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TEN YEAR ASSESSMENT
OF INSTRUCTIONAL UNITS FOR
TEACHING PROFIT MAXIMIZING
PRINCIPLES INDUCTIVELY

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INTRODUCTION

Teachers have always been concerned whether they are teaching students what they should. Of more consequence, they are concerned with the relative degree of change in student behavior taking place in their classrooms and laboratories. The question foremost in the minds of teachers is whether students are gaining the knowledge and skill in the particular discipline they are presumably trying to instill.

Accountability of educational endeavors is in vogue. The many publics of our society are questioning the merits of today's educational programs, especially at the secondary level (1). The recent decline in students' test performance in basic communication and math skills is causing taxpayers to ask some rather pertinent questions regarding the worth and effectiveness of public school education. In too many instances, the need to establish some degree of accountability or to assess the relative effects of the teacher's endeavors upon the students' behavior has been considered a threat to the teacher. This need not be the case. Teachers, as professionals, have the responsibility to determine whether the subject matter covered in their instructional programs is beneficial to students in developing them into productive, useful citizens.

Teaching-learning effectiveness can be measured, in part, by assessing students' acquisition of knowledge after they have received instruction in a particular discipline. Assessment of student performance is a vital part of the teaching-learning process. It should serve both the student and the teacher. Evaluation should provide an indication of progress for the student and, at the same time, provide a method of measuring teaching effectiveness for the teacher.

Instructional programs in vocational education in agriculture are changing due to: (a) increased enrollment of a more heterogeneous group of students; (b) rapidly changing technology in all facets of agriculture; and (c) expanded employment opportunities in the non-farm agri-business sector. This creates a significant problem for program planners relative to *how to teach, what to teach, when to teach it and how long to spend on it*. Sound curriculum planning then becomes even more important as agricultural educators attempt to serve stu-

dents who have diversified needs, interests and occupational goals in agriculture.

It is obvious that in the future greater emphasis must be placed upon the teaching of principles of agricultural science and their ultimate application to the world of work in agriculture (2). It is no longer educationally sound to teach only the specific facts related to agribusiness and renewable natural resources without blending in the "why" with the "know how" aspects of agricultural science. The ultimate goal of any educational endeavor is the acquisition of knowledge and understanding along with the application of this knowledge to actual situations and problems.

The *Principles Approach* of curriculum development in tandem with the *Inductive Mode of Teaching* lends itself to instruction directed towards the development of understanding and the ability to make appropriate and practical application of acquired knowledge.

The *Inductive Mode of Teaching* is designed to assist students discover the "why" by developing understanding of a principle through the use of situations and problems. Inductive teaching leads the student from simple, concrete situations to complex generalizations. This evolves from the "association of commonalities" of a number of examples to the discovery of the principle itself.

In the 1960's, considerable research was conducted on the *Principles Approach* of curriculum development. The practicality of utilizing this approach to teach biological principles in agriculture was explored in California (3) and Ohio (4). It was found in Nebraska (5) that students' achievement when taught by the Principles Approach was greater than students taught using traditional curriculum patterns. Work completed in Ohio (6) revealed the value of the inductive mode of teaching to enhance student understanding of basic economic principles. The effectiveness of a teacher reference utilizing the Principles Approach and Inductive Mode of Teaching was researched by Zurbrick (7). It was found that student understanding of marketing principles was enhanced to a statistically significant degree when compared to the traditional teaching technique. McCormick (8) found in an Arizona study that there was greater than a 51%

increase in student understanding of agricultural marketing principles when prepared instructional units employing the Principles Approach and the Inductive Mode of Teaching were used in instructional programs in Arizona high schools.

Since the early 1970's, the only research thrust that the author could locate, generated to evaluate the effectiveness of prepared instructional units designed to teach agricultural science principles was in Arizona. As is the case with most innovative educational materials, once they have been developed and in some cases evaluated, they gather dust in libraries. In addition to this type of "innovation backlash," an assessment of instructional methods and materials on teaching-learning effectiveness is usually undertaken on a one time, one population basis. It was felt by the researcher that a continuous, long-range study of the effectiveness of prepared instructional units designed to teach inductively principles of agricultural science would add credence, over time, to a comprehensive assessment of these instructional materials. At the same time, the materials would be kept in front of the teachers. It has been recognized for a long time that utilization of materials (by teachers) is much more difficult to achieve than production of materials (9).

The ultimate intent of this research project was to improve the quality of instructional programs in vocational agriculture in Arizona by providing teachers with prepared instructional materials of known quality.

PURPOSE OF THE STUDY

The primary purpose of this study was (a) to develop instructional resource units, to serve as a teacher reference for teaching profit maximizing principles, employing the Principles Approach and utilizing the inductive mode, and (b) to assess the effectiveness of these units by measuring the relative change in students' understanding of the principles resulting from the utilization of the prepared units in instructional programs in vocational agriculture in Arizona.

As the research endeavor progressed, an additional purpose evolved; that being, to validate a criterion-referenced evaluative instrument on Profit Maximizing Principles. "Criterion-referenced," as used in this publication, connotes that each individual test item is referenced to a specific objective contained in the instructional units; not to acceptable performance levels.

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

1. Will there be a significant change in students' understanding of profit maximizing principles, based upon pretest and posttest scores, after having received instruction using the prepared resource units?
2. Are there differences in students' understanding of specific profit maximizing principles based upon test score information?

3. Does in-service training received by teachers in the use of the inductive mode of teaching and resource unit exposure have a positive influence upon students' understanding of profit maximizing principles as measured by mean score difference in pretest and posttest performance of students?
4. Does the academic quarter in the school year when instruction was given affect students' understanding of profit maximizing principles as evidenced by test score analysis?

In order to achieve the ultimate intent of this study, a multi-phased plan was designed since both developmental and evaluative dimensions were involved.

Phase I — Development of Instructional Units

Phase II — Selection of Multiple Choice Examination

Phase III — Evaluation of Units Through Field Testing

Phase IV — Validation of Criterion-Referenced Evaluative Instrument

DEVELOPMENT OF INSTRUCTIONAL UNITS

The seven profit maximizing principles synthesized by the researcher in 1964 (10) were used for the development of the instructional units. The following working definitions for these principles were developed to serve as a basis for content included in the respective instructional units.

I. DIMINISHING PHYSICAL RETURNS:

The application of additional units of variable resources to a unit of fixed resource increases total output but, after a certain point, the amount added to total output by each successive unit of variable resource diminishes.

II. DIMINISHING ECONOMIC RETURNS:

After a certain point, the economic returns for each successive unit of variable resource added to a unit of fixed resource tends to decline. However, the farm manager, in order to secure maximum profits, should continue adding variable resources to fixed resources as long as marginal returns are greater than marginal costs.

III. FIXED-VARIABLE COSTS:

The cost per unit of production can be decreased by spreading fixed costs over more units of production. Therefore, a manager should continue using more resources, if capital is available, to increase production as long as variable costs are covered by the marginal returns.

IV. SUBSTITUTION:

When two or more types of resource inputs can be used to produce a given amount of output, the value of the resource replaced or displaced by another resource should be greater than the value of the resource added if the farm manager is to secure maximum profits.

V. OPPORTUNITY COSTS:

The profit of a farm business will be greatest if each unit of land, labor, and capital is used where it will add the greatest marginal returns to the farm business; thus, the farm manager cannot change the distribution of a single unit of variable resource input without reducing farm income.

VI. COMBINATION OF ENTERPRISES:

The best combination of enterprises is where a farm business is so organized that the farm manager cannot add to or expand the size of one enterprise or delete or contract another enterprise without reducing income of the farm business.

VII. TIME RELATIONSHIPS (TIME COMPARISON):

Before investing limited capital resources in the farm business, the farm manager should determine the present value of future income in order to make comparisons between alternatives over time; that is, determine the economic feasibility of making capital investments in the present to obtain income in the future.

Utilizing the working definitions developed, seven units of instruction were designed employing the inductive mode of teaching. The unit titles were as follows:

- I. Principle of Diminishing Physical Returns
- II. Principle of Diminishing Economic Returns
- III. Principle of Fixed-Variable Costs
- IV. Principle of Substitution
- V. Principle of Opportunity Costs
- VI. Principle of Combination of Enterprises
- VII. Principle of Time Comparison

In the development of the seven units, every effort was made to adapt the technical information dealing with each principle (a) to the level of high school students' comprehension and (b) to strengthen instruction in decision-making by developing understanding of the principles on the part of the students.

Each instructional unit contained the following seven components:

1. Unit Title
2. Unit Objectives
3. Introduction
4. Teaching-Learning Activities
5. Association of Examples
6. Arriving at the Principle
7. Student Activities

Pilot Testing

The instructional units were pilot tested in two high school departments of vocational agriculture in Arizona during the 1967–68 school year. The primary purpose for pilot testing was (a) to evaluate the general level of student acceptance of the approach and (b) to assess the degree of difficulty of the subject matter content. The results of the pilot testing revealed satisfactory respon-

siveness and acceptance by both the students and the teachers regarding content of the units and the method of instruction utilized.

