRU's according to their measured reading ability, referred to as "two-reference unit classrooms". The control group consisted of classrooms in which all students used the "original" (high reading level) Plant Growth and Development SRU, referred to as "one-reference unit classrooms".

Table 3 shows a comparison of treatment and control groups posttest mean correct response by grade level and overall.

TABLE 3. Comparison of Treatment and Control Groups' Posttest Mean Correct Response by Grade Level and Overall.

Group/Value	Mean Correct Response		Overall (331 students)
	Ninth Grade (268 students)	Tenth Grade (63 students)	
Treatment (n=11)	27.7113	29.5405	28.0894
Control (n=10)	27.2540	29.3077	27.6053
Difference	.4573	.2328	.4841
Percent Difference	.8628	.4392	.9134
t*	.47	.13	.56

\*t  $\geq$  1.97 indicates significance at the .05 alpha level with 19 df.

When data were compared between treatment and control groups, there was a .91 percent increase in understanding of plant growth and development among students in the treatment classrooms as opposed to those in the control classrooms. With a computed t-value of .56, this increase, however, was not statistically significant at the .05 alpha level.

A comparison of data between 9th grade students in the treatment and control groups showed a similar trend. There was a .86 percent increase in student understanding (knowledge) among students in the treatment classrooms as opposed to those in the control classrooms. This increase represented a computed t-value of .47 which was statistically insignificant.

Data concerning the mean correct responses of students in treatment and control classrooms were further analyzed using scattergrams. A definite correlation between reading ability and performance on the posttest was evident from the positive linear nature of the scattergrams. This relationship held true for the treatment group, the control group, and overall. Overall, this correlation had a Pearson r of .69177 which was significant at the .00001 level of confidence.

A similar comparison of data for 10th grade students in the two groups yielded similar results.

To further analyze the data, a comparison of posttest mean correct response of low and of medium reading ability students in treatment and control groups was made. Low reading ability students were defined as those achieving a level of reading performance below the 25th percentile rank as measured by the reading vocabulary and reading comprehension sections of the California Achievement Test. Medium reading ability students were defined as those achieving a reading performance level between the 25th and 49th percentile rank.

A comparison of posttest mean correct response of the low reading ability students in treatment and control groups is presented in Table 4.

TABLE 4. Comparison of Posttest Mean Correct Responses of Low Reading Ability Students in Treatment and Control Groups by Grade Level and Overall.

Group/Value	Mean Correct Response		
	Ninth Grade (36 students)	Tenth Grade (4 students)	Overall (40 students)
Treatment (n=11)	19.9375	20.5000	20.0000
Control (n=10)	21.2000	25.5000	21.5907
Difference	-1.2625	-5.0000	-1.5909
Percent Difference	-2.38	-9.43	-3.002
t*	-.45	-1.781	-.567

\*t  $\geq$  1.97 indicates significance at the .05 level with 19 df.

As noted in the above table, there was a three percent difference in student understanding of plant growth and development among students in the treatment group classrooms as compared to those in the control group classrooms. However, with a computed t-value of  $-.567$ , this difference was not statistically significant at the  $.05$  alpha level.

A comparison of 9th grade students and 10th grade students of low reading ability in treatment and control groups shows 2.38 percent and 9.4 percent difference, respectively, in student understanding of plant growth and development. Computed t-values indicate no statistically significant difference.

Table 5 shows a comparison of posttest mean correct responses of medium reading ability students in treatment and control groups.

TABLE 5. Comparison of Posttest Mean Correct Responses of Medium Reading Ability Students in Treatment and Control Groups by Grade Level and Overall.

Group/Value	Mean Correct Response		
	Ninth Grade (65 students)	Tenth Grade (11 students)	Overall (76 students)
Treatment (n=11)	22.5429	26.7500	23.3256
Control (n=10)	25.8000	30.3333	26.2121
Difference	-3.2571	-3.5833	-2.8865
Percent Difference	-6.14	-6.76	-5.4462
t*	-1.142	-1.257	-1.012

\* $t \geq 1.97$  indicates significance at the  $.05$  level with 19 df.

