

# The Effectiveness of Using the Instructional Strategy Diagnostic Profile to Prescribe Improvements In Self-Instructional Materials Teaching Abstract Concepts

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**Abstract.** An important question in instructional design is how can existing materials be improved to optimize learning situations for students. Most research on instructional improvement to date has either attended to what needs to be revised and ignored how the revisions should be made or described very specific revisions that were not generalizable into principles. This study describes the success in producing improved learning, confidence, attitude, and test time (without appreciably increasing study time) by improving materials according to prescriptions of the ISDP.

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While much is done in instructional technology in the way of designing new instruction, it would be far more efficient to evaluate existing instruction for its effectiveness and remedy its deficiencies. Diamond, Eickman, Kelly, Holloway, Vickery, and Pascarella (1975) state that we presently give a 19th century education to individuals who will live in the 21st century. The Carnegie Commission (1972) saw informational technology as being able to impact on this dilemma by allowing a wider dissemination of information and by forcing instructors to be more analytical in approach and more conscious about method.

While the Carnegie Commission refers to technology as the use of electronics communication systems, the second definition of instructional technology presented by the Commission on Instructional Technology is just as applicable. That definition states, "It (instructional technology) is a systematic way of designing, carrying out, and evaluating the total process of learning and teaching in

terms of specific objectives, based on research in human learning and communication, and employing a combination of human and non-human resources to bring about more effective instruction" (1970, p.7).

Of particular importance in the above definition is "based on research in human learning and communication." Snelbecker (1974) and Glaser (1976) both recognize the importance of learning theory and instructional theory in instructional design and both see learning theory as descriptive of how humans learn and instructional theory as prescriptive of what must be done to the learning environment to affect the student.

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Clearly, then, the challenge for instructional designers in higher education is to develop methods that are not only used to evaluate instructional materials but also to prescribe changes in those materials—changes based upon what is believed to be true about human learning.

The only method developed to date that addresses itself to instructional analysis and prescription is the Instructional Strategy Diagnostic Profile (ISDP) developed by Merrill, Richards, Schmidt, and Wood (1977). A research review done by Merrill, Olsen, and Coldeway (1976) describes the eight propositions upon which the ISDP is based and demonstrates considerable support for five of them and partial support for one other.

## Problem

The purpose of this study was to determine the effectiveness of the ISDP in analyzing and prescribing changes in self-

instructional materials that teach abstract concepts similar to those taught in colleges and universities. It was designed not as a test of the relative effectiveness of each principle, but as a holistic examination of the ISDP process.

## Hypotheses

The following null hypotheses were tested.

1. There will be no significant difference in *performance on objective tests* among students using materials with a high ISDP rating (high consistency and adequacy), a medium ISDP rating (high consistency), and a low ISDP rating (as is).
  2. There will be no significant difference
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in the amount of *confidence* felt by students taking the three types of instruction.

3. There will be no significant difference in *attitude* toward any of the three types of instruction.

4. There will be no significant difference in the *amount of time* it takes students to complete the three types of instructional materials.

5. There will be no significant difference among students taking the three types of instruction in the *time taken to complete an examination* on that instruction.

## Definition of Terms

The following definitions are provided to enable the reader to understand important terms and concepts common to this study.

*Abstract Concepts:* concepts the referents of which are not directly perceptible such as time and emotion. (Reed and Dick, 1968)

*Instructional Strategy Diagnostic Profile:* a set of questions and ratings from which

one can make prescriptions to improve instructional materials.

*Task-Content Matrix:* a method of classifying instructional objectives and test items according to content (what is to be learned) and task (how it is to be learned).

*Consistency:* the measure of similarity between test items and objectives on the task-content matrix.

*Adequacy:* a measure of the exit level of behavior required by the objective compared to the needs of a curriculum. It also refers to the quality of the instruction based on the demands created by the test item.

