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ABSTRACT

Instructional System Technology in recent years has been characterized by an increase in individualized instruction and the modularization of the curriculum. In traditional systems the learners are forced to take blocks of instruction the size of entire courses and these are much too large. The courses can now be broken down into conceptual subdivisions and these into series of modules. Each module has clearly stated behavioral objectives regardless of the nature of the intellectual performance prescribed in it. The test items of the module are derived from the objectives rather than from the instructional materials currently in use to attain them. The instructional materials for a module may be offered on different tracks which feature different levels of abstraction thus accommodating the different learning characteristics of individual learners. Most instructional system developers today are looking ahead to a time when good modules will be developed at many localities and circulated widely for use at various institutions. There is a growing need for a valid and widely applicable method of evaluating modules of instruction. Three basic criteria are relevant to the evaluation of a module of instruction: (1) the amount of learning that results, (2) the dollar equivalent cost to the instructional organization of providing the module, and (3) the amount of learner time consumed by interaction with the module. An example is given comparing three different versions of a module. (CK)

THE MEASUREMENT OF INSTRUCTIONAL ACCOMPLISHMENTS

by

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I. The Individualization and Modularization of Instruction

Instructional System Technology in recent years has been characterized by an increase in individualized instruction and the modularization of the curriculum. Through the system approach the benefits of individualization have been applied to large masses of students. It has been demonstrated that it is not necessary to instruct in large groups which are locked together by a mass uniform presentation. Groups are now taught as individuals with self-pacing and differing learning prescriptions based on the characteristics of the individual learners. By breaking down the content into modules of small size it has also become a simple matter to combine modules in different ways for different learners. Modularization has provided the breakthrough to custom tailored curriculums with much flexibility in crossing disciplinary lines.

In traditional systems the learners are forced to take blocks of instruction the size of entire courses and these are much too large. The courses can now be broken down into conceptual subdivisions and these into series of modules. A module may be as small as a single lesson and be based on a single concept. Some modules may stand alone and be included singly in any individual's curriculum. In other cases a series of modules may be linked in a sequence of increasing complexity so that prior ones are prerequisites for the next.

Each module has clearly stated behavioral objectives regardless of the nature of the intellectual performance prescribed in it. The test items of the module are derived from the objectives rather than from the instructional materials currently in use to attain them. The test items are used to provide both a pretest and posttest for each module. A sufficiently high pretest score permits the learner to skip over the module and go on to a subsequent one. The same criterion level score is ordinarily required of the learner on the posttest in order for the learner to move on to the next module.

The instructional materials for a module may be offered on different tracks which feature different levels of abstraction thus accomodating the differing learning characteristics of individual learners. For example, within a single module one track may consist of a printed narrative which explains the content in the style of a textbook; a second track might break the content down into smaller steps and present it more slowly, perhaps as a slide tape presentation using more visuals and featuring frequent stops for student responses on a special response sheet. A third track for this module might consist of a linear program with carefully structured small steps at a relatively concrete level. Which track a learner would pursue might be determined by a combination of the pretest score and the learning characteristics of the individual. The choice of track could be left up to the learner who would be provided with the information necessary to make an appropriate decision.

Most instructional system developers today are looking ahead to a time when good modules will be developed at many localities and circulated widely for use at various institutions. Such an exchange of modules will vastly increase the potential curriculum at any individual school. Projects are underway which are attempting to collect and evaluate existing modules from different sources and this trend is likely to continue and to increase. All institutions will then have access to more resources than do the richest ones today.

II. The Measurement of Instruction

A. CRITERIA

There is a growing need for a valid and widely applicable method of evaluating modules of instruction. There is a need for a general index of goodness to indicate how good a module is relative to other modules dealing with different content. There is also a need for a method of qualitatively ranking two or more versions or editions of the same module, i.e. ones which share the same objectives and test. For those producing modules it is of much practical importance to know whether or not various changes or subsequent editions represent improvements, and whether the local product is superior to a version of a module imported from elsewhere.

Three basic criteria are relevant to the evaluation of a module of instruction: 1) the amount of learning that results from use of the module, 2) the dollar equivalent cost to the instructional organization of providing the module of instruction, and 3) the amount of learner time consumed by interaction with the module. To instruct efficiently is to maximize learning while minimizing dollar and time costs. All instructional organizations try to accomplish as much change as possible to their students with as little resource expenditure as possible. These considerations are summarized in what might be called the "instructional accomplishment index".