Teachers in the pilot testing program suggested that transparency masters be developed for each example contained in the units. It was their opinion that these visual aids would increase the overall effectiveness of the prepared units and also reduce the amount of time required by teachers to teach the material. In addition, minor revisions were made in the instructional units.

The revised instructional units on Profit Maximizing Principles (11), including a set of 40 transparency masters, were published and disseminated to all teachers of vocational agriculture in Arizona in June 1968. This completed Phase I of the research project.

Revision of Units

In the development of instructional units of this nature, it was necessary to use current facts and figures if the examples were to be realistic and meaningful to students. The prices paid for inputs and value received for outputs in agricultural production have inflated drastically in the past decade. Therefore, the prices and values used in the 1968 edition of the instructional units became outdated in a few years.

The second edition of the seven instructional units on Profit Maximizing Principles (12) was printed in May 1975. This edition updated the figures in the examples used to illustrate the principles. The seven principles were not altered in any way and thus were exactly the same as those found in the original edition. However, an effort was made to further clarify some of the examples to assist teachers to better utilize the materials.

In-Service Workshops

Intensive 1-week workshops have been conducted for Arizona teachers each June since 1969 using prepared instructional units pertaining to profit maximizing and agricultural marketing principles (13). These in-service activities were designed primarily to prepare new, inexperienced teachers of vocational agriculture for teaching basic principles of agricultural science utilizing units of instruction based upon the inductive teaching mode.

Beginning in June 1976, instructional units on animal nutrition principles (14) have also been included in the basic principles seminar.

Teachers participating in these workshops were exposed to the subject matter content included in the units and, also, had an opportunity to gain actual experience in a classroom setting in the use of the inductive mode of teaching. Selected techniques, procedures and teaching devices were discussed and demonstrated throughout these workshops by the staff members in charge. In addition, instructional units, transparency masters and other teaching tools were provided each participant. For analysis purposes, those teachers who participated in one of these workshops were designated as "trained" teachers.

METHODS AND PROCEDURES

The evaluation phase of this research was designed to be of a continuous, long-range duration (10 years). It was initially anticipated that this time span would be required in order to secure a population of sufficient magnitude and diversity. This would allow the relative effect of the prepared instructional units on change in student understanding of basic agricultural science principles to be statistically evaluated.

Departments of vocational agriculture in Arizona served as pilot schools to test the effectiveness of the prepared instructional units. During the 10 years of field testing (1968–69 school year through 1977–78 school year), 59 classroom units involving 684 students participated in the study.

The "One-Group, Pretest-Posttest Design" (15) was employed for statistical interpretation of data collected during the field testing phase of the project. In using this design, the dependent variable (student understanding) was measured before and after the independent variable (instruction) was applied and the amount of change in the dependent variable computed.

The design has many inherent weaknesses. It is recognized that history, maturation, pretesting and statistical regression may be partially responsible for change in student understanding. Since this was a quasi-experimental study, it was felt by the researcher that the model was acceptable to achieve the objectives of the study.

The evaluative instrument used in the field testing program was designed by the researcher (10) in 1964 but never validated. The same instrument was used as both the pretest and posttest in this study. It consisted of 45 multiple choice questions designed to measure student understanding, in whole or in part, of the principles. Each test item was referenced to a specific principle as displayed in table 1.

Principle	Test Item Number Referenced to a Specific Principle
Diminishing Physical Returns	1, 18, 23, 32, 34, 41
Diminishing Economic Returns	2, 7, 24, 35, 36, 42
Fixed-Variable Costs	4, 9, 14, 19, 29, 33, 44
Substitution	3, 8, 13, 25, 28, 37, 43
Opportunity Costs	5, 10, 15, 20, 26, 39, 45
Combination of Enterprises	6, 11, 16, 21, 27, 30
Time Relationships	12, 17, 22, 31, 33, 40

In assembling the evaluative instrument for field testing purposes, neither test items nor pages were numbered. The order of collating the individual pages was varied to provide a means for retaining the discriminatory power of each question.

Pretest and posttest scores from 684 high school students enrolled in vocational agriculture programs in Arizona between the 1968–69 and 1977–78 school years were manually graded and recorded on master coding sheets. Only test scores from students taking both the pre- and posttest were utilized. Thus, the threat to internal validity created by mortality was eliminated. Responses to individual test items were entered on IBM cards and data analyzed at the Computer Center, University of Arizona.

Data on the quarter of the academic year units were taught and whether the teacher was "trained" or "untrained" were identified for each student participating in the study and were used as moderator variables.

The differences in pretest and posttest scores (number of correct responses) were used to determine the relative change in students' understanding of profit maximizing principles, overall and specific. A comparison was made between mean score difference in pretest and posttest performance of students to determine the influence of (a) in-service training received by teachers in the use of the inductive mode of teaching and resource unit exposure, and (b) the academic quarter during the school year in which instruction was given on students' understanding of the principles.

An item analysis was computed for each test item contained in the evaluative instrument to determine (a) the percent of students in the population correctly answering each question; (b) discrimination index; and (c) the percent of the upper 27% and the lower 27% of the students answering each item correctly. In addition, test reliability and difficulty factor were calculated for the overall evaluative instrument.

ANALYSIS OF DATA

The overriding intent of this study was to determine the amount of knowledge students would acquire by being taught the principles of agricultural science using the inductive mode and prepared instructional units. To assess the relative effectiveness of prepared units on profit maximizing principles, a measurement of students' understanding before and after exposure was utilized. The major concern was to determine whether there would be a statistically significant change in students' understanding from mean correct pretest scores to mean correct posttest scores. It was also desirous to evaluate the impact of in-service training of the teachers and the academic quarter of the school year in which the units were taught based upon relative change in student understanding of profit maximizing principles. Finally, the validation of a Criterion-Referenced Evaluation Instrument on Profit Maximizing Principles was made possible from the data collected.

Change in Student Understanding

To assess the effectiveness of prepared instructional units designed to teach inductively profit maximizing principles, the relative change in student understanding was calculated. A comparison of mean correct responses

between the pretest and posttest by principles and overall scores is shown in table 2.

The overall mean correct responses for the students on the pretest and posttest were 18.7675 and 23.9080, respectively. This resulted in a percentage correct response of 41.7 on the pretest and 53.1 on the posttest. Overall, this represents a 27.39% increase in understanding of profit maximizing principles by the 684 students involved in the instructional program. With a computed t-value of 21.61, this increase was statistically significant at the .001 level of confidence. Therefore, the first question cited under purpose of the study that "there will be a significant change in students' understanding of profit maximizing principles after having received instruction using the prepared resource units" must be answered in the affirmative since a statistically significant increase in understanding was achieved.

sis of data collected between 1968 and 1972 was made to check for significant differences between pre- and posttest scores. It was found that the mean correct responses for the students tested to that time was 18.657 on the pretest and 23.706 on the posttest. This represented a 27.0% increase in understanding of profit maximizing principles. It is also interesting to note that there was an increase in mean correct responses between pre- and posttest performance of students tested for each principle. The increase in test scores for each principle ranged from a low of .518 correct responses for "time comparison" to a high of .890 for "diminishing economic returns.

Now that a comparison can be made between test score information at the end of 5 years and again at the end of 10 years, it is interesting to note the degree of consistency existing in pretest and posttest performance

Table 2. Comparison of mean correct responses between the pretest and posttest by principle and overall scores (N = 684).

Principle	Mean Correct Responses			Percent Change	t*
	Pretest	Posttest	Difference		
Diminishing Physical Returns	2.9444	3.7135	.7691	+26.12%	12.05
Diminishing Economic Returns	2.3553	3.1901	.8348	+35.44%	13.49
Fixed-Variable Costs	2.8202	3.5556	.7354	+26.08%	10.81
Substitution	2.8289	3.7193	.8904	+31.47%	13.21
Opportunity Costs	2.5994	3.4474	.8480	+32.62%	12.80
Combination of Enterprises	2.3845	2.9561	.5716	+23.97%	9.24
Time Relationships (Time Comparisons)	2.8348	3.3260	.4912	+17.33%	8.15
Overall Score (Combined Principles)	18.7675	23.9080	5.1405	+27.39%	21.61

*t = 1.645 at .10 level of confidence
 = 1.960 at .05
 = 2.576 at .01
 = 3.291 at .001
 df = 683

It was also found that there was an increase in students' understanding of each of the seven principles under study. The range in percent change was +17.33 to +35.44. The greatest increase in understanding was for the "principle of diminishing economic returns" while the least percent increase was associated with the "time relationships principle." Computed statistical test values indicated that there was a statistically significant increase in understanding at the .001 level for each of the seven profit maximizing principles as revealed by t-values ranging from 8.15 to 13.49. Thus, question #2 which states "there will be differences in students' understanding of specific profit maximizing principles based upon test score information," must also be answered in the affirmative since students' change in understanding of specific principles did differ in percentage increase.