A comparison of data between medium reading ability students in treatment and control classrooms shows a 5.4 percent difference in students' understanding of plant growth and development as measured by mean correct responses. With a computed t-value of  $-1.012$ , this difference was not statistically significant.

It can also be noted in Table 5 that a comparison between both 9th and 10th grade students of medium reading ability shows consistent percentage differences in posttest scores. However, these respective differences were not statistically significant.

This phase of the research provided data valuable to determine selected reading indices of students enrolled in 9th and 10th grade vocational agriculture programs in Arizona. Table 6 reveals the values of selected

reading indices for 9th and 10th grade vocational agriculture students in selected Arizona high schools at the time the study was conducted.

TABLE 6. Values of Reading Indices for Ninth and Tenth Grade Vocational Agriculture Students in Selected Arizona High Schools (n = 353).

Reading Index	Ninth Grade (n = 288)	Tenth Grade (n = 65)
Scale Score. (Mean)	578.36	587.63
Percentile Rank	54	59
Grade Equivalent	10.0	10.1

The reading mean percentile rank for 9th graders participating in this phase of the study was 54. This corresponds to a grade equivalent of 10.0. Tenth grade participants had a reading mean percentile rank of 59 which corresponds to a grade equivalent of 10.1. The mean scale scores for 9th and 10th grade subjects were 578.36 and 587.63, respectively.

During the same time frame this phase of the study was conducted, ninth grade students in Arizona were reading at the 10.2 grade level, while nationally they were reading at a grade level of 9.7 as reported by the Arizona Department of Education. Tenth grade students in Arizona were reading at an 11.2 grade level during this same period of time, while nationally tenth grade students were reading at 10.7 grade level. Ninth and tenth grade vocational agriculture students in Arizona involved in this study possessed reading abilities comparable to the national average.

#### PHASE II - EFFECT OF READABILITY OF INSTRUCTIONAL MATERIALS MATCHED WITH CLASSROOMS TAUGHT BY THE SAME TEACHER

The results of the first phase of this study tend to indicate that matching student reference units of varying reading levels with student reading ability yielded only minimal effect on students' increase in knowledge of subject matter. Thus, phase II of this study was designed to control for the relative effectiveness of the teacher's teaching ability. To achieve this, only Arizona vocational agriculture teachers who taught two classes of freshmen or two classes of sophomore students and who would teach a unit and use either the Livestock Selection or the Livestock Feeding SRU were utilized. As pointed out earlier, these two SRU's were selected because they were taught in most departments of vocational agriculture in Arizona. It was the desire of the researchers to utilize approximately twenty classroom units in this phase of the study.

As with phase I, it was desirable to determine selected reading indices of those 9th and 10th grade vocational agriculture students participating in this phase of the study. Table 7 shows values of selected reading indices for the 9th and 10th grade vocational agriculture students by specific SRU at the time the study was conducted.

It will be noted that those students who participated in this study utilizing the Livestock Selection SRU had a percentile rank of 63. Those students involved with the Livestock Feeding SRU possessed a 67 percentile rank. These ranks correspond to a grade equivalent of 10.4 and 10.9, respectively. It is further interesting to note that those students in the Livestock Feeding group had a higher mean scale score, higher upper and lower range values and read at a higher grade level than did those in the Livestock Selection group. However, students using the Livestock Selection and Livestock Feeding SRU's were, on the average, reading above grade level.

TABLE 7. Values of Reading Indices for Student Participants by Specific SRU's (n = 529).

Reading Index	Livestock Selection SRU n = 345	Livestock Feeding SRU n = 184
Scale Score (Mean)	592.133	602.190
Scale Score (Range)	391-800	423-819
Percentile Rank	63	67
Grade Equivalent	10.4	10.9

A comparison of posttest mean correct response in treatment and control groups by specific SRU is revealed in Table 8.