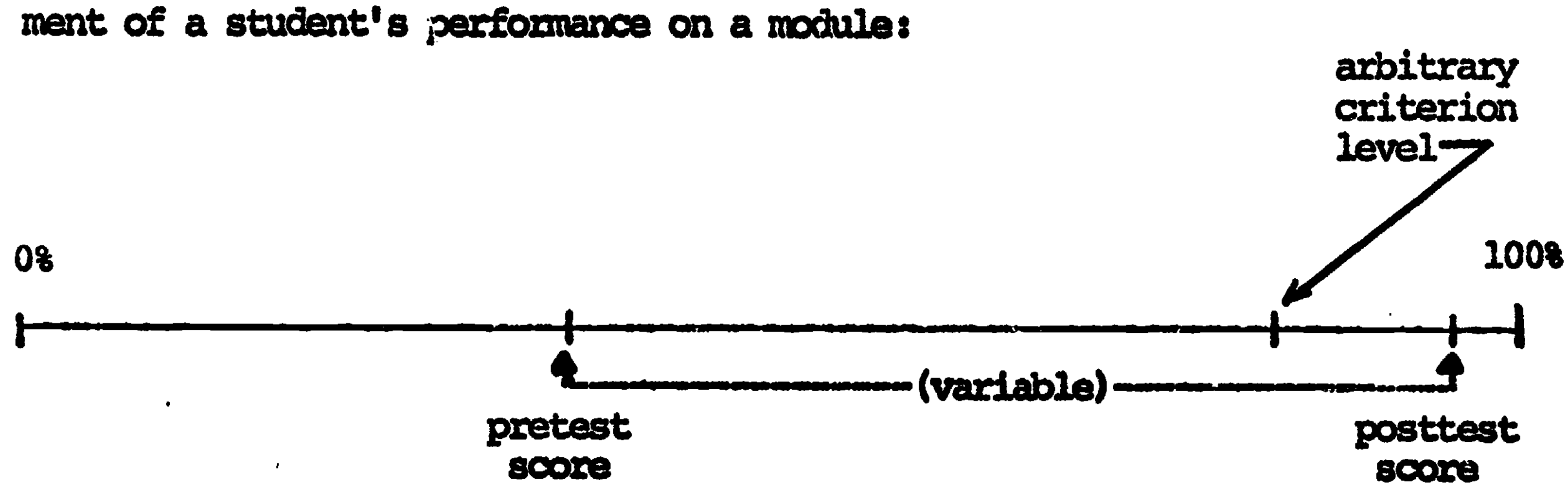
$$\text{Instructional Accomplishment} = \frac{\text{LEARNING}}{\text{DOLLAR COST X LEARNER TIME}}$$

The instructional accomplishment index expresses output per unit of input; the produced commodity is learning, defined as a change in behavior; the expended resources are both the system's money and the learner's time. These two resources are given equal weight in the I_A index, because it is important to give full consideration to the interests of the learners and to avoid hiding weak instruction by forcing students to expend excessive amounts of their time making up for its deficiencies.

B. UNITS OF MEASURE

Learning: Behavioral objectives are specified for each module of instruction and the test items are written relative to those objectives. Because the test items relate to the objectives, they can, and should be written prior to the design of the specific instructional activities intended to lead the students to the attainment of those objectives. Correct responses on posttest items that would not have been answered correctly on the pretest represent changes in behavior that constitute learning. Thus the gain scores across the pre- and posttest can be taken as measures of the student's learning. If the test scores are expressed as per cents, then the learning can be expressed in "units" of percentage points. However, for use in the I_A index, the measure is slightly altered from simple gain scores as explained in the next section.

The figure below illustrates the significant features of a measurement of a student's performance on a module:



The baseline represents the degree of attainment of the behavioral objectives of the module in terms of test scores from 0% to 100%. The criterion level is arbitrarily set and is frequently at 90%. For skills involving the use of the surgeon's knife the criterion level would ordinarily be higher, while for skill at successfully kicking football field goals from distances greater than midfield the criterion level would ordinarily be less than 90%. Regardless of where the criterion level is set, a posttest score must equal or exceed the criterion level in order to be regarded as a valid posttest. Otherwise the testing experience is simply counted as another learning activity, and another attempt to get a permissible posttest score is subsequently arranged. As the figure emphasizes, the pretest score, the posttest score, and the range between them are all variables.