As previously mentioned, this study was designed to be of a continuous, long-range nature—10 years in duration. At the end of the 5th year of field testing, an analy-

sis of students. This provides substantial evidence of the reliability, over time, of the prepared instructional units to assist students acquire knowledge of profit maximizing principles. In addition, the measurement capacity of the evaluative instrument was reinforced.

Influence of In-Service Workshops

One of the moderator variables investigated in this study dealt with the influence of in-service training received by teachers in the use of the inductive mode of teaching and resource unit exposure on student understanding of profit maximizing principles. For analysis purposes, those teachers who participated in one of the intensive, previously described 1-week workshops were designated as "trained" teachers. "Untrained" teachers were those who participated in the study but had not attended a basic principles workshop. A comparison of mean score differences in pretest and posttest performance of students taught by "untrained" and "trained" teachers is found in table 3.

Table 3. Comparison of mean score difference in pretest and posttest performance of students by specific and combined principles between untrained and trained teachers (N = 684).

Principle	Mean Score Difference—Pretest to Posttest		Difference	t*
	Students of Untrained Teachers (N = 481)	Students of Trained Teachers (N = 203)		
Diminishing Physical Returns	.7792	.7165	-.0627	.44
Diminishing Economic Returns	.7492	.9948	+.2456	1.78
Fixed-Variable Costs	.5732	1.0619	+.4887	3.24
Substitution	.8344	.9742	+.1398	.93
Opportunity Costs	.8408	.8247	-.0161	.11
Combination of Enterprises	.5265	.6649	+.1384	1.00
Time Relationships (Time Comp.)	.4841	.5361	+.0520	.39
Overall (Combined Principles)	4.7877	5.7732	+.9855	1.85

*t = 1.645 at .10 level of confidence
 = 1.960 at .05
 = 2.576 at .01
 = 3.291 at .001
 df = 682

The 203 students of teachers receiving training had a higher score differential for the overall principles than the 481 students taught by "untrained" teachers. The overall mean score difference for students of "untrained" and "trained" teachers was 4.7877 and 5.7732, respectively. Thus, students taught profit maximizing principles by "trained" teachers performed better than those taught by "untrained" teachers. The difference was statistically significant at the .10 level based upon a computed t-value of 1.85. It is interesting to point out that there was a 20.6% increase in the performance of students taught by "trained" teachers over those students taught by "untrained" teachers.

It should be noted that students taught by "trained" teachers performed at a lower level for the "diminishing physical returns" and "opportunity costs principles" than students taught by "untrained" teachers; however, not at a statistically significant level of confidence.

One of the contributing factors which might affect the differences in mean scores from the pretest to posttest was the fact that a majority of the teachers designated as "trained" were recent college graduates with a minimum of teaching experience.

The effect of in-service training received by teachers did produce a positive influence upon students' understanding of profit maximizing principles at a statistically significant level. Therefore, question 3 pertaining to the effect of in-service training on student performance must be answered "yes."

Effect of Quarter of School Year Taught

The quarter of the school year when the instructional units were taught was another moderating variable tested for its effect upon student performance. Table 4 presents a comparison of difference in mean correct responses between pretest and posttest by quarter of school year taught.

The effect of quarter (school year) the units were taught upon student understanding revealed no significant difference. For all principles combined, the highest difference in mean score occurred for the 2nd quarter while the least effective quarter was the third.

It is interesting to note that the highest mean score difference for specific principles occurred in the 1st quarter for one principle; in the 2nd quarter for two; none in the 3rd quarter and two in the fourth. Based upon the findings, question 4 must be answered "no," since there was not sufficient statistical evidence to indicate that the academic quarter of the school year when instruction was given had an effect upon students' understanding of profit maximizing principles.

VALIDATION OF CRITERION-REFERENCED EVALUATIVE INSTRUMENT

The degree of confidence that can be placed upon the findings reported thus far is directly proportionate to the accuracy of the measurement capacity (validity) of the evaluative instrument used. The validity of a test represents the extent to which the test measures what it purports to measure (16).

As pointed out earlier, "Criterion-referenced" connotes that each individual test item is referenced to a specific objective contained in the instructional units; not to acceptable performance levels.

From the data collected during the conduct of this study, it was possible to calculate several descriptive measurement criteria useful to determine the overall effectiveness (validity) of the evaluative instrument to assess student understanding of profit maximizing principles. These measurement criteria were: test reliability; difficulty factor; mean and discriminatory power. The item analysis on each test item also revealed the (a)

Table 4. Comparison of difference in mean correct responses between pretest and posttest for specific and combined principles by quarter of school year taught (N = 684).

Principle	Mean Score Difference—Pretest to Posttest				F Probability*
	First Quarter (N = 176)	Second Quarter (N = 256)	Third Quarter (N = 210)	Fourth Quarter (N = 42)	
Diminishing Physical Returns	.7500	.7070	.8857	.6429	.651
Diminishing Economic Returns	.7443	.9415	.7289	1.0952	.302
Fixed-Variable Costs	.8750	.6875	.6333	.9524	.461
Substitution	.9034	.9102	.8333	1.0000	.935
Opportunity Costs	.8693	.9648	.7381	.5952	.403
Combination of Enterprises	.6591	.5859	.4810	.5714	.756
Time Relationships (Time Comparisons)	.3920	.5664	.5333	.2381	.474
Overall (Combined Principles)	5.1932	5.3633	4.8333	5.0952	.837

*P>.05

percentage of students who correctly answered each question; (b) questions' discrimination index, and (c) percentage of students selecting each choice.

Table 5 reveals the evaluative instrument had a test reliability coefficient of .89. Reliability was measured by using the Kuder-Richardson Formula 20 which provides an estimate of the internal consistency of the instrument (17). Since the test reliability was greater than .8, this instrument was considered highly acceptable for this criterion.

Table 5. Descriptive measurement criteria to determine the effectiveness of the criterion-referenced evaluative instrument.

Measurement Criterion	Numerical Value*
Test Reliability	.89
Difficulty Factor	44.80
Mean (average score/correct responses)	24.84
Standard Deviation	8.82
Range of Discriminatory Indices	.04 to .71

*Based upon posttest data only.

The average score on the 45 criterion-referenced items contained in the evaluative instrument was 24.84 correct responses. This represents a difficulty factor of 44.80 which indicates that the average student incorrectly answered 45% of the test items. Since the desired difficulty factor for a 4-option multiple choice question is 62% (18), this instrument was somewhat easy.

The discrimination index is a measure of how well each test item separated the students achieving the higher scores (upper 27%) on the evaluative instrument from those who received the lower scores (lower 27%). The minimum acceptable high-low difference (discrimination) by professional standards is .10 (19). As found in Table 5, the range of discrimination indices ranged from .04 to .71.

The frequency distribution of the discrimination indices by categories for the 45 item evaluative instrument is shown in Table 6.

Table 6. Frequency distribution of discrimination indices by categories for the 45-item criterion-referenced evaluative instrument.

Rating of Discriminatory Power	Index Range by Category	Number of Items	Percent of Items
Low	0– .20	5	11.1
Average	.21– .40	6	13.3
High	.41– .60	25	55.6
Very High	.61– .80	9	20.0
Extreme	.81– 1.00	0	0.0
		45	100.0

As shown in table 6, five of the items possessed "low" discriminatory power while 25 questions or 55.6% had discrimination indices of .41– .60 which is indicative of "high" discriminatory power. There were nine or 20.0% of the test items with "very high" discrimination indices.

It is evident that the instrument had the ability to discriminate satisfactorily between the performance of low and high achievers since 40 items or 88.9% ranked in the "average" to "very high" categories.

The measurement capacity of the criterion-referenced evaluative instrument used in this study was considered to be an effective tool to assess student understanding of profit maximizing principles. This judgment was based upon the data obtained in the validation of the instrument which revealed a test reliability of .89, a difficulty factor of 44.8 and a "high-very high" discriminatory power for over 75% of the test items.

The criterion-referenced evaluative instrument, validated as a result of this study, is found in Appendix A. Individual item statistics are shown under each test item.

SUMMARY

Prepared instructional resource units, employing the principles approach and utilizing the inductive mode, can serve as effective teacher references for teaching profit maximizing principles. Evidence of the worth of these units to promote student understanding is the fact that there was a 27.4% increase in posttest performance of the 684 students involved in this study. In addition, test analysis for each specific principle contained in the instructional units revealed a t-value far in excess of that required to be statistically significant at the .001 level of confidence.

The effect of in-service training received by teachers did have a positive influence upon students' understanding of profit maximizing principles. Although not statistically significant at the .05 level, there was a 20.6% increase in the performance of students taught by

"trained" teachers over those students taught by "un-trained" teachers.

The quarter of the school year when the instructional units were taught had no effect upon student understanding of profit maximizing principles. In general, students involved in this study tended to perform at a higher level during the 2nd and 4th quarters. Their level of performance was poorest during the 3rd quarter.

The measurement capacity of the criterion-referenced evaluative instrument used in the study was high. This instrument was considered to be an effective evaluation tool to assess understanding of profit maximizing principles since it possesses a test reliability of .89 and contains 40 test items with known discriminatory power exceeding .21.