When posttest score data were compared between treatment and control groups for both SRU's utilized in this phase, there was a -2.35 and a -1.51 percent difference in understanding of livestock selection and livestock feeding, respectively. However, the impact of modified SRU's on student performance on a cognitive examination was less than for the control group.

TABLE 8. Comparison of Posttest Mean Correct Responses in Treatment and Control Groups by Specific SRU (n = 529).

Group/Value	Mean Correct Response	
	Livestock Selection (n = 345)	Livestock Feeding (n = 184)
Treatment (n=9)	21.040	24.425
Control (n=9)	21.980	25.150
Difference	-.940	-.725
Percent Difference	-2.35	-1.51

Table 9 shows the comparison of posttest mean score, standard deviation and standard error in treatment and control groups by specific SRU used in this phase of the study.

TABLE 9. Comparison of Posttest Mean Score, Standard Deviation and Standard Error in Treatment and Control Groups by Specific SRU (n=529).

Value	Livestock Selection (n = 345)		Livestock Feeding (n = 184)	
	Treatment	Control	Treatment	Control
Mean	21.04	21.98	24.425	25.150
Standard Deviation	2.721	2.318	2.052	5.204
Standard Error	.860	.733	1.026	2.602
t		-.83*		-.26*

\* $t \geq 2.101$  indicates significance at the .05 alpha level with 17 df.

Data presented in the above table reveal t-values of -.83 and -.26 for the Livestock Selection and the Livestock Feeding SRU's, respectively. These values indicate that there was no significant difference between the performance of students in the treatment and control groups on posttests for either of the SRU's utilized in this study. The modification of the Livestock Selection or the Livestock Feeding SRU to a lower readability had no significant impact upon students' understanding of these agricultural subject matter areas. Likewise, controlling a teacher's teaching effectiveness has little or no impact upon student performance.

Since neither the lowering of the readability of student reference units nor controlling for teacher's teaching ability had a significant impact upon student performance, it was desirable to learn what might cause the difference. An analysis of covariance was computed to ascertain the influence of CAT scores upon student performance. Table 10 presents the analysis of covariance of posttest scores on livestock selection.

Data presented in Table 10 show the F-value for the covariate (CAT score) to be 81.688 which indicates significance at the .001 alpha level. Thus, the difference in student performance on the posttest for livestock selection is due to the individual student's reading ability, not due to the modification of the student reference units.

TABLE 10. Analysis of Covariance of Posttest Scores of 9th and 10th Grade Vocational Agriculture Students Using CAT as Covariate on Livestock Selection (n=345).

Source	Sum of Squares	df	Mean Squares	F	Significance of F
Main Effects Unit*	23.411	1	23.411	1.057	.305
Covariate CAT**	1809.181	1	1809.181	81.688	.001
Explained Variance	3337.066	22	151.685	6.849	.001
Residual Variance	7131.496	322	22.148		
TOTAL	10468.562	344	30.432		

\*The Livestock Selection Student Reference Unit.

\*\*Reading ability level as measured by the California Achievement Test in grade equivalents.

The analysis of covariance of posttest scores on livestock feeding is presented in Table 11.

It is interesting to note that the same effect of CAT scores on student performance for the Livestock Feeding SRU was also found for the Livestock Selection unit. An F-value for the covariate of 90.312 was statistically significant at the .001 alpha level.



TABLE 11. Analysis of Covariance of Posttest Scores of 9th and 10th Grade Vocational Agriculture Students Using CAT as Co-variant on Livestock Feeding (n=184).

	Sum of Squares	df	Mean Squares	F	Significance of F
Main Effect Unit*	2.763	1	2.763	.096	.757
Covariate CAT**	2604.365	1	2604.365	90.312	.001
Explained Variance	4300.919	14	307.208	10.653	.001
Residual Variance	4873.516	169	28.837		
TOTAL	9174.435	183	50.134		

\*The Livestock Feeding Student Reference Unit.