*Primary Presentation Form:* according to the ISDP Training Manual, all instruction takes place in either of two modes: telling the student something or questioning him/her about it. Each of these modes can be used with either of two instructional elements: generalities or examples. Combining the modes with the elements results in four basic types of instructional presentations, TG, Tell via generality (Generality); Teg, Tell via example (Example); QG, Question via generality (Generality Practice); Qeg, Question via example (Practice).

#### Limitations

This study focused on the evaluation and improvement of self-instructional materials that are designed to teach abstract conceptual information typical of that which is learned in college and university educational settings.

This study was also limited to the ISDP ratings for test item/objective consistency, test item/presentation consistency and presentation adequacy. There is a rating for justification of task level, but it makes assumptions about the instruction and its relation to the curriculum outside the course being studied. Since the importance of this study is to determine if instruction can be improved so as to aid students in meeting the stated objective, it was decided not to revise the objective, which would thus confound the issue.

### Review of Literature and Related Studies

#### Early Research

Some of the earliest literature in the area of instructional materials improvement is reviewed by Twyford (1969) in the fourth edition of the Encyclopedia of Educational Research. The studies cited (Fletcher, 1953, and Jaspen, 1953) contain several practical drawbacks (i.e., cost) and do not directly attack the problem of prescriptively evaluating "classroom ready" materials and making

needed revisions.

During the 1960's there were many reports of improvement to auto instructional language courses. Typical of these is a study by Newmark (1964) which states that materials were revised but states no rationale other than student performance, for making those revisions. Another study typical of this research is that by Morton (1967) which examines course revisions in detail but talks of revisions which are highly situationally

would lead one to conclude:

1. Revised materials are more effective than original materials.
2. The most effective revision techniques are based on student test data.
3. This body of research attends to what needs to be revised but not to how the revisions should be made.

#### Description of Revisions

In another body of research in instructional revision, the researchers have

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**"The most important feature of the process was the determining of why certain instructional sequences were ineffective and what could be done to improve them."**

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specific and contribute little that is generalizable to the literature of instructional revision.

Since 1960 the studies conducted in the area of instructional materials revision would seem to fall into three broad categories: (1) techniques for revising instructional materials; (2) revisions that have been made to instructional materials; and (3) deriving principles of instructional revision.

#### Techniques for Revision

There are several different types of techniques, described in various degrees of detail, found in the literature. Bjerstedt (1964) describes a system that is intuitively based. Rosen (1968) and Dick (1968) both conclude that test data is an important factor in instructional revision. Lipe (1971) used a purely statistical method for ranking modules by need for revision, which he concluded was too complicated. Abedor (1972) used a technique based on student-teacher confrontation and subjective student feedback, which he concluded was very discouraging for the teachers. Robinson (1972) and Sulzen (1972) both concluded that the knowledge of objectives played an important role in instructional improvement. Proger, Carfioli, and Kalapos (1973) suggest a simulation model for evaluating materials. Kull (1974) credits P. Kenneth Komoski with the phrase "Learner Verification Information" but states that the method is not specific. Thiagarajan (1976) and Kandaswamy, Stolovitch, and Thiagarajan (1976) conclude that little is known about how to match the Learner Verification data with the types of revision.

A review of the above references

described, in various degrees of detail, what changes they made in the instruction but fail to cite the specific reasons for making those changes. Deisler and McNeil (1960) report on making six specific changes to an auto tutorial science program but fail to explain why. Gropper, Lumsdaine, and Shipman (1961) list revisions made to two television programs and list the features of the revision technique, but, again, don't cite a rationale for making the revisions. McEntee and Rivers (1971) describe changes made to the U.S. Naval Academy leadership course. The revisions were limited to adding and omitting test items, and, again, no rationale was given for the changes.

There are some reports of instructional revision where a rationale has been given, but it is in the sketchiest of terms. Williams et al. (1965) cite suggestions by students as the basis for revising a series of self administered workshops in in-service audio visual education. Rahmlow (1971) contends that by looking for certain response patterns in module tests, improvements can be made to either test items or content. Burger (1974) lists error rate and student interviews as the basis for making improvements to a math program.