Appendix A

Criterion-referenced evaluative instrument on profit maximizing principles

Description:

Item statistics were generated on each item contained in the evaluative instrument. These data are found under each test item.

Total correct responses—The percentage of students correctly answering each question provides a measure of the relative difficulty of each question. A well-designed evaluative instrument should contain test items with various levels of difficulty arranged in an increasing order of difficulty.

The questions contained in the appendix were developed to test specific concepts contained in the instructional units. Individual questions should not be used to interpret a principle in total. Certain

questions might also be subjected to varying interpretation when not used in conjunction with the instructional unit.

Percentage Response for each distractor—The percentage of students selecting each choice is useful in appraising the value of the distractors and in analyzing why students are incorrectly answering each item. *NOTE:* Data (number and percentage) listed under response 5 indicates non-recordable responses caused by duplicate answers, or illegible responses.

Discrimination Index—A measure of how well each test item separated the students achieving the high scores (upper 27%) on the instrument from those receiving the lowest scores. Test items with a discrimination index of less than .20 should generally not be used as a means of measuring student understanding.

Test Item Analysis:

- ITEM 1.** A farmer is told that he can obtain an increase in daily gain of feeder pigs by the addition of ½ lb. of protein supplement placed in the daily ration. He thinks this is good and, therefore, adds 1 lb. of protein supplement to the daily ration. Which of the following results is most likely to occur?
- _____ a. daily gain per head will be doubled.
 - _____ b. daily gain per head will remain the same.
 - _____ c. daily gain per head will increase but not double.
 - _____ d. daily gain will actually decrease.

ITEM STATISTICS					
Multiple Choice Responses and Percentages					
Correct Answer = 3					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5*</u>
Upper 27%					
N = 36	0	0	36	0	0
PCT = 100.00	0.00	0.00	100.0	0.00	0.00
Lower 27%					
N = 23	6	3	23	5	1
PCT = 60.53	15.79	7.89	60.53	13.16	2.63
Total Correct					
N = 99	6	4	99	11	2
PCT = 81.00	4.92	3.28	81.15	9.02	1.64
Discrimination Index = .39					

*Non-recordable responses

- ITEM 2.** A farmer is able to produce 70 bushels of oats per acre with the application of 100 lb. commercial fertilizer per acre. By varying only one factor of production, in this case, the amount of fertilizer applied, he can receive a yield increase of 12 bushels per acre with the application of 200 lb. of additional commercial fertilizer. A 300 lb. increase in fertilizer would result in an additional yield increase of 6 bushels per acre and a 400 lb. increase in an additional yield of 2 bushels per acre. If oats will sell for \$1.60 per bushel and the fertilizer costs \$8.00 per hundred, how much fertilizer should be applied to maximize his net income?
- _____ a. 100 lb.
 - _____ b. 300 lb.
 - _____ c. 400 lb.
 - _____ d. 500 lb.

ITEM STATISTICS					
Multiple Choice Responses and Percentages					
Correct Answer = 2					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
Upper 27%					
N = 22	6	22	8	0	0
PCT = 61.11	16.67	61.11	22.22	0.00	0.00
Lower 27%					
N = 18	9	18	9	1	1
PCT = 47.37	23.68	47.37	23.68	2.63	2.63
Total Correct					
N = 66	25	66	27	1	3
PCT = .54	20.49	54.10	22.13	.82	2.46
Discrimination Index = .14					

- ITEM 3.** Purchasing a larger piece of machinery in order to reduce the cost required to complete a particular operation is feasible if:
- _____ a. the savings in labor is less than the cost of owning the larger machine.
 - _____ b. there is sufficient capital available.
 - _____ c. the savings in labor is equal to the cost of owning the larger machine.
 - _____ d. the value of labor saved is greater than the cost of owning the larger machine.

ITEM STATISTICS					
Multiple Choice Responses and Percentages					
Correct Answer = 4					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
Upper 27%					
N = 33	0	0	3	33	0
PCT = 91.67	0.00	0.00	8.33	91.67	0.00
Lower 27%					
N = 12	8	7	10	12	1
PCT = 31.58	21.05	18.42	26.32	31.58	2.63
Total Correct					
N = 78	14	9	18	78	3
PCT = .64	11.48	7.38	14.75	63.93	2.46
Discrimination Index = .60					

- ITEM 4.** Up to harvest time a farmer has spent \$40 per acre for labor, seed, and machine costs on oats. Price of oats has fallen, and a severe local drought has reduced his yields. With an anticipated price of \$1.60 per bushel on an expected yield of 10 bushels per acre, the farmer cannot expect to make a profit on this crop. Assuming that the oats crop can be harvested for \$8 per acre, the farmer should:
- a. assume his \$40 loss for the year and leave the oats in the field.
 - b. harvest the oats crop.
 - c. sell the oats crop as pasture for \$4 per acre.
 - d. sell the oats crop for hay at \$6 per acre.

ITEM STATISTICS					
Multiple Choice Responses and Percentages					
Correct Answer = 2					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
Upper 27%					
N = 21	3	21	3	9	0
PCT = 58.33	8.33	58.33	8.33	25.00	0.00
Lower 27%					
N = 16	5	16	3	13	1
PCT = 42.11	13.16	42.11	7.89	34.21	2.63
Total Correct					
N = 56	10	56	11	42	3
PCT = .46	8.20	45.90	9.02	34.43	2.46
Discrimination Index = .16					

- ITEM 5.** Assuming a farmer with limited capital can get \$4 return for each \$1 invested in protein supplement for hogs, he should invest his limited funds in a new crop variety if:
- a. net profit on the crop is increased.
 - b. investments in new varieties return at least \$4 for \$1 of added costs.
 - c. investments in new varieties return more to net profit than investments in protein for hogs.
 - d. investments in new varieties increase yields per acre, crop quality and total farm gross income.

ITEM STATISTICS					
Multiple Choice Responses and Percentages					
Correct Answer = 3					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
Upper 27%					
N = 21	4	7	21	4	0
PCT = 58.33	11.11	19.44	58.33	11.11	0.00
Lower 27%					
N = 13	10	7	13	7	1
PCT = 34.21	26.32	18.42	34.21	18.42	2.63
Total Correct					
N = 56	19	26	56	20	1
PCT = .46	15.57	21.31	45.90	16.39	0.82
Discrimination Index = .24					

ITEM 6. On a large cash grain and hay farm where summer labor is limited, which one of the following enterprises would fit in the best, providing adequate facilities and equipment exist?

- a. sheep
- b. cattle feeding
- c. hog feeding
- d. laying hens

ITEM STATISTICS					
Multiple Choice Responses and Percentages					
Correct Answer = 1					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
Upper 27%					
N = 14	14	19	2	1	0
PCT = 38.89	38.89	52.78	5.56	2.78	0.00
Lower 27%					
N = 6	6	20	7	4	1
PCT = 15.79	15.79	52.63	18.42	10.53	2.63
Total Correct					
N = 28	28	69	16	8	1
PCT = .23	22.95	56.56	13.11	6.56	0.82
Discrimination Index = .23					

ITEM 7. Referring to the table below, which level of fertilizer application would yield the most return to the farmer per \$1 invested in fertilizer?

<u>Quantity of Fertilizer Added</u>	<u>Total Yield</u>	<u>Added Fertilizer</u>	<u>Value of Added Yield</u>
0 lb.	60 bushels	\$0.00	\$0.00
10 lb.	65 bushels	1.50	4.50
20 lb.	68 bushels	1.50	2.70
30 lb.	70 bushels	1.50	1.80
40 lb.	71 bushels	1.50	.90

- a. 10 lb.
- b. 20 lb.
- c. 30 lb.
- d. 40 lb.

ITEM STATISTICS					
Multiple Choice Responses and Percentages					
Correct Answer = 1					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
Upper 27%					
N = 13	13	4	17	2	0
PCT = 36.11	36.11	11.11	47.22	5.56	0.00
Lower 27%					
N = 11	11	14	6	6	1
PCT = 28.95	28.95	36.84	15.79	15.79	2.63
Total Correct					
N = 45	45	27	40	9	1
PCT = .37	36.89	22.13	32.79	7.38	0.82
Discrimination Index = .07					

ITEM 8. Assuming that 100 lb. of pork can be produced either with 340 lb. corn and 15 lb. soybean meal or with 270 lb. corn and 40 lb. soybean meal, which item below would be the most important for the farmer to consider before he makes the decision regarding which combination to feed?

- a. the price of soybean meal per pound.
- b. the price of corn per pound.
- c. the price of hogs per hundred weight.
- d. the price of corn and soybean meal per pound.

ITEM STATISTICS					
Multiple Choice Responses and Percentages					
Correct Answer = 4					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
Upper 27%					
N = 33	1	0	2	33	0
PCT = 91.67	2.78	0.00	5.56	91.67	0.00
Lower 27%					
N = 18	4	5	10	18	1
PCT = 47.37	10.53	13.16	26.32	47.37	2.63
Total Correct					
N = 91	6	9	15	91	1
PCT = .75	4.92	7.38	12.30	74.59	0.82
Discrimination Index = .44					

ITEM 9. Referring to fixed costs such as insurance and taxes and variable costs such as seed, feed, and fertilizer as they relate to the farm business, which of the following costs must be paid by the farmer even if nothing is produced?