\*\*Reading ability level as measured by the California Achievement Test in grade equivalents.

The data presented in Tables 10 and 11 provide further credence to one of the findings of phase I of this study. There is a significant relationship between a student's reading ability and his/her achievement on a paper-pencil cognitive examination as used in vocational agriculture programs in Arizona.

### PHASE III - EFFECT OF ALTERED FORMAT STYLE UPON STUDENT PREFERENCE

Since the results of both phase I and II of this study revealed no significant change in student posttest scores as a result of the modification of SRU's by lowering their readability, a third phase was designed to assess the effect of altered format style upon student preference of student reference units. As mentioned earlier, three different format styles were developed for the Plant Diseases SRU in which size of print (type), number of columns per page and outline symbols were altered. These three format styles were referred to as Sample A, B, or C. These three styles were used with 248 freshmen and sophomore vocational agriculture students.

The 248 students involved in this phase of the study were administered the California Achievement Test, level 18, Form D to ascertain their relative reading ability. Based upon CAT scale scores, the students were grouped into low, medium and high reading ability levels. Table 12

summarizes the data concerning participating students' reading ability grade equivalent level scores.

TABLE 12. Reading Ability Scores of Sampled Arizona 9th and 10th Grade Vocational Agriculture Students as Grouped into Low, Medium and High Reading Ability Level Subgroups (n = 248).

California Achievement Test Grade Equivalent Score	Number of Students	Percent of Students
Low (less than 9.0)*	62	25
Medium (9.0 to 10.9)**	57	23
High (greater than 10.9)***	129	52

\*less than freshman level

\*\*freshman through sophomore level

\*\*\*greater than sophomore level

It is interesting to note that three-fourths of the Arizona 9th and 10th grade vocational agriculture students who participated in this study read at or above grade level. Over one-half read above grade level. This finding is consistent with the findings of phase I.

Table 13 shows students' survey responses concerning their type size and column width preference for the Plant Diseases SRU.

TABLE 13. Number and Percentage of 9th and 10th Grade Vocational Agriculture Students' Preference for Type size and Column Width for the Plant Diseases SRU (n = 248).

Type Size/Column Format Preferred	Number of Students	Percent of Students
Pica/Single (Sample A)	131	52.8
Elite/Single (Sample B)	56	22.6
Elite/Double (Sample C)	61	24.6
TOTAL	248	100.0

Over one-half (52.8%) of the surveyed students preferred the pica (large) type and single column format. Elite type with two columns per page was preferred by nearly 25 percent of the students, while elite type with single column was the choice of almost 23 percent. There was a 2:1:1 preference ratio between the three format styles. It is interesting to point out that the pica/single column format is the same format presently used for all SRU productions developed in the Department of Agricultural Education at the University of Arizona. Thus, students' preference as found in this phase of the study could be due to "conditioning".

Would the reading ability of students affect their preference of format style? To answer this question, a comparison was made between low, medium and high reading ability student groups. The type size and column width (number of columns per page) preference of sampled students of varying reading ability levels for the Plant Diseases SRU by percent is shown in Table 14.

TABLE 14. Percentage of 9th and 10th Grade Vocational Agriculture Students of Varying Reading Ability Levels Preference for Type Size and Column Width for the Plant Diseases SRU (n = 248).

Type Size/Column Format Preferred	Reading Ability Level (Grade Equivalent)		
	Low (less than 9.0)	Medium (9.0 - 10.9)	High (greater than 10.9)
Pica/Single (Sample A)	48.8%	52.6%	55.8%
Elite/Double (Sample B)	27.4%	22.8%	24.0%
Elite/Single (Sample C)	25.8%	24.6%	20.2%
TOTAL	100.0%	100.0%	100.0%

The percentage preference of the pica, single column format for low, medium and high reading level groups of students was 48.8, 52.6 and 55.8, respectively. The high reading ability group preferred the pica, single column format at the highest percent level, while this group preferred the elite, single column format the least (20.2%).