An analysis of the above measure of learning reveals two factors: 1) It is desirable to obtain the highest possible posttest score, 2) It is desirable to maximize the gain score. Once a pretest level is established the goal for the learner is to score 100% on the posttest, i.e. attain the highest percentage of possible gain where possible gain is the difference between 100% and the pretest score. The instructional potential of a module should be capable of producing a gain range extending close to the 100% level. deemed adequate if a module were able to bring a zero pretest student only to the 70% level and no higher even though by relative standards a gain score of 70% would usually be considered quite high.

The concept of maximizing the percentage of gain between the pretest score and 100% encompasses both the concept of maximizing the posttest score and maximizing the absolute value of the gain score. Thus maximizing the percentage of gain possible beyond the pretest score emerges as the most significant and fundamental concept. The notion of desirability for a high posttest score is included, and so is the notion of a high absolute value on the gain score. But now the placement of the gain score range on the zero-to-100 test score scale is taken into account insomuch as, regardless of how wide the gain score range is, its effect is measured in terms of how close to the top of the scale it reaches.

The mathematical expression of the attained percentage of possible gain score beyond the pretest level is $\frac{S_f - S_i}{100 - S_i} \times 100$, where S_f is the final or posttest score and S_i is the initial or pretest score. The value of this expression is used for the learning in the numerator of the I_A index.

Cost: The total cost to the instructional organization of providing the instruction can be expressed in dollars, because the cost of all resources expended by the system, including personnel time, can be converted to their dollar equivalents. Cost factors, in addition to materials and salaries, might include depreciations, rents, taxes, utilities, amortizations, or other direct or indirect costs. The particular combination of factors to be included would depend on the nature and purpose of the specific instance of measurement. When determining the cost per student to provide a module of instruction it is necessary to amortize initial production costs across the useful lifetime of those products and to consider the number of students who will actually use them.

Time: The learner's time of interaction with a module of instruction is simply measured in hours and is the total time for pursuing instructional activities, testing, being tutored, or otherwise assisted.

C. CALCULATING THE I_A INDEX

The nominal units of the instructional accomplishment index are thus "percentage points per dollar-hour". The index value is normally computed on the basis of a large sample of students who use a given module of instruction. The learning and time factors are the computed means for all students using the module. The cost factor is the mean cost per student.

The instructional accomplishment index is the resultant learning divided by the product of the cost to the instructional system to provide the experience and the learner's time consumed by involvement with the instruction. Th learning measure is essentially based on changes in test scores, and therefore ΔS, the change in scores, is the symbol chosen to represent it. ΔS is equal to $\frac{S_f - S_i}{100 - S_i} \times 100$ as explained in the previous section. The sum of all intervals of learner instruction occurring between the pre- and posttest is divided by the number of students and this mean is denoted by T and is expressed in hours. The sum of all relevant costs incurred by the instructional system in providing the module of instruction is divided by the number of students, and that cost per student is denoted by C and is expressed in dollars.

The formula for the instructional accomplishment index is thus

$$I_A = \frac{\Delta S}{C \times T}.$$

D. GRAPHIC ANALYSIS OF THE INSTRUCTIONAL ACCOMPLISHMENT INDEX

If a module of instruction is to be improved according to the I_A index, then the new version must increase the $\Delta S/CT$ ratio. This can be done either by 1) commiting further resources in an effort to get a disproportionately higher amount of learning, 2) altering the nature of the learning activities while maintaining the same net CT value in an effort to get more learning, or 3) reducing the net CT resource input while trying to get a less-than-proportional decrease in learning. Figure 1 graphically illustrates these alternatives.