- _____ a. both variable and fixed costs. _____ c. fixed costs.
 _____ b. variable costs. _____ d. neither variable nor fixed costs.

ITEM STATISTICS					
Multiple Choice Responses and Percentages					
Correct Answer = 3					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
Upper 27%					
N = 35	1	0	35	0	0
PCT = 97.22	2.78	0.00	97.22	0.00	0.00
Lower 27%					
N = 16	12	4	16	4	2
PCT = 42.11	31.58	10.53	42.11	10.53	5.26
Total Correct					
N = 84	25	6	84	5	2
PCT = .69	20.49	4.92	68.85	4.10	1.64
Discrimination Index = .55					

ITEM 10. Based on the "Return per \$100 Investment" table below, a farmer with \$1,000 capital to invest in his farm business should invest the most in:

Returns per \$100 Investment				
<u>Capital</u>	<u>Bonds</u>	<u>Buildings</u>	<u>Machinery</u>	<u>Dairy Equipment</u>
1st \$100	\$104	\$155	\$158	\$170
2nd \$100	104	148	143	160
3rd \$100	104	136	139	151
4th \$100	104	115	135	140
5th \$100	104	100	130	136

- _____ a. bonds. _____ c. machinery.
 _____ b. buildings. _____ d. dairy equipment.

ITEM STATISTICS					
Multiple Choice Responses and Percentages					
Correct Answer = 4					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
Upper 27%					
N = 36	0	0	0	36	0
PCT = 100.11	0.00	0.00	0.00	100.00	0.00
Lower 27%					
N = 20	8	2	6	20	2
PCT = 52.63	21.05	5.26	15.79	52.63	5.26
Total Correct					
N = 96	10	5	9	96	2
PCT = .79	8.20	4.10	7.38	78.69	1.64
Discrimination Index = .47					

ITEM 11. A dairyman is milking an average of 40 head of dairy cows monthly and is not utilizing his good hired man efficiently during the winter. He has a large poultry house which is not being used presently and has also a surplus of corn. What should he do?

- a. expand his dairy herd.
- b. custom hire his corn production.
- c. buy 50 to 100 feeder pigs in late fall to feed out each winter.
- d. sell the surplus corn and let the hired man rest some in the winter.

ITEM STATISTICS					
Multiple Choice Responses and Percentages					
Correct Answer = 3					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
Upper 27%					
N = 28	7	1	28	0	0
PCT = 77.78	19.44	2.78	77.78	0.00	0.00
Lower 27%					
N = 14	12	5	14	5	2
PCT = 36.84	31.58	13.16	36.84	13.16	5.26
Total Correct					
N = 76	29	6	76	9	2
PCT = .62	23.77	4.92	62.30	7.38	1.64
Discrimination Index = .41					

ITEM 12. With limited capital, a farm operator would tend to invest his available capital in:

- a. long-term land improvements.
- b. quick turnover operations.
- c. new machinery and equipment.
- d. labor saving equipment.

ITEM STATISTICS					
Multiple Choice Responses and Percentages					
Correct Answer = 2					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
Upper 27%					
N = 33	1	33	0	2	0
PCT = 91.67	2.78	91.67	0.00	5.56	0.00
Lower 27%					
N = 8	10	8	6	12	2
PCT = 21.05	26.32	21.05	15.79	31.58	5.26
Total Correct					
N = 59	29	59	8	24	2
PCT = .48	23.77	48.36	6.56	19.67	1.64
Discrimination Index = .71					

ITEM 13. With a capital investment of \$5,000, a farmer could install an automatic feeding system for his dairy cows. It is estimated that this system would save approximately 300 hours of chore labor per year. In order for the farmer to make a sound decision on whether or not to invest in this system, he would need to consider which of the following:

- a. the possible return on the \$5,000 if invested elsewhere in the farm business.
- b. whether the labor saved could be profitable utilized elsewhere in the farm business.
- c. the annual fixed and variable costs for operating and maintaining the new feeding system.
- d. all of the above.

ITEM STATISTICS					
Multiple Choice Responses and Percentages					
Correct Answer = 4					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
Upper 27%					
N = 35	1	0	0	35	0
PCT = 97.22	2.78	0.00	0.00	97.22	0.00
Lower 27%					
N = 15	4	7	10	15	2
PCT = 39.47	10.53	18.42	26.32	39.47	5.26
Total Correct					
N = 89	7	14	10	89	2
PCT = .73	5.74	11.48	8.20	72.95	1.64
Discrimination Index = .58					

ITEM 14. A farmer has an average fixed cost of \$25 per acre on land planted to corn. Assuming that the variable cost required to produce one bushel of corn remains the same, if the farmer increases corn production per acre, he will:

- _____ a. lower the per bushel cost of producing corn.
 _____ b. increase the per bushel cost of producing corn.
 _____ c. not affect the per bushel cost of producing corn.
 _____ d. decrease the variable costs per bushel of corn.

ITEM STATISTICS					
Multiple Choice Responses and Percentages					
Correct Answer = 1					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
Upper 27%					
N = 29	29	1	4	2	0
PCT = 80.56	80.56	2.78	11.11	5.56	0.00
Lower 27%					
N = 6	6	16	10	5	1
PCT = 15.79	15.79	42.11	26.32	13.16	2.63
Total Correct					
N = 54	54	25	23	18	2
PCT = .44	44.26	20.49	18.85	14.75	1.64
Discrimination Index = .65					

ITEM 15. A farmer has \$1,600 to invest in his farm business. He is presently raising 100 acres of small grain and has been harvesting with his own combine but the combine needs to be replaced. The cost of harvesting with his own combine is \$3 per acre while custom combining costs \$4 per acre. He can save \$100 each year by doing his own combining. If the present combine can be replaced for \$1,600, the \$100 saved by doing his own harvesting is about 6% return on his investment. If the \$1,600 were invested in dairy cows, it would return \$200 above costs; what should the farmer do?

- _____ a. replace the combine and continue harvesting small grain because he saves \$100 per year.
 _____ b. invest the money in dairy cows and hire the combining done.
 _____ c. plant more acres of small grain in order to reduce fixed costs on the combine.
 _____ d. invest in a smaller combine which would still get the harvesting done efficiently.

ITEM STATISTICS					
Multiple Choice Responses and Percentages					
Correct Answer = 2					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
Upper 27%					
N = 27	4	27	4	1	0
PCT = 75.00	11.11	75.00	11.11	2.78	0.00
Lower 27%					
N = 13	6	13	7	11	1
PCT = 34.21	15.79	34.21	18.42	28.95	2.63
Total Correct					
N = 71	15	71	16	18	2
PCT = .58	12.30	58.20	13.11	14.75	1.64
Discrimination Index = .41					

ITEM 16. A supplementary enterprise such as hogs following steers in a feedlot does:

- _____ a. compete with another enterprise but also adds directly to the production of that enterprise.
- _____ b. compete with other enterprises without adding to their production.
- _____ c. add directly to the productivity of another enterprise.
- _____ d. neither compete with nor add to the production of another enterprise, yet increases the net farm income.

ITEM STATISTICS					
Multiple Choice Responses and Percentages					
Correct Answer = 4					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
Upper 27%					
N = 28	3	2	3	28	0
PCT = 77.78	8.33	5.56	8.33	77.78	0.00
Lower 27%					
N = 11	8	7	11	11	1
PCT = 28.95	21.05	18.42	28.95	28.95	2.63
Total Correct					
N = 67	17	14	22	67	2
PCT = .55	13.93	11.48	18.03	54.92	1.64
Discrimination Index = .49					

ITEM 17. Whether or not a farm operator should adopt a soil improvement plan requiring an immediate large outlay of capital in order to insure a higher income in 5 years will depend upon:

- _____ a. the present need for income.
- _____ b. the current rate of interest on borrowed money.
- _____ c. the potential for increasing his farm output.
- _____ d. all of the above.

ITEM STATISTICS					
Multiple Choice Responses and Percentages					
Correct Answer = 4					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
Upper 27%					
N = 34	2	0	0	34	0
PCT = 94.44	5.56	0.00	0.00	94.44	0.00
Lower 27%					
N = 20	8	3	6	20	1
PCT = 52.63	21.05	7.89	15.79	52.63	2.63
Total Correct					
N = 93	12	5	10	93	2
PCT = .76	9.84	4.10	8.20	76.23	1.64
Discrimination Index = .42					

ITEM 18. Feeding trials have indicated that the first 50 lb. of pork can be produced with 150 lb. of feed; the second 50 lb. of pork with 200 lb. of feed; and the third 50 lb. of pork with 275 lb. of feed. Therefore, a farmer who feeds out hogs:

- _____ a. can expect less added gain from each additional pound of feed fed to hogs being fattened.
- _____ b. can expect more feed efficiency as hogs approach market weight.
- _____ c. can produce the fourth 50 lb. of pork for 300 lb. of feed.
- _____ d. can expect all of the above.