Based upon the data in Table 14, it is apparent that students of the three reading ability level groups did not differ appreciably among themselves as to their type size and column width preference for the Plant Diseases SRU. All groups tended to hold to the overall 2:1:1 ratio of preference for the pica.

A third alteration in format style pertained to the use or non use of outline symbols along page margins to help indicate topic arrangement. Table 15 shows student preference by percentage as to the use or non use of outline symbols.

TABLE 15. Percentage of 9th and 10th Grade Vocational Agriculture Students' Preferences for the Use or Non Use of Outline Symbols Along Page Margins (n = 248).

Use of Outline Symbols Preferred	Format (type size/columns per page)		
	Pica/Single	Elite/Double	Elite/Single
Yes	67.2%	70.6%	67.7%
No	32.8%	29.4%	33.3%
TOTAL	100.0%	100.0%	100.0%

Students' preference for the use of outline symbols was 67.2 percent for the pica, single column; 70.6 percent for the elite, double column; and 67.7 percent for the elite, single column format styles. It is evident that over two of every three students surveyed in this study preferred the use of outline symbols in page margins to help indicate topic arrangement. This 2:1 preference/non preference ratio held approximately constant for all three format styles assessed.

Based upon data presented in Tables 14 and 15, those 9th and 10th grade vocational agriculture students who participated preferred student reference units prepared using pica type and one column per page with outline symbols along page margins.

#### PHASE IV - EFFECT OF ALTERED FORMAT STYLE UPON STUDENTS' READING SPEED AND COMPREHENSION

Student preference is an important consideration in developing instructional materials; however, the ability of these prepared instructional materials to affect change in student understanding is probably more important. If it were possible to design instructional materials which were preferred by students and at the same time resulted in the greatest amount of knowledge acquisition, the value and effectiveness of these materials would be enhanced.

Phase IV of this study was designed to determine if a timed reading speed and comprehension test would reveal a statistically significant difference in readability for any of the three format styles tested. Table 16 summarizes the data collected to make this determination.

TABLE 16. Mean Reading Speed and Comprehension Scores of Students Using the Three Sample Units, Unadjusted for Reading Ability Levels of Students Within Each Assigned Unit (n = 66 Pica/Single, n = 70 Elite/Single, n = 110 Elite/Double)

Mean Score	Unit		
	Pica/Single	Elite/Single	Elite/Double
Speed*	492	472	467
Comprehension**	.55	.48	.53

\* number of words read during the three minute reading period

\*\* percentage of correct responses on a paper and pencil comprehension test following the three minute reading period, adjusted for how far each student read

It should be noted that when data were analyzed relative to reading speed and comprehension scores, two cases were missing.

Students randomly assigned the sample Plant Diseases SRU using the pica, single column format style read more words in a timed three minute reading test than did those students using the other two format styles. It is interesting to note that those students using the elite, single column format read slightly more words than did those reading the elite, double column format.

Although there was only slight differences in percentages of correct responses on the "Reading Comprehension Test", those students reading from the pica, single column format style performed better than the other two groups.

In order to determine if there was a statistically significant difference on reading speed and test scores due to format style, analyses of covariance were conducted. Table 17 shows the analysis of covariance pertaining to students' reading speeds.

TABLE 17. Analysis of Covariance of Selected Arizona 9th and 10th Grade Vocational Agriculture Students' Reading Speeds Using Reference Units Having Three Selected Format Styles (n = 246).

	Sum of Squares	df	Mean Square	F	Significance of F
Main Effects Unit*	17203.625	2	8601.813	.408	.666
Covariate CAT**	407313.588	1	407313.588	19.307	.001
Explained Variance	424517.213	3	141505.738	6.708	.001
Residual Variance	5126476.666	243	21096.612		
TOTAL	5550993.879	246	22565.016		

\* The three sample format units: Pica/single column, Elite/double column and Elite/single column

\*\* Reading ability level as measured by the California Achievement Test in grade equivalents

The reading speeds of students participating in this study using the Plant Diseases SRU were not affected in a statistically significant manner by altering the unit's format style. This is indicated because the F-value for variation in students' reading speeds due to use of the three sample SRU formats was statistically significant at only the .666 alpha level.