Some studies of instructional improvement state rationales which must be questioned on the basis of reliability. VanderMeer and Montgomery (1964) state that changes they made in educational filmstrips were "based on the data collected from tests and on the basis of experience, intuition, and imagination." In a similar study on the improvement of instructional films, VanderMeer, Morrison, and Smith (1965) based their

changes on test results, results of previous film studies (presumably studies similar to those of Fletcher and Jaspen), and the results of a series of staff conferences. The Learning Research and Development Center (1973) improved self-instructional materials in curriculum development using as a basis unit rating sheets, which were inconclusive (many weren't returned), post-tests, and mailers students could use to ask questions.

To summarize this descriptive research, one could consider the following:

1. The revisions that were made are described in terms ranging from broad sweeping generalization to mention of content areas needing revision, to specific revisions made to individual pictures and captions in filmstrips.

2. The description of the basis for the revisions that were made, if listed at all, is often sketchy and of questionable reliability.

3. Again, as in the first section of this review, the emphasis is on what is to be revised and not how it is to be revised.

#### Principles of Revision

Several investigators have noted the problem of no reliable basis for revision and have attempted to derive principles for instructional improvement. Silberman, Coulson, Melarango, and Newark (1964) inferred from tutorial sessions three principles of revision; gap, irrelevancy, and mastery.

Moore (1968) lists four principles, the content of which is similar to Silberman

of empirical revision, Baker and Alkin (1973) state that, since in most research the revision is done by the experimenter, the improvement could quite possibly be related to experimenter bias or time on task as opposed to techniques. They go on to suggest that a viable alternative to reporting empirical research is the writing of detailed technical reports when successful (in terms of program effects and staff satisfaction) formative evaluation activities have been completed.

#### Related Studies

While this would seem a possible alternative, this author believes a far more productive solution would be to predicate revisions on empirically tested, theoretically based methods for structuring the stimulus materials.

Work of this nature was done by Gropper and Glasgow (1966), and Gropper (1967). These two studies provide evidence that stimulus materials revised on theoretically based principles can be used to increase student learning.

The thrust of Gropper's study was to determine if student response was needed when the stimulus materials were presented properly. On the basis of his results, Gropper concludes that structuring the materials properly makes a significant difference, but in order for performance to approach what would be expected from programmed instruction, a response mechanism must be built in.

The only prescriptive evaluation tool developed for revising instruction by

evidence that presentation forms in an instructional sequence must be consistent with test items.

Other studies have been supportive of the ISDP. Richards (1976) found that nutrition instruction with a high ISDP consistency rating produced significantly more learning than instruction with the same content with a low consistency rating. Sharp (1978) found evidence to support four of the original ISDP principles. Choi, Merrill, Callahan, Hawkins, and Norton (1979) found evidence to partially support the hypothesis that students in organic chemistry who studied a text with a higher ISDP rating would perform better on a test than students who studied a text with a lower ISDP rating.

This preceding work has shown the ISDP to be used effectively to design and to revise classroom materials and self-instructional materials teaching concrete concepts. The purpose of the present study was to determine the effectiveness of the ISDP in analyzing faulty self-instructional materials and prescribing revisions to presentation so as to improve the teaching of abstract concepts.

## Method

### Subject Matter and Materials

The materials used for the study were extracted from *Orientation to Instructional Media* (Welliver, 1975), a course syllabus and self-instructional text for the basic instructional media course at The Pennsylvania State University. A study of the comprehensive exams revealed that students' performance was appreciably lower on a module on learning theory than any other. Since there appeared a discrepancy between expected performance and actual performance, and since the module content was highly abstract, it was considered ideal for this study. The materials were edited to facilitate experimental administration.

### Subjects

Subjects were volunteers solicited from survey courses, introductory courses, and general education courses from three of the colleges of The Pennsylvania State University. Subjects received four dollars for participating and two additional dollars for scoring in the top half of their respective cells.