ITEM 21. Competing enterprises are those which compete with one another for the use of a farmer's resources; if one enterprise is increased, the other enterprise decreases. Therefore, all enterprises:

- a. become competitive at some point.
- b. never become completely competitive.
- c. become helpful to each other at some point.
- d. should be considered as separate business ventures.

ITEM STATISTICS					
Multiple Choice Responses and Percentages					
Correct Answer = 1					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
Upper 27%					
N = 28	28	1	0	7	0
PCT = 77.78	77.78	2.78	0.00	19.44	0.00
Lower 27%					
N = 8	8	7	8	10	5
PCT = 21.05	21.05	18.42	21.05	26.32	13.16
Total Correct					
N = 64	64	16	14	22	6
PCT = .52	52.46	13.11	11.48	18.03	4.92
Discrimination Index = .57					

ITEM 22. A particular farm has a 25 acre woodlot with a good stand of young trees. To insure optimum growth, a capital investment of \$50 per acre is required to improve the woodlot. Which of the following operators should invest the necessary capital in this enterprise?

- a. an elderly operator with ample capital.
- b. a fairly young operator with ample capital.
- c. an operator with other enterprises which will pay 10% return on investment.
- d. a young operator with a need for a quick return.

ITEM STATISTICS					
Multiple Choice Responses and Percentages					
Correct Answer = 2					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
Upper 27%					
N = 26	0	26	10	0	0
PCT = 72.22	0.00	72.22	27.78	0.00	0.00
Lower 27%					
N = 8	4	8	21	3	2
PCT = 21.05	10.53	21.05	55.26	7.89	5.26
Total Correct					
N = 47	4	47	61	6	4
PCT = .39	3.28	38.52	50.00	4.92	3.28
Discrimination Index = .51					

ITEM 23. An 8 lb. ration of cracked corn and sufficient roughage and protein supplement fed daily to an 800 lb. steer will yield a 2 lb. daily gain in weight. If the amount of cracked corn is increased to 16 lb. per day with sufficient roughage and protein supplement added to balance the ration, the daily gain will now most likely be:

- a. twice that of the 8 lb. ration of cracked corn.
- b. less than the 8 lb. ration of cracked corn.
- c. more than the 8 lb. ration of cracked corn.
- d. more than twice that of the 8 lb. ration of cracked corn.

ITEM STATISTICS					
Multiple Choice Responses and Percentages					
Correct Answer = 3					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
Upper 27%					
N = 34	0	1	34	1	0
PCT = 94.44	0.00	2.78	94.44	2.78	0.00
Lower 27%					
N = 14	5	12	14	3	4
PCT = 36.84	13.16	31.58	36.84	7.89	10.54
Total Correct					
N = 79	12	18	79	8	5
PCT = .65	9.84	14.75	64.75	6.56	4.10
Discrimination Index = .58					

ITEM 24. To secure maximum profit through increased milk production, a dairyman should increase the daily ration fed dairy cows until the cost of the additional feed is:

- _____ a. greater than the value of the increased milk production.
 _____ b. less than the value of the increased milk production.
 _____ c. equal to the value of the increased milk production.
 _____ d. one-half the value of the increased milk production.

ITEM STATISTICS					
Multiple Choice Responses and Percentages					
Correct Answer = 3					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
Upper 27%					
N = 25	2	8	25	1	0
PCT = 69.44	5.56	22.22	69.44	2.78	0.00
Lower 27%					
N = 9	6	12	9	6	5
PCT = 23.68	15.79	31.58	23.68	15.79	13.16
Total Correct					
N = 52	13	39	52	12	6
PCT = .43	10.66	31.97	42.62	9.84	4.92
Discrimination Index = .46					

ITEM 25. If 1 lb. of soybean meal will substitute for 1.2 lb. of linseed meal of equal nutritional value and soybean meal sells for 10.2 cents/lb. and linseed meal sells for 8 cents/lb., the livestock farmer who wishes to make the largest net income should:

- _____ a. feed 68% soybean meal and 32% linseed meal.
 _____ b. feed all soybean meal.
 _____ c. feed 20% soybean meal and 80% linseed meal.
 _____ d. feed all linseed meal.

ITEM STATISTICS					
Multiple Choice Responses and Percentages					
Correct Answer = 4					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
Upper 27%					
N = 22	4	4	6	22	0
PCT = 61.11	11.11	11.11	16.67	61.11	0.00
Lower 27%					
N = 4	9	2	18	4	5
PCT = 10.53	23.68	5.26	47.37	10.53	13.16
Total Correct					
N = 40	23	9	44	40	6
PCT = .33	18.85	7.38	36.07	32.79	4.92
Discrimination Index = .51					

ITEM 26. A farmer's profit will be greatest if each unit of land, labor, and capital is used:

- a. in such a manner that it will add the most to gross returns of the farm business.
- b. on the enterprise in which the farmer has the greatest interest and ability.
- c. on the enterprises where he will realize the greatest yield per acre or animal unit.
- d. such a manner that will add the most to net returns of the farm business.

ITEM STATISTICS					
Multiple Choice Responses and Percentages					
Correct Answer = 4					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
Upper 27%					
N = 31	4	0	1	31	0
PCT = 86.11	11.11	0.00	2.78	86.11	0.00
Lower 27%					
N = 9	10	9	6	9	4
PCT = 23.68	26.32	23.68	15.79	23.68	10.53
Total Correct					
N = 65	27	11	14	65	5
PCT = .53	22.13	9.02	11.48	53.28	4.10
Discrimination Index = .62					

ITEM 27. Combining crop enterprises to reduce uncertainty is advantageous particularly for:

- a. the beginning farmer with ample capital.
- b. a tenant farmer with specialized machinery.
- c. a farmer with unlimited capital.
- d. a farmer with limited capital.

ITEM STATISTICS					
Multiple Choice Responses and Percentages					
Correct Answer = 4					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
Upper 27%					
N = 31	3	0	2	31	0
PCT = 86.11	8.33	0.00	5.56	86.11	0.00
Lower 27%					
N = 11	5	7	11	11	4
PCT = 28.95	13.16	18.42	28.95	28.95	10.53
Total Correct					
N = 64	16	12	25	64	5
PCT = .52	13.11	9.84	20.49	52.46	4.10
Discrimination Index = .57					

ITEM 28. A four-plow gasoline tractor burns 4 gallons of fuel per hour, and a four-plow diesel tractor burns 3 gallons of fuel per hour. A farmer should consider purchasing a diesel tractor if:

- a. the annual fuel costs are less for the diesel tractor.
- b. the annual savings in fuel costs will be more than the additional annual cost of owning the diesel tractor.
- c. the annual savings in fuel costs will equal the total costs incurred in owning the gasoline tractor.
- d. the rate of operation per acre is the same with the diesel tractor as the rate for the gasoline tractor.

ITEM STATISTICS					
Multiple Choice Responses and Percentages					
Correct Answer = 2					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
Upper 27%					
N = 33	0	33	0	3	0
PCT = 91.67	0.00	91.67	0.00	8.33	0.00
Lower 27%					
N = 11	8	11	9	7	3
PCT = 28.95	21.05	28.95	23.68	18.42	7.89
Total Correct					
N = 76	10	76	15	17	4
PCT = .62	8.20	62.30	12.30	13.93	3.28
Discrimination Index = .63					

ITEM 29. A farmer has been feeding cattle on his 300 acre farm since 1965 with the help of an up-to-date set of machinery and a good full-time hired man. He has always fed out 75 head of calves and 50 head of yearlings per year. Over the last 5 years he has invested \$15,000 in his cattle feeding operation for buildings and modern feeding equipment. His net income has decreased even with the addition of efficient feeding facilities and he cannot understand why. Can you explain the reason?

- a. cattle feeders can expect losses for several years in a row.
- b. he should have fed out all yearlings.
- c. he has increased overhead costs without changing his volume of business.
- d. he made the wrong choice of enterprises as dairying is a better enterprise.

ITEM STATISTICS					
Multiple Choice Responses and Percentages					
Correct Answer = 3					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
Upper 27%					
N = 35	0	1	35	0	0
PCT = 97.22	0.00	2.78	97.22	0.00	0.00
Lower 27%					
N = 24	6	2	24	3	3
PCT = 63.16	15.79	5.26	63.16	7.89	7.89
Total Correct					
N = 103	6	6	103	3	4
PCT = .84	4.92	4.92	84.43	2.46	3.28
Discrimination Index = .34					

ITEM 30. By diversifying crop enterprise rather than specializing in one major crop, the crop farmer will:

- a. reduce risk and uncertainty.
- b. decrease annual labor efficiency.
- c. facilitate the use of more labor saving equipment.
- d. concentrate production knowledge.