The use of students' CAT grade equivalent reading ability scores as a moderator variable and covariate revealed that variation in students' reading speeds through the three sample units due to reading ability was statistically significant at the .001 level of confidence. This finding is consistent with the findings of earlier phases of this study.

The analysis of covariance addressing students' scores on comprehension of reference units having three selected format styles is summarized in Table 18.

TABLE 18. Analysis of Covariance of Selected Arizona 9th and 10th Grade Vocational Agriculture Students' Comprehension Scores Using Reference Units Having Three Selected Format Styles (n = 246).

	Sum of Squares	df	Mean Square	F	Significance of F
Main Effects Unit*	.190	2	.095	1.489	.228
Covariate CAT**	3.097	1	3.097	45.435	.001
Explained Variance	3.288	3	1.096	17.137	.001
Residual Variance	15.476	242	.064		
TOTAL	18.764	245	.077		

\* The three sample format units: Pica/single column, Elite/double column and Elite/single column

\*\* Reading ability level as measured by the California Achievement Test in grade equivalents

The F-value for variation in students' reading comprehension scores due to the use of sample formats was 1.489 which had a significance of .228. Students' reading comprehension scores of the same units as measured by a paper-pencil test were, like reading speed scores, not affected in a statistically significant way by altering the format style of the Plant Diseases SRU in the three selected ways.

Although students showed a strong preference for the pica, single column format in phase III of this study and had slightly higher comprehension scores, all three sample SRU format styles tested proved to have more or less equal comprehensibility.

It was the individual student's reading ability which made the difference regarding students' reading comprehension. It should be pointed out that in all four completed phases of this study reading ability was statistically related to student performance on a cognitive examination.

#### PHASE V - EFFECT OF READABILITY OF INSTRUCTIONAL MATERIALS ON CLASSROOMS WITH NO FORMAL INSTRUCTION

Phase I-IV of this study revealed that the alteration of student reference units by lowering readability; by controlling teachers' teaching

ability; by changing size of type; by using single or double column format; and by using outline symbols along page margins made no statistically significant difference in student knowledge of selected agricultural subject matter as measured by a cognitive examination. Does the problem solving, interactive method of teaching utilized by Arizona teachers of vocational agriculture make a difference in posttest scores? In order to answer this question, phase V of the study was conducted to assess the influence of the readability of written instructional units on classrooms where teachers' influence in the form of formal instruction was controlled by eliminating the teacher from the educational environment.

As with the other phases of this longitudinal study, it was important that reading indices be determined for those students participating in this phase. Table 19 shows the values of selected reading indices of treatment and control groups for the Soils SRU.

TABLE 19. Values of Reading Indices of Student Participants in Treatment and Control Groups for the Soils SRU (n = 222).

Reading Index	Soils SRU	
	Treatment (n = 125)	Control (n = 97)
Scale Score (Mean)	566.520	597.267
Scale Score (Range)	391-742	457-787
Percentile Rank	50	64
Grade Equivalent	9.2	10.7

Students in the treatment group had a mean scale score of 566.52, while those students in the control group read on the average at a higher level (597.267). Students in the treatment and control groups had a percentile rank of 50 and 64, respectively. Treatment group students read at the grade level of 9.2, while those in the control group had 10.7 grade reading level.

Relative to student performance, Table 20 compares the posttest mean correct responses of treatment and control groups for the Soils SRU.



TABLE 20. Comparison of Posttest Mean Correct Responses in Treatment and Control Groups for the Soils SRU (n = 214)\*.

Group/Value	Mean Correct Responses
Treatment (Mean)	17.562
Control (Mean)	18.830
Difference	-1.268
Percent Difference	-3.17

\*Eight sets of data were illegible and were treated as missing data.