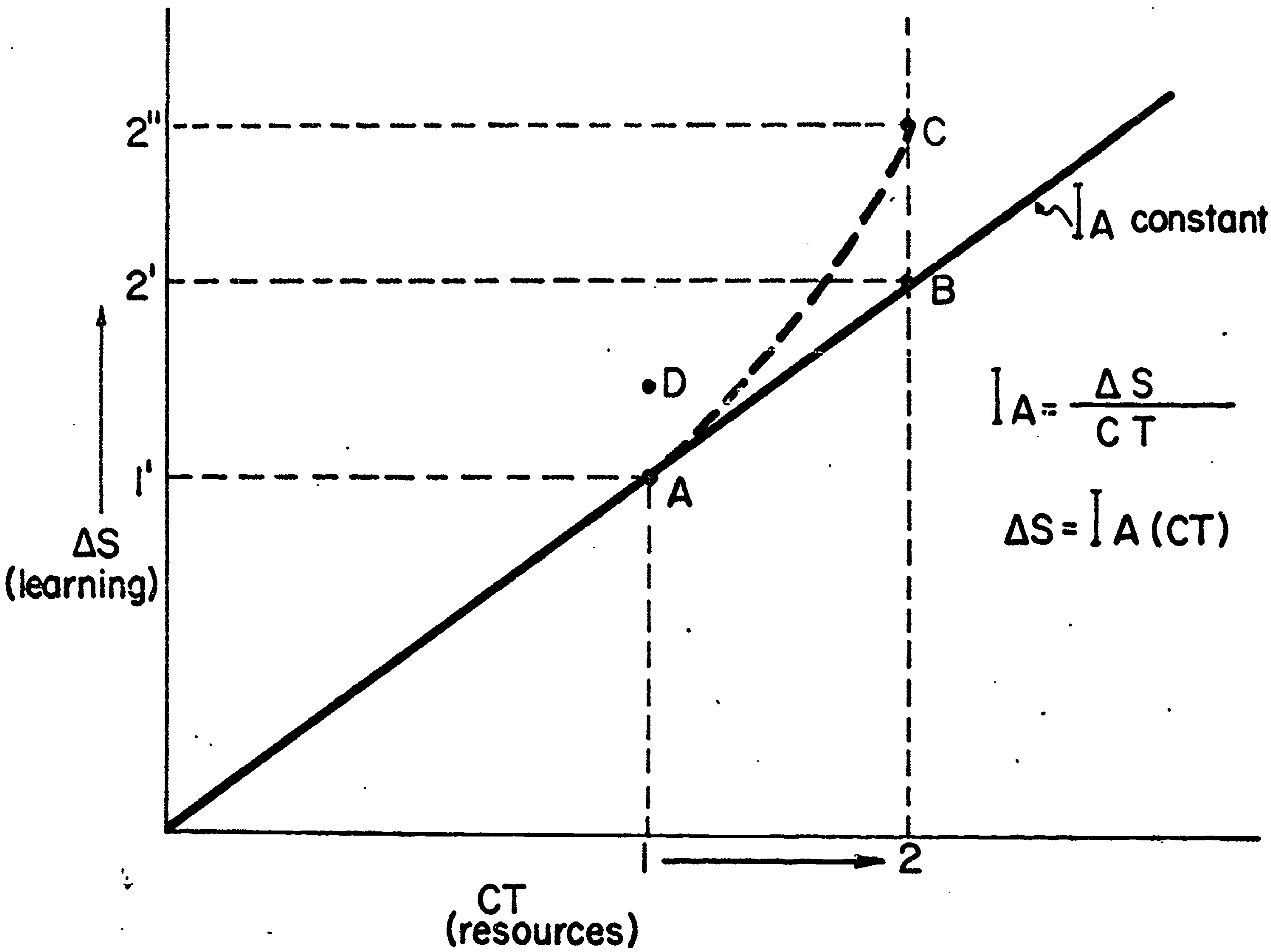


FIG. 1 INTERPRETATION OF INCREASES IN THE ΔS/CT RATIO.

If the initial version of a module consumes the resources indicated by position 1 on the CT axis and results in a level of learning indicated by position 1' on the ΔS axis, then point (A) establishes the straight diagonal line on the previous figure. If a second version is then developed which utilizes more resources as indicated by position 2 on the CT axis, reference to point (B) above and hence to position 2' on the ΔS axis gives the breakeven point for resultant improvement in learning (the anticipated directly proportional increase). The same value of I_A would result. For a higher I_A value, the resultant learning from the resource increase would have to climb at some disproportionately higher rate, indicated by the dashed curve, so that some higher point (C) would be reached and a level of learning (2") would be attained. A similar argument can be made for reductions in the CT resource input. An effort to provide different activities at the same resource level would simply be an effort to get more learning (point D) through an equally expensive but different instructional strategy.