ITEM STATISTICS					
Multiple Choice Responses and Percentages					
Correct Answer = 1					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
Upper 27%					
N = 35	35	0	0	1	0
PCT = 97.22	97.22	0.00	0.00	2.78	0.00
Lower 27%					
N = 17	17	3	8	7	3
PCT = 44.74	44.74	7.89	21.05	18.42	7.89
Total Correct					
N = 80	80	6	20	12	4
PCT = .66	65.57	4.92	16.39	9.84	3.28
Discrimination Index = .52					

ITEM 31. In your judgment, which of the following farm operators would be more inclined to invest in a long-range conservation plan?

- a. a beginning farmer who is short on capital.
- b. a tenant with a long-term lease.
- c. an owner/operator with money in a savings account.
- d. an owner/operator who is heavily in debt.

ITEM STATISTICS					
Multiple Choice Responses and Percentages					
Correct Answer = 3					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
Upper 27%					
N = 28	3	5	28	0	0
PCT = 77.78	8.33	13.89	77.78	0.00	0.00
Lower 27%					
N = 13	6	10	13	5	4
PCT = 34.21	15.79	26.32	34.21	13.16	10.53
Total Correct					
N = 62	21	27	62	7	5
PCT = .51	17.21	22.13	50.82	5.74	4.10
Discrimination Index = .44					

ITEM 32. Assuming all other production factors are of no influence, the fertility of a given field is sufficient to produce 80 bushels of corn per acre without additional nitrogen. The addition of 10 lb. of available nitrogen to 1 acre of the above land will increase the yield 10 bushels per acre. If a second 10 lb. of available nitrogen is applied to the same land, the yield per acre will most likely:

- a. increase the same number of bushels per acre as the first 10 lb. of available nitrogen applied.
- b. increase less bushels per acre than the first 10 lb. of available nitrogen applied.
- c. increase more bushels per acre than the first 10 lb. of available nitrogen applied.
- d. not be affected by the additional 10 lb. of available nitrogen applied.

ITEM STATISTICS					
Multiple Choice Responses and Percentages					
Correct Answer = 2					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
Upper 27%					
N = 35	0	35	1	0	0
PCT = 97.22	0.00	97.22	2.78	0.00	0.00
Lower 27%					
N = 13	5	13	13	4	3
PCT = 34.21	13.16	34.21	34.21	10.53	7.89
Total Correct					
N = 78	7	78	25	8	4
PCT = .64	5.74	63.93	20.49	6.56	3.28
Discrimination Index = .63					

ITEM 33. A beginning farmer with limited capital in the amount of \$10,000 has had to make a choice between the following two alternatives: (1) purchase a new combine (estimated life 10 years) for \$10,000, or (2) purchase a used combine for \$5,600 (estimated life 6–7 years) and have \$4,400 to invest in needed lime and fertilizer. He decided to buy the used combine and have the \$4,400 for other production uses on the farm. He made the correct decision. Why did he make the correct decision?

- a. the annual savings in fixed costs on the used combine will be enough to replace the machine it wears out.
- b. the added net return from the expenditure for lime and fertilizer will provide sufficient money to replace the machine when it wears out.
- c. the return on investment is higher on the used combine than on the new combine.
- d. beginning farmers have the tendency to "over invest" in machinery and "under invest" in other production resources.

ITEM STATISTICS					
Multiple Choice Responses and Percentages					
Correct Answer = 2					
	1	2	3	4	5
Upper 27%					
N = 24	4	24	7	1	0
PCT = 66.67	11.11	66.67	19.44	2.78	0.00
Lower 27%					
N = 9	14	9	7	4	4
PCT = 23.68	36.84	23.68	18.42	10.53	10.53
Total Correct					
N = 56	31	56	20	11	4
PCT = .46	25.41	45.90	16.39	9.02	3.28
Discrimination Index = .43					

ITEM 34. Based on the table below showing the yield at different levels of nitrogen used per acre of wheat, which statement is most nearly correct?

No. of lb. of Nitrogen Added	Total Yield Per Acre
0	30 bushels
10	38 bushels
20	42 bushels
30	44 bushels
40	45 bushels

- _____ a. the bushels added to the total yield by each successive 10 lb. of additional nitrogen increases at a uniform rate.
- _____ b. the bushels added to the total yield by each successive 10 lb. of additional nitrogen increases at a diminishing rate.
- _____ c. the bushels added to the total yield are greater at the 20 lb. level.
- _____ d. the 40 lb. rate will yield the best return on a farmer's investment in fertilizer.

ITEM STATISTICS					
Multiple Choice Responses and Percentages					
Correct Answer = 2					
	1	2	3	4	5
Upper 27%					
N = 33	0	33	1	2	0
PCT = 91.67	0.00	91.67	2.78	5.56	0.00
Lower 27%					
N = 12	8	12	10	4	4
PCT = 31.58	21.05	31.58	26.32	10.53	10.53
Total Correct					
N = 73	13	73	24	8	4
PCT = .60	10.66	59.84	19.67	6.56	3.28
Discrimination Index = .60					

ITEM 35. Commercial fertilizer should be applied to crops as long as:

- _____ a. the added production returns increase gross farm income.
- _____ b. the added fertilizer maintains soil productivity.
- _____ c. the added production returns are more than the added cost of the fertilizer.
- _____ d. the added fertilizer increases crop yields per acre.

ITEM STATISTICS					
Multiple Choice Responses and Percentages					
Correct Answer = 3					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
Upper 27%					
N = 34	2	0	34	0	0
PCT = 94.44	5.56	0.00	94.44	0.00	0.00
Lower 27%					
N = 9	6	6	9	13	4
PCT = 23.68	15.79	15.79	23.68	34.21	10.53
Total Correct					
N = 76	11	9	76	22	4
PCT = .62	9.02	7.38	62.30	18.03	3.28
Discrimination Index = .71					

ITEM 36. An approved practice for increasing the per acre yield of soybeans has been discovered and tested at the State Experimental Station. A farmer should adopt the new practice if:

- _____ a. it will improve the quality of soybeans.
 _____ b. it will increase soybean receipts more than expenses.
 _____ c. it will increase the size of volume of the farm business.
 _____ d. it will increase gross farm income.

ITEM STATISTICS					
Multiple Choice Responses and Percentages					
Correct Answer = 2					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
Upper 27%					
N = 31	0	31	0	5	0
PCT = 86.11	0.00	86.11	0.00	13.89	0.00
Lower 27%					
N = 10	5	10	6	14	3
PCT = 26.32	13.16	26.32	15.79	36.84	7.89
Total Correct					
N = 57	6	57	13	42	4
PCT = .47	4.92	46.72	10.66	34.43	3.28
Discrimination Index = .60					

ITEM 37. For maximum net returns, a farmer should substitute machinery for labor when:

- _____ a. the annual cost of machine use is equal to the cost of labor.
 _____ b. the value of labor saved is more than the annual cost of machine use.
 _____ c. there is a limited supply of labor.
 _____ d. the additional machine will increase labor efficiency.

ITEM STATISTICS					
Multiple Choice Responses and Percentages					
Correct Answer = 2					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
Upper 27%					
N = 34	1	34	0	1	0
PCT = 94.44	2.78	94.44	0.00	2.78	0.00
Lower 27%					
N = 10	2	10	8	15	3
PCT = 26.32	5.26	26.32	21.05	39.47	7.89
Total Correct					
N = 78	4	78	14	22	4
PCT = .64	3.28	63.93	11.48	18.03	3.28
Discrimination Index = .68					

ITEM 38. In analyzing the farm business, depreciation should be considered as:

- a. a variable cost.
- b. a fixed cost.
- c. an opportunity cost.
- d. an operating cost.

ITEM STATISTICS					
Multiple Choice Responses and Percentages					
Correct Answer = 2					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
Upper 27%					
N = 33	1	33	0	2	0
PCT = 91.67	2.78	91.67	0.00	5.56	0.00
Lower 27%					
N = 13	9	13	6	7	3
PCT = 34.21	23.68	34.21	15.79	18.42	7.89
Total Correct					
N = 72	23	72	7	16	4
PCT = .59	18.85	59.02	5.74	13.11	3.28
Discrimination Index = .57					

ITEM 39. A farmer can borrow only \$400 for chemicals to control weeds on 100 acres of corn, 100 acres of wheat, and 100 acres of barley. Previous weed control trials have indicated that he can expect the following returns per \$1 invested in chemicals:

	Return per Additional \$1 of Chemicals		
	Corn	Wheat	Barley
1st \$100	\$2.50	\$1.50	\$1.25
2nd \$100	2.25	1.25	1.00
3rd \$100	1.75	.75	.50
4th \$100	1.25	.50	.25

He should:

- a. put all \$400 worth on corn.
- b. put \$300 on corn and \$100 on wheat.
- c. put \$200 on corn and \$200 on wheat.
- d. distribute it evenly over all these crops.