### Development of Materials

The objectives, test items, and instructional materials were evaluated and rated for consistency and adequacy

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**"Three sets of instructional materials were examined: the original set, the set with improved consistency rating, and the set with improved consistency and adequacy ratings."**

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et al. The problem here lies in the way these principles were tested. Both studies used acceptable instructional materials and impaired them by introducing gaps and/or irrelevant items and/or eliminating branching. This "backdoor" approach to validating principles of revision is questionable. It would seem more worthwhile to find an unsatisfactory program and improve it by implementing the unproven principles.

Baker (1970) concluded that empirical revision rules generalized across developers and across subject areas paid off modestly. These results should be questioned due to flaws in experimental procedure and design.

In another discussion of the problems

prescribing changes for stimulus and response presentations is the Instructional Strategy Diagnostic Profile. In addition to the research review already mentioned, further support for its principles has been offered by four additional studies.

The work which established the first principles of the ISDP was done by Wood (1976). He found that the difficulty of a problem and an index of the presence of primary presentation forms (rule, example, and practice) could be used as predictors of student achievement.

In a study conducted by Merrill, Wood, Baker, Ellis, and Wulfbeck (1977) supporting evidence was found for four of the original ISDP Principles, plus

according to the ISDP procedures. (For an overview of the ISDP, see Choi, Merrill, Callahan, Hawkins, and Norton, 1979). The numerical ratings were used only as a guide for determining relative effectiveness. The most important feature of the process was the determining of why certain instructional sequences were ineffective and what could be done to improve them. Prescriptions were written for revising the instruction. Improvements to the instruction resulted in two new sets of materials. The first set was improved by insuring consistency between objectives, test items, and instruction. The second was an improvement on the first, accomplished by attending to the adequacy criteria of the ISDP. This means there were three sets of instructional materials, the effectiveness of which was examined: the original set (form A), the set with improved consistency rating (form B), and the set with improved consistency and adequacy ratings (form C).

The first step in the revision process was to examine the original test items and compare them to the stated module objective. This comparison was made using the ISDP task/content matrix. The next step was to determine which types of primary presentation forms or displays were required for the instruction of the given task/content combination. For example, the instruction required for a student to remember and paraphrase a fact requires that Tell via Example and Question via Example displays be present. In order for an instructional sequence to have a consistency rating of 1.00, the test item must have the same task/content level as the objective and all of the required instructional displays must be present. The prescriptions for improving the consistency rating in these materials consisted largely of correcting poorly written test items and adding examples and practice items for various instructional sequences.

The greatest changes in structure and appearance of the materials came as a result of improving the adequacy rating. The three important issues addressed by the adequacy rating process are consistency, isolation, and help. For example, the instruction required for a student to remember and paraphrase a concept requires that Tell via Generality, Tell via Example, and Question via Generality displays be present. The consistency issue was resolved by assuring that all of the displays are in fact present. (It should be noted that improving the consistency rating will, by itself, have a positive effect

on the adequacy rating). The isolation issue is resolved by assuring that the generality statement (in this instance, the concept), examples of the concept, practice items, and feedback are separated from supporting text material and identified as such. The help issue is resolved by assuring that there are mnemonics and/or simplified representations of the generality, example, and feedback displays and that there are no helps in the practice item. All of these issues must be resolved for an instructional sequence to have an adequacy rating of 1.00. Resolution of these issues consisted mostly of separating the facts and concepts to be learned from the text and identifying them, separating the examples of concepts from the text and identifying them, adding mnemonics to assist in the learning of concepts, and including mnemonics in the feedback.

Special mention must be made of the type of mnemonic used in this study. The facts requiring mnemonics consisted of elements of learning theory that had to be associated with the name of the theorist who created them. It was felt that by creating a "box" out of the initial of the theorist's name and incorporating the name into the "box", a visual cue would be added that would aid the remembering of the relationship of the theoretical element to the theorist. Further, placing the element of theory into the box served the purpose of separating and identifying the concepts which were to be learned.

and a monitor would take their study materials and give them their exams. Again, as they began and completed their exams they marked their time cards accordingly.