Figure 1 is thus useful for determining the performance required of a subsequent version in order to be considered an improvement over the existing one.

Figure 2 illustrates the variations in I_A as the resource input varies while learning remains constant. In cases where it is believed possible to reduce the resource expenditure without incurring any decrease in learning, this figure is useful in predicting the resulting higher I_A value. For example, if one version of a module results in a ΔS of 90% (lower curve), for a (CT) resource input of .9 dollar-hours, the resultant I_A value would be 100. If a new version could be produced that would require an expenditure of only .6 dollar-hours, then from the graph it can be seen that the I_A value would rise to 150 provided ΔS did not change. If the same example had involved ΔS constant at the 100% level (upper curve), then I_A would have risen from 111 to 167.

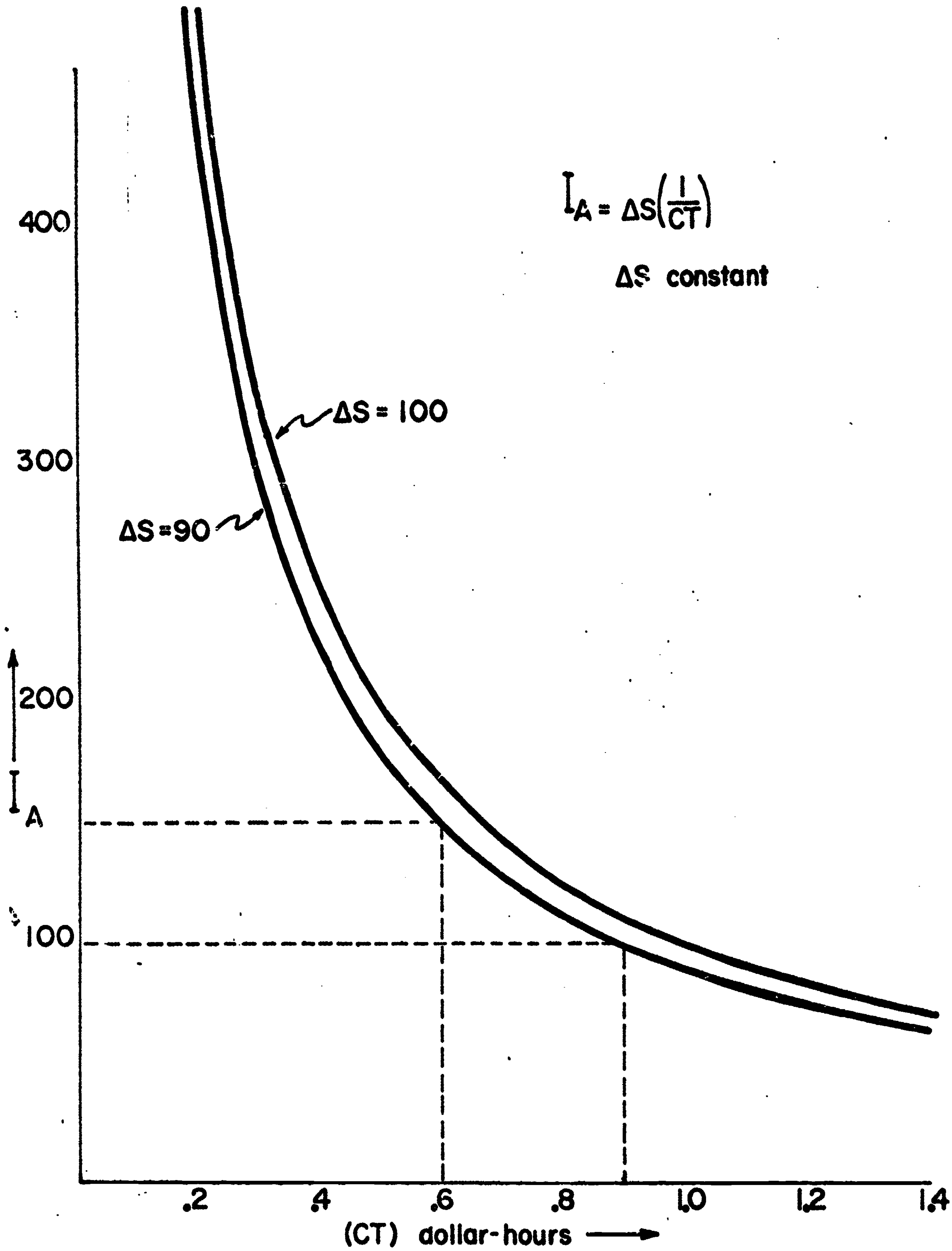


FIG. 2 THE I_A INDEX AS A FUNCTION OF EXPENDED RESOURCES WITH LEARNING HELD CONSTANT

It is easy to see in figure 2 how the value of I_A increases with a positive acceleration as resources are conserved and the learning level is maintained. This results in a disproportionately higher reward for the increasingly efficient use of resources. The I_A value is very sensitive to variations in resources near the lower limit, especially within the 0.0-1.0 dollar-hour range.

III. Applications of the Instructional Accomplishment Index

A. COMPARISON OF VERSIONS FROM DIFFERENT SOURCES

The following example involves the use of the I_A index to compare three different versions of a module. These versions are the products of different design teams, and the situation is typical of what might be expected if the same module were developed at three different institutions. Once a module is defined in terms of its behavioral objectives and there is agreement on what shall constitute a valid test of the attainment of those objectives, then the instructional accomplishment index provides a useful method of comparing all completed versions that come forth from whatever source.

Suppose that a biology module is being prepared covering the sprouting characteristics of corn, and that the objectives have been specified and the tests written. Three versions of the module exist, each featuring a different set of instructional activities intended to insure the learner's attainment of the same set of behavioral objectives. These versions represent the efforts of three different teams of instructional designers each of which has produced what it believes to be the best approach to the task.

1. VERSIONS: The first team of designers decided that th's