Students in the control group performed somewhat higher on the paper-pencil test than did those students using the lower reading level reference (treatment group). Based upon results evolving from the earlier phases of this study, this could be expected since those students in the control group had a higher reading ability percentile rank (Table 19). However, there was only a 3.17 percent difference in understanding of soils among students in the two groups.

Table 21 reveals the comparison of posttest mean scores, standard deviation and standard error between treatment and control groups for the Soils SRU.

TABLE 21. Comparison of Posttest Mean Scores, Standard Deviation and Standard Error in Treatment and Control Groups for Soils SRU (n = 214)

Value	Soils SRU	
	Treatment (121 Students) n = 10	Control (93 Students) n = 9
Posttest Mean Scores	17.562	18.828
Standard Deviation	5.660	5.812
Standard Error	.515	.603
t*		-.48

\*t  $\geq$  2.110 indicates significance at the .05 alpha level with 17 df.

It should be noted that the computed t-value of -.48 was not statistically significant at the .05 alpha level. Although students in the control group (higher readability reference) did perform better on the cognitive

examination than did those students in the treatment group, it was apparently due to their higher reading ability and not because of alterations in the student reference unit. Thus, controlling for the teacher's influence on the teaching-learning process by eliminating the teacher from the educational environment had little or no significant impact upon student performance as measured by a multiple choice paper-pencil posttest. Students utilizing both high and low readability (reading level) Soils SRU's absorbed basically the same amount of understanding of this agricultural subject matter area.

From data presented in Table 22, it can be noted that the covariate (reading index) had an F-value of 138.438 which indicates a significance at the .001 alpha level; thus, the difference in student performance on the cognitive examination for the Soils SRU was due, again, to the individual student's reading ability and is not likely due to the alteration of the Soils student reference unit.

TABLE 22. Analysis of Covariance of Posttest Scores on Soils SRU (n = 214).

Source	df	SS	F	p
Treatment	1	20.611	1.034	.311
Covariate (Reading Index)	1	2760.455	138.438	.001
Error	201	4007.932		
TOTAL	203	6835.510		

In summary, the results of this phase of the study reveal that when teachers' influence is controlled, the reading level of the student reference units had no statistical impact upon student understanding of Soils as measured by posttest scores.

PHASE VI -- EFFECT OF LOW READING LEVEL STUDENT REFERENCE UNIT WITH OR WITHOUT ILLUSTRATIONS (GRAPHICS)

The effect of altering student reference units by lowering their readability; by matching students' reading ability with readability of instructional materials; by controlling for teachers' teaching ability; by changing format styles; and by controlling for formal instruction resulted in no statistical difference upon student performance on a cognitive examination. The final phase of this longitudinal study was designed to determine the effect of altered graphics in the form of illustrations upon

student understanding of the Plant Diseases SRU written at a grade level of 8.6.

As pointed out under METHODS AND PROCEDURES of this bulletin, CAT scores were not determined for students participating in this final phase. Based upon the findings of the previous phases of this research, controlling students' reading ability had revealed no statistically significant impact upon any of the independent variables tested.

A comparison of posttest mean correct responses for treatment and control groups for the Plant Diseases SRU is found in Table 23.

TABLE 23. Comparison of Posttest Mean Correct Responses for Treatment and Control Groups for the Plant Diseases SRU (n = 148).

<u>Group/Value</u>	<u>Mean Correct Responses</u>
Treatment (Mean)	27.11
Control (Mean)	27.21
- - - - -	- - - - -
Difference	-.10
Percent Difference	-.00167

There was a -.00167 percent difference in understanding of plant diseases among students in the treatment group classrooms which utilized Plant Diseases SRU's with illustrations as compared to those students in control group classrooms. Based upon data presented in Table 23, it appears the use of altered graphics (illustrations) has little or no impact upon student performance on the multiple choice examination.

Students in the control group performed only slightly higher on the posttest than did those students blocked in control group classrooms.