#### Instrumentation

Students' abilities to perform were measured by a thirty-five item multiple choice objective test made from items developed for the original and the revised forms of instruction. The test was checked for content validity by the instructional media course instructors and was found to be a valid instrument for assessing the learning of course content. The KR-20 reliability coefficient of the test is .78. The confidence score was measured by students' reactions to thirty-five, five point confidence scales, one for each answer. The attitude of the students toward the instruction was measured by a fifteen item, five point Likert Scale (Oppenheim, 1966). The instruments measuring performance, confidence, and attitude were combined into one eighty-five item examination. The amounts of time required to complete the instruction and to complete the test were taken from records each subject made of the time he or she started and completed those tasks. The subject could observe the time from a large digital clock clearly visible at the front of the room.

#### Statistical Design

The design of the study was a one-way analysis of variance measuring the dif-

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#### Experimental Procedures

Subjects were assembled in a classroom and randomly assigned to three different groups. Each subject was given a packet containing one set of self-instructional materials, one optical scan answer sheet, one time card, and one blank sheet of paper. Subjects were instructed on the procedure of the experiment, questions were entertained, and the subjects were directed to three different classrooms.

As each student began and completed interacting with the study materials, he or she recorded the time from a large digital clock at the front of the room. As students finished, they raised their hands

ferences among the three levels of instructional quality. This design was used for each of the dependent variables—performance, study time, test time, affect, and confidence. Multiple comparisons of the means were made using the Tukey-WSD technique and a familywise Alpha level of .05.

#### Results

The means and standard deviations for all five scores from the three different instructional groups are shown in Table 1. It may be noted that there are differences in all scores except study time favoring the materials revised for im-

proved consistency and adequacy. There was an eleven percent improvement in performance, a twelve percent improvement in confidence, a twelve percent improvement in attitude, and a fifteen percent decrease in test time from the original version to the most improved version.

An examination in Table 2 reveals that these differences are significant, and a series of Tukey-WSD follow up tests show that the significant differences are between the original version and the version with improved consistency and adequacy.

There were no significant differences in

materials are better able to meet stated performance objectives. Since the number of concepts and facts to be learned was the same in all three forms of instruction and since the major differences in performance were observed between subjects studying the original materials and subjects studying the materials with optimum consistency and adequacy ratings, it can be concluded that the structuring of instructional materials according to ISDP principles has a direct positive effect on the amount of content that is learned.

#### Confidence

Students who study ISDP revised

confident that he has mastered the correct material adequately.

#### Attitude

Students who study ISDP revised materials have a better attitude toward their instructional materials. Logically, there would appear to be a strong association between confidence and attitude. If a student feels that he is learning properly and the time he spends interacting with study materials is not wasted, he is bound to have a positive attitude toward those materials. What may be even more important is that if he has a good attitude toward his study materials, he will probably spend more time interacting with them and be likely to reap even greater rewards.

#### Study Time

Students do not take an appreciably greater amount of time to study ISDP revised materials. Even though the number of pages of written material was increased from thirteen to thirty pages and the number of practice items the subject had to answer was increased from six to twenty-two, the mean study time increased less than 12 percent. The probable explanation for this is that the revised material is organized in such a way that the student can immediately pick out the important points of the lesson. It would seem that this factor allows the student to process more information in a given instructional sequence in a shorter period of time.

#### Test Time

Students who study ISDP revised materials complete examinations in less time. If students know the answers to test items and if they are confident that their answers are correct, they will spend less time in searching the test item for clues, equivocating over choices, guessing, or other non-productive behavior.

In summary, it may be concluded that the ISDP principles form an effective diagnostic and revision tool that can be effectively used to improve instruction.

Another conclusion that can be drawn from the data is that improving self-instructional materials on the basis of consistency between objectives, test items, and instruction is not sufficient to assure improved learning, confidence, attitude, or test time. This should be contrasted with the findings of Richards (1976) where improvements of consistency, only, yielded significant improvements in student performance. The crucial difference is that the Richards study examined changes in lecture and handout

Table 1.