content could best be taught by using realistic plastic models of corn sprouts in various stages of growth. They purchased such a set of materials from a biological supply house and built a module around the use of these models. Their design utilizes tape recorded directions for the learners who are told how to examine the various models and to record their observations on a special response sheet. At the end of the lesson the narrator sums up what the student should have learned. The total development cost for materials and labor to accomodate 400 students is $250 for the completed module plus an additional 3¢ per student for furnished expendable materials.

The second team of designers discount the value of the models and instead use a slide-tape program featuring photographs of real corn sprouts and illustrative line drawing done by an experienced instructional illustrator. A student response sheet is used during the program for recording responses requested by the program, and a summary in the form of a set of written notes is provided to each student for purposes of review study. The total development cost for materials and lab is $375 plus an additional 4¢ per student for furnished expendable materials.

The third team of designers supply each learner with a quantity of real corn sprouts which have been preserved in a solution and acquired from biological suppliers. The learner gets a list of questions which he is expected to answer by examining the preserved specimens. In addition, this team shoots a 15 minute Super-8 motion picture which uses time lapse photography to show corn grains in the process of sprouting. The total development cost of this module is $525 plus an additional 10¢ per student for furnished expendable materials.

2. <u>TESTING THE VERSIONS</u>: Suppose that these three versions of

the module are tested on three similar groups of learners. Each test group has 400 students and is randomly drawn from a pool of 1200 students having a pretest mean of 40%.

The first group, using the plastic models with taped directions and a response sheet, tended to waste some of their time in excessively handling the models and trying to discriminate their features. This group had a mean time of 48 minutes and a mean posttest score of 88%. The second group, using the more structured and paced slide-tape approach with response sheet and notes, had a mean time of 42 minutes and a posttest mean of 92%. The higher test score was apparently the result of good structuring of the basic presentation and the student's use of the notes for review. The third group, using the preserved specimens and the film, had a mean time of 56 minutes and a posttest mean score of 93%. The preserved specimens were messy to use and it was more difficult to see their characteristics than when either the plastic models or the good line drawings were used. Thus the students took a longer time with this version, yet their test results were the highest of the three groups.