Although the posttest mean correct responses between treatment and control groups showed the lowest net percent difference of any of the independent variables tested in this study, it should be noted that the criterion-referenced evaluative instrument used had only a test reliability coefficient of .74. McCormick and Cox (1988) noted the predetermined criterion of acceptable reliability for CREI as follows:

.50 - .59	Low
.60 - .69	Medium
.70 - .79	High
.80 - Above	Extremely High

Since the desired test reliability should be greater than .8, the instrument used in this phase did not possess as high a reliability coefficient as other CREI's used throughout this study. No attempt was made to determine if a CREI with a test reliability of .74 would influence the results.

However, it should be pointed out that the Plant Diseases CREI had a difficulty of 54.74%. With this difficulty, it was the most difficult CREI used in the study. Due to its difficulty, the correct mean correct responses of both treatment and control groups could be lower for this phase than for others included in this study.

Table 24 reveals the comparison of posttest mean scores, standard deviation and standard error in treatment and control groups for the Plant Diseases SRU.

TABLE 24. Comparison of Posttest Mean Scores, Standard Deviation and Standard Error in Treatment and Control Groups for Plant Diseases SRU (n = 148).

Value	Treatment (81 Students) n = 5	Control (67 Students) n = 5
Posttest Mean Scores	27.11	27.21
Standard Deviation	7.07	6.95
Standard Error	.786	.849
t*	-.0226	

\*t ≥ 2.306 indicates significance at the .05 alpha level with 8 df.

It should be pointed out that a computed t-value of -.0226 was not statistically significant at the .05 alpha level. Thus, the independent variable of adding two to three illustrations per printed page to demonstrate visually the concept or principle being presented made no statistical difference upon student understanding of plant diseases as measured by a paper and pencil cognitive test. Students utilizing Plant Diseases SRU's with illustrations and those using SRU's without illustrations derived basically the same amount of understanding of plant diseases.

As with the other independent variables tested throughout this multi-phased study, the use of graphics in the form of illustrations had little or no impact upon student performance on a cognitive test; thus it can be inferred this alteration, likewise, made no statistical difference upon students' understanding of plant diseases as measured by posttest assessment.

## SUMMARY AND DISCUSSION

Altering instructional materials by lowering their readability, by matching students' reading ability with readability of instructional materials, by controlling for teachers' teaching ability, by changing format style, by controlling for formal instruction (student-teacher interaction), or by using graphics in the form of illustrations to accommodate students with varying reading abilities did not result in significant difference in student understanding of selected agricultural subject matter.

There was a positive correlation (significant relationship) between individual student's reading ability and his/her performance on the posttests. Students possessing higher reading abilities performed better (higher scores) on the posttests than did those students with lower reading abilities.

In the aggregate, vocational agriculture students in Arizona who participated in this study were reading at grade level or above. Students enrolling in vocational agriculture in Arizona possessed reading abilities comparable to the national average.

Controlling the relative effectiveness of a teacher's teaching ability had little or no impact upon student performance on posttests.

Vocational agriculture students preferred instructional materials prepared utilizing pica (large) type and single column format with outline symbols. This style was the preference of low, medium and high reading ability level groups of students. Student performance (words read and higher score) was slightly better when the pica, single column format was used.

Controlling for the teacher's influence on the teaching-learning process had little or no impact upon student performance on posttests. Nor did the use of illustrations affect students' understanding.

Evidence generated from the six phases of this study reveal that the "original" student reference units developed for The Two Year Core Curriculum for Vocational Agriculture in Arizona are satisfactory for use by students enrolled in 9th and 10th grade classes of vocational agriculture. Vocational agriculture students in Arizona can effectively utilize instructional materials written at reading levels (grades) higher than their chronological age.

## RECOMMENDATIONS

Based upon the results and conclusions of this study, the following recommendations for further research are made. It is recommended that:

1. A study be conducted which analyzes the efficacy of the various measures of readability.
2. A study be designed and conducted to assess the relationship between students' reading ability and the California Achievement Test (CAT).

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