Means and Standard Deviations of Three Treatment Groups for Five Dependent Variables

Dependent Variables	Statistic	Original	Improved Consistency	Improved Consistency and Adequacy
Performance	$\bar{X}$	22.55	24.50	26.40
	S.D.	4.71	5.35	4.35
Confidence	$\bar{X}$	3.61	3.81	4.09
	S.D.	.66	.52	.50
Attitude	$\bar{X}$	3.35	3.56	3.83
	S.D.	.55	.54	.46
Study Time in Minutes	$\bar{X}$	36.42	40.30	40.60
	S.D.	10.69	13.06	11.26
Test Time in Minutes	$\bar{X}$	28.29	24.97	23.90
	S.D.	4.76	5.68	6.03

the amount of study time, even though the improved version had more than twice the number of pages of instruction than the original. Based on these findings, hypotheses 1, 2, 3, and 5 are rejected, and hypothesis 4 is accepted.

### Conclusions and Recommendations

The purpose of this study was to determine the effectiveness of the Instructional Strategy Diagnostic Profile in analyzing and prescribing changes in self-instructional materials that teach abstract concepts similar to those taught in colleges and universities. Based on the results of this experiment, the following conclusions are made.

#### Performance

Students who study ISDP revised

materials have more confidence in what they have learned. This would appear to be a direct result of the student knowing exactly what he is supposed to learn. Following ISDP processes dictates that the important generalities that a student is required to master be set apart and identified. While other methods can be used to inform a student of what is considered important—such as writing the behavioral objectives at the beginning of a module—separating and identifying each point provides an immediate visual cue which doesn't rely on the student's memory. Further, this separation provides an easily accessible reference for the student to check what he has learned with what he was supposed to learn. By being aware of what is required of him and by being able to ascertain that he is achieving his goals, he can be more

materials, while this study examined changes in self-instructional materials. It is critically important for self-instructional materials to be structured in accordance with ISDP adequacy criteria. It would appear that it would be a waste of resources to commit time and/or money to revising self-instructional materials on the basis of consistency criteria alone.

#### Implications for Practice

With the costs of higher education being constantly scrutinized and frequently cut, and with the problem of declining enrollments facing college and university administrators, the growing trends are toward creating new markets for educational programs. The retaining of students who previously failed academically is one such market. It could be argued that one critical factor involved in academic failure is the failure of the instructional materials used by the school to meet the needs of those students. That failure could be cognitive or affective in nature. That is to say, the material could fail to explain content clearly, or it could fail to motivate students into wanting to learn.

It would seem that if a course instructor or a curriculum committee observed that student performance was at a lower level than expected, they could consider the ISDP as a viable possibility for improving their instructional system. This could have a very positive effect on student retention and thus help to ease the financial strains of institutions of higher learning.

Very few instructional programs produce optimum results—that is, every student achieving the objective of the course. In view of this common situation, almost every course could benefit from revision efforts of some kind. As a purely practical matter, however, the effort required in revising instruction dictates that only those aspects (segments, modules, features) of instruction causing the most difficulty should be selected as potential revision projects.

Another relationship should be drawn between colleges and universities, in contrast to trade schools, technical schools, military schools and business training centers. Instructional technology seems to have a stonger foothold in the latter group, as any look through the classified ads of *The Chronicle of Higher Education* would indicate. However, it would appear by comparing this study to Merrill, Wood, et al. (1977), that the ISDP is even more effective at improving instruction of abstract material taught

more often in four-year institutions than the more concrete kinds of information taught more frequently at other types of training facilities.

While the author would not suggest tampering with instructional systems or materials that are found to have an adequate degree of effectiveness, for those courses or instructional sequences which are not producing desired results, the

eighteen percent when viewed over one module doesn't amount to much, but viewed over a long course could amount to several days which could result in a substantial savings. When this is added with the fact that study time is not significantly affected, especially considering the improved performance, it would seem to be a financially wise investment to revise faulty materials

Table 2.