3. DETERMINING THE COST PER STUDENT: The question is how to rank these three instructional accomplishments. Before applying the instructional accomplishment index to these three cases, it is first necessary to determine what costs are to be considered. The production costs in terms of labor and materials have been specified for the three versions as $250, $375, and $525. For the sake of this example, it shall be assumed that in each case sufficient materials were produced to enable a group of 400 students to be accomodated, and it shall further be assumed that the necessary facilities to accomodate them in the intended way are available. This might be a Learning Center which can provide

individualized instruction to as many as 400 students who must get through a given module within a specified period of time. Regardless of the version of the module being used by a student, in this example an overhead cost factor of 5¢ per student will be included in the cost figure for each student studying a module of instruction in the facility. The cost factor used for the instructional accomplishment index computations will thus consist of the amortized per student production cost, the per student cost of furnished expendable materials, and the overhead factor for facility use.

The amortized per student production cost is not meaningful if it is simply amortized over the interval of the test if the materials actually last longer than the test interval or would be suitable for use with groups larger than the test group. For example, a costly set of slides might be used by the test group and suffer almost no depreciation either through wear or through the outdating of their content. To divide the production cost by the number of test subjects would result in a much higher per student cos actor than would be the case if the cost were divided by the total number of students who could use the slides during their potential useful life. Similarly, the cost of a videotape broadcast to the test group would have a much higher cost-per-student factor for the test group alone than if the production costs were divided by the vast numbers of potential users who might use the videotape if it were broadcast as part of an extention course. The quality of an instructional accomplishment must be based in part on the potential real cost per student rather than on the cost per student only during the test. Thus, while the test interval is all that need be considered in order to determine valid means for the test scores and the learner time consumed by the module, if either the useful life or the capacity of the materials exceeds the time limit or number of students in the test group respectively then the cost per student must be determined on the basis of the projected longivity of the materials or the magnitude of their audience in normal nontest use.

Production costs must be broken down into two catagories, the initial design and production costs that are incurred only once and the costs of reproduction of multiple copies of the materials. It is only the former costs which are amortized over the useful lifetime of the module. The latter costs involving the reproduction of multiple copies of the materials are amortized over the useful lifetime of the material. A version of a module may remain in use a long time during which the students wear out numerous copies of its materials.

It is difficult to anticipate the useful life of a module, because that life can be terminated by a number of unforeseen factors such as the introduction of new knowledge, new curriculum revision plans, or the introduction of a superior version. Nevertheless, an estimate does need to be made so that the initial development costs can be amortized realistically.

The anticipated physical life of materials subjected to repeated use by students is somewhat easier to estimate. Extrapolations can be made on the basis of physical deteriorations measured during the test interval. If the test interval is not of sufficient length to provide useful deterioration data, then it may be useful to conduct independent destruction tests on the materials and search out other test results on the physical life of such materials. These costs can be reduced to a fixed increment per utilization which amortizes the cost of the materials over that number of utilizations determined to be their mean physical life.

Let us now return to our example. We shall assume in this case that the content is sufficiently stable so that no updating of the content because of new knowledge is probable in the relevant future. Therefore, for purposes of comparing the three versions of this module about corn sprouting it will be presumed that each version would have a life of three years, a somewhat arbitrary interval beyond which a superior version would have been found to replace the initial one. If the test group of 400 students is taken to be the number who would typically study this module during a semester, then over a three year period about 3,000 students would use the module assuming summer session loads were about one-third as heavy as during regular semesters. Therefore, initial development costs, excluding multiple copies of materials, are to be amortized over 3,000 students in order to compute the development cost per student.

The expendable materials must be treated in two catagories: 1) those materials furnished to each student and not retrieved for use by others, and 2) those materials which are used repeatedly by many students and which wear out over a period of time and have to be replaced. The former type consists mostly of single use documents such as worksheets or response sheets. These costs for the three modules have already been specified as 3¢, 4¢, and 10¢ per student. The following table shows the breakdown of costs for initial development (amortized over 3,000 students) and the cost of the multiple copies of reusable materials (to be amortized over their mean physical lifetimes).

Initial Dev. Plus Copies for 400 Students	Initial Dev. Only	Cost Per Student (3,000 students)	Initial Copies (cost for 400 students)	Cost Per Student (reusable materials)
$250	$200	6.7¢	$ 50	1.9¢
$375	$225	7.5¢	$150	6.2¢
$525	$400	13.3¢	$125	9.4¢

TABLE I: AMORTIZATIONS OF INITIAL DEVELOPMENT AND MULTIPLE COPY COSTS.