ITEM STATISTICS					
Multiple Choice Responses and Percentages					
Correct Answer = 2					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
Upper 27%					
N = 16	8	16	3	9	0
PCT = 44.44	22.22	44.44	8.33	25.00	0.00
Lower 27%					
N = 9	2	9	7	17	3
PCT = 23.68	5.26	23.68	18.42	44.74	7.89
Total Correct					
N = 40	15	40	18	45	4
PCT = .33	12.30	32.79	14.75	36.89	3.28
Discrimination Index = .21					

ITEM 40. A dairyman is milking 50 Holstein cows with a yearly milk production record of 8,000 lb. per cow. He has \$10,000 capital to invest in his dairy enterprise. He has had to make a choice between the following alternatives: (1) invest \$10,000 in an ultra-modern feeding system, or (2) invest \$6,000 in a "conventional type" feeding system and have \$4,000 to invest in higher production cows. He decided to invest the \$10,000 in the modern feeding system. He made the wrong decision. Why?

- _____ a. the annual depreciation charge is more than he can profitably afford.
- _____ b. \$10,000 is too much to invest in buildings and equipment for 50 cows.
- _____ c. the added returns from the investment in high producing cows would have yielded more profit to the farmer in the long run than the new feeding system.
- _____ d. his neighbors think he made a mistake.

ITEM STATISTICS					
Multiple Choice Responses and Percentages					
Correct Answer = 3					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
Upper 27%					
N = 28	0	8	28	0	0
PCT = 77.78	0.00	22.22	77.78	0.00	0.00
Lower 27%					
N = 19	7	9	19	0	3
PCT = 50.00	18.42	23.68	50.00	0.00	7.89
Total Correct					
N = 82	9	27	82	0	4
PCT = .67	7.38	22.13	67.21	0.00	3.28
Discrimination Index = .28					

ITEM 41. The normal seeding rate for barley is 90 lb. per acre. Two fields with comparable capability and fertility levels are seeded to barley. Field "A" is seeded at the rate of 115 lb. per acre and Field "B" is seeded at the rate of 140 lb. per acre. Assuming that growing conditions were identical for each field, we might predict that the yield per acre of Field "B" would be:

- _____ a. twice the yield of Field "A."
- _____ b. the same yield as Field "A."
- _____ c. less than the yield of Field "A."
- _____ d. more than the yield of Field "A."

ITEM STATISTICS					
Multiple Choice Responses and Percentages					
Correct Answer = 4					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
Upper 27%					
N = 26	1	1	8	26	0
PCT = 72.22	2.78	2.78	22.22	72.22	0.00
Lower 27%					
N = 10	2	10	13	10	3
PCT = 26.32	5.26	26.32	34.21	26.32	7.89
Total Correct					
N = 68	5	15	31	68	3
PCT = .56	4.10	12.30	25.41	55.74	2.46
Discrimination Index = .46					

ITEM 42. It is profitable for a farmer to borrow money to expand his farm business when the borrowed money:

- _____ a. returns more than the cost of borrowing money.
- _____ b. can be secured at a low interest rate.
- _____ c. can improve the level of production.
- _____ d. will increase volume of business.

ITEM STATISTICS						
Multiple Choice Responses and Percentages						
Correct Answer = 1						
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	
Upper 27%						
N = 36	36	0	0	0	0	
PCT = 100.00	100.00	0.00	0.00	0.00	0.00	
Lower 27%						
N = 13	13	8	3	9	5	
PCT = 34.21	34.21	21.05	7.89	23.68	13.16	
Total Correct						
N = 77	77	15	11	14	5	
PCT = .63	63.11	12.30	9.02	11.48	4.10	
Discrimination Index = .66						

ITEM 43. A hog raiser should substitute barley for corn in a ration as long as:

- a. barley is 80¢ per bushel and corn is \$1 per bushel.
- b. barley and corn substitute at the same rate of total digestible nutrients.
- c. the value of the corn replaced is less than the cost of the barley added.
- d. the value of the corn replaced is more than the cost of the barley added.

ITEM STATISTICS						
Multiple Choice Responses and Percentages						
Correct Answer = 4						
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	
Upper 27%						
N = 23	1	7	5	23	0	
PCT = 63.89	2.78	19.44	13.89	63.89	0.00	
Lower 27%						
N = 8	5	12	10	8	3	
PCT = 21.05	13.16	31.58	26.32	21.05	7.89	
Total Correct						
N = 50	11	29	29	50	3	
PCT = .41	9.02	23.77	23.77	40.98	2.46	
Discrimination Index = .43						

ITEM 44. In the long-run, usually 15– 20 years, all costs encountered in operating a farm business become:

- a. variable costs.
- b. fixed costs.
- c. submarginal.
- d. capital costs.

ITEM STATISTICS						
Multiple Choice Responses and Percentages						
Correct Answer = 2						
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	
Upper 27%						
N = 18	5	18	6	7	0	
PCT = 50.00	13.89	50.00	16.67	19.44	0.00	
Lower 27%						
N = 13	10	13	5	7	3	
PCT = 34.21	26.32	34.21	13.16	18.42	7.89	
Total Correct						
N = 56	27	56	15	21	3	
PCT = .46	22.13	45.90	12.30	17.21	2.46	
Discrimination Index = .16						

- ITEM 45.** Assuming that a farmer is efficiently managing his farm business, the last dollar spent on a factor of production, such as seed, fertilizer, machinery, or buildings, will yield a marginal or added return:
- _____ a. greater than the last dollar earned from all other factors of production.
 - _____ b. exactly equal to the last dollar earned from all other factors of production.
 - _____ c. less than the last dollar earned from all other factors of production.
 - _____ d. twice as large as the last dollar earned from all other factors of production.

ITEM STATISTICS					
Multiple Choice Responses and Percentages					
Correct Answer = 2					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
Upper 27%					
N = 11	16	11	9	0	0
PCT = 30.56	44.44	30.56	25.00	0.00	0.00
Lower 27%					
N = 10	11	10	9	5	3
PCT = 26.32	28.95	26.32	23.68	13.16	7.89
Total Correct					
N = 28	57	28	24	10	3
PCT = .23	46.72	22.95	19.67	8.20	2.46
Discrimination Index = .04					

LITERATURE CITED

1. G. H. Gallup. "The 10th Annual Gallup Poll of the Public's Attitudes Toward the Public Schools," *Phi Delta Kappan*, Vol. 60, No. 1, September 1978, pp. 33–45.
2. American Vocational Association, *Agricultural Education for the Seventies and Beyond*, Report of the Committee on Agricultural Education. Commission on Education in Agriculture and Natural Resources, National Research Council, Washington, D.C., July 1971.
3. S. S. Sutherland and W. E. Sims. "Biological Principles Related to Agriculture." California: University of California at Davis, and California State Department of Education, 1963.
4. J. T. Starling. "Integrating Biological Principles with Instruction in Vocational Agriculture." (Ph.D. dissertation, The Ohio State University, 1964).
5. R. L. Peterson. "An Experimental Evaluation of the Principles Approach for Teaching Vocational Agriculture to High School Students." (Ph.D. dissertation, University of Nebraska, 1969).
6. R. L. Barker. "An Appraisal of Instructional Units to Enhance Student Understanding of Profit Maximizing Principles." (Ph.D. dissertation, The Ohio State University, 1967).
7. P. R. Zurbrick. "Effectiveness of a Teacher Reference Utilizing an Inductive Mode and Principles Approach in Teaching High School Vocational Agriculture Students." (Ph.D. dissertation, The Ohio State University, 1971).
8. F. G. McCormick. *Effectiveness of Instructional Units Designed to Teach Agricultural Marketing Principles*. Technical Bulletin No. 219, Agricultural Experiment Station, Tucson: University of Arizona, June 1975.
9. R. E. Spillman and Herbert Bruce, Jr. "V-TECS: The Push to Competency-Based Curriculum," *American Vocational Journal*, Vol. 51, No. 6, September 1976, p. 31.
10. F. G. McCormick. "The Development of an Instrument for Measuring the Understanding of Profit Maximizing Principles." (Ph.D. dissertation, The Ohio State University, 1964).
11. *Instructional Units on Profit Maximizing Principles*, Agricultural Experiment Station, Tucson: University of Arizona, June 1968.
12. *Instructional Units on Profit Maximizing Principles*, Agricultural Experiment Station, Tucson: University of Arizona, May 1975.
13. *Instructional Units on Agricultural Marketing Principles*, Agricultural Experiment Station, Tucson: University of Arizona, August 1969.
14. *Instructional Units on Animal Nutrition Principles*, Agricultural Experiment Station, Tucson: University of Arizona, September 1975.
15. D. B. Van Dalen. *Understanding Educational Research*, McGraw-Hill, Inc., 1966, pp. 253–256.
16. B. W. Tuckman. *Conducting Educational Research*, Harcourt Brace Jovanovich, Inc., 1972, p. 139.
17. N. E. Gronlund. *Measurement and Evaluation in Teaching*, MacMillian Co., New York, 1968, p. 83.
18. Educational Testing Service. *Tests and Measurement Kit*, Princeton, N.J., 1973.
19. P. B. Diederich. *Short-cut Statistics for Teacher-Made Tests*, Educational Testing Service, Princeton, N.J., 1973.

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