#### A Summary of the Means, Degrees of Freedom, and F-Ratios on Effects of Instructional Quality on Five Dependent Variables

Form of Instruction	Mean	df	F-Ratio	P
Performance				
Original	22.55	2,88	4.71	.011
Improved Consistency	24.50	2,88		
Improved Consistency and Adequacy	26.40	2,88		
Confidence				
Original	3.61	2,88	5.73	.005
Improved Consistency	3.81	2,88		
Improved Consistency and Adequacy	4.09	2,88		
Attitude				
Original	3.35	2,88		
Improved Consistency	3.56	2,88	6.39	.003
Improved Consistency and Adequacy	3.83	2,88		
Study Time*				
Original	36.42	2,88		
Improved Consistency	40.30	2,88	1.22	.301
Improved Consistency and Adequacy	40.60	2,88		
Test Time*				
Original	28.29	2,88		
Improved Consistency	24.97	2,88	5.29	.007
Improved Consistency and Adequacy	23.90	2,88		

\*in minutes

ISDP would seem to be a valuable improvement tool which could be used effectively in colleges and universities.

Although the thrust of this study was the examination of revision to materials, the content of which is taught typically in colleges and universities, there is one implication for any institution where training is done by independent study and the financial cost of training time is a factor. A saving of test time of over

according to ISDP principles.

#### Implications for Further Research

It has been shown in this study that ISDP revised instructional materials are more effective in an experimental setting. However, the true value of self-paced, self-instructional materials lies in their use in a mastery model over a period of days or weeks. The results of this study have some interesting implications for that type

of learning situation which would warrant further investigation. For example, if students can learn more material in about the same amount of time, as this study shows, it should take students less time to reach mastery of the content area. It would also seem logical to assume that if students had a higher attitude toward their course materials and more confidence in their learning, they would probably spend more time interacting with those materials. This in turn could bring about even greater differences in performance over the length of a course. To carry this one step further, the increase in performance could produce a still greater difference in attitude. These are logical continuations that may appear obvious, but should be tested empirically.

Another consideration worth investigating is the use of ISDP revised materials with students at different levels of development and different levels of ability. This could have wide implications for use in elementary and secondary

ISDP revision of the instruction.

It would also seem warranted to conduct a study similar to Merrill, Wood, et al. (1977) in which various principles are teased apart to determine their individual contributions to the learning environment. It should be remembered that the study was concerned with the teachings of concrete concepts and that several predicted outcomes were not realized because, according to the author, the criterion tasks were not of such difficulty as to require some of the assistance provided by the ISDP prescribed improvements. Reed and Dick (1968) concluded that abstract concepts are more difficult to learn than concrete concepts. Therefore, some of the outcomes predicted for the Merrill, Wood, et al. (1977) study may be found true for abstract content.

Keeping in mind the Carnegie Commission's goals for the year 2000, it would seem appropriate that a study be made to determine if entire courses of instruction can be improved via ISDP

**"Students who study ISDP revised materials are better able to meet stated performance objectives,...have more confidence in what they have learned,...have a better attitude toward their instructional materials,...do not require an appreciably greater amount of study time,...and complete examinations in less time."**

schools. However, before one could recommend the use of these types of learning materials for other types of students, it must be determined if students functioning at a lower developmental state or students with sub-collegiate aptitude levels could benefit from them.

Previous research (Twyford, 1969; Rosen, 1968; Dick, 1968; Abedor, 1972; and others) indicates that almost any effort at revision is of some value. Additional research could contrast one or more of these largely undefined techniques with that of the ISDP. It could also serve to further verify the utility of a theoretical approach and to determine if, in fact, the ISDP is more effective than any other presently documented or utilized technique for producing increases in desirable student outcomes through instructional revision. In effect, the experiment would be testing: (1) the effects of the original instruction, (2) an intuitively revised version of the instruction, and (3) a theoretically based or

methods so that independent study can take place inside and outside of traditional learning centers with a maximum of effect and a minimum of communication problems.

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