In the above table column one is the sum of columns two and four; column three is column two divided by 3,000 (the number of students who would use the module during the three year lifespan of the version). Column five is computed by estimating on the basis of experience the mean physical lifetime of the reusable materials (tapes, slides, films, etc.) in terms of the number of individual utilizations they can stand (based in this example on 400 per semester and 400/3 per summer session). This number of students is then divided into the cost of those multiple copies which is listed in column four.

An examination of column two reveals a substantially higher development cost for the third version. While the first two involved the development of tapes and slides, the third version involved the development of a time lapse motion picture. In general, it is more costly both in time and money to design and produce good motion pictures, and this is reflected.

The differences in column five reflect both the differences in cost for multiple copies as reflected in column four and the very different rates at which the different types of materials wear out. The first version had a low initial multiple copy cost because it involved only tape recordings. In addition, simple tape recordings last a relatively long time compared to either synchronized slide-tape materials or motion picture films. Because the tapes would last almost as long as the projected life of the version (three years), the number of students who would use these initial copies is just slightly under the 3,000 total students who would use the version over its lifetime. The actual estimate is 2,600 students for which the $50 cost amortizes to 1.9¢ per student.

There is more to go wrong with a slide-tape program both because of the addition of slides and because the automatic slide advance pulses on the tape increase the probability that the tape will not continue to function properly. Hence, the physical lifetime of the initial materials for version two is projected to be slightly less than that of the simple tapes in version one. It is estimated that the slide-tape materials would last only through the first 2,400 students for a cost per student of 6.2¢.

Version three involves the multiple use of copies of Super-8 motion picture film which cost a total of $125 to provide. However, film does not stand as many plays as do slides or tapes; prints become scratched, sprocket holes tear, and splices become frequent as the breaks are repaired. It is therefore estimated that the film prints will last only three semesters plus the intervening summer session thus serving 1,333 students. The initial multiple copy cost of $125 for the prints thus amortizes over 1,333 students to yeild a cost per student of 9.4¢.

The following table summarizes the various costs for each of the three versions with all costs expressed in terms of the cost per student per interaction with the module.

	Version I	Version II	Version III
Use of Instructional Facilities	5.0¢	5.0¢	5.0¢
Initial Development Amortized Over Three Years	6.7¢	7.5¢	13.3¢
Single Use Materials	3.0¢	4.0¢	10.0¢
Multiple Use Materials Amortized Over Their Expected Physical Life	1.9¢	6.2¢	9.4¢
COST PER STUDENT:	16.6¢	22.7¢	37.7¢

TABLE II: SUMMARY OF COSTS PER STUDENT FOR THE THREE VERSIONS

4. DETERMINING THE LEARNING (ΔS): Before a computation of the I_A indices can be made for the three versions, it is necessary to compute the learning factors (ΔS) for use in the numerator of each I_A (see sections II-B and II-C). The following table gives the ΔS learning factor for each version based on the posttest results presented in section III-A-2.

	VERSION I	VERSION II	VERSION III
$\Delta S = \frac{S_f - S_i}{100 - S_i} \times 100 =$	$\frac{88 - 40}{100 - 40} \times 100$	$\frac{92 - 40}{100 - 40} \times 100$	$\frac{93 - 40}{100 - 40} \times 100$
	= 80.0	= 86.7	= 88.3

TABLE III: LEARNING FACTORS FOR THE THREE VERSIONS FOR USE IN COMPUTATION OF THE I_A INDICES.

These values represent the attained percentage of those objectives remaining to be attained beyond those already attained at the time of the pretest.

5. TIME AND COST EXPRESSED FOR USE IN THE I_A COMPUTATIONS: Time is to be expressed in hours. From section III-A-2 the comperative tests of the versions yielded mean times of 48, 42, and 56 minutes respectively which equal .800 hr., .700 hr., and .934 hr.

The costs per student expressed in dollars, from the bottom of Table II, are .166 dollars, .227 dollars, and .377 dollars.

6. COMPUTATION OF THE THREE I_A INDEX VALUES:

VERSION I	VERSION II	VERSION III
$I_A = \frac{\Delta S}{C \times T}$	$I_A = \frac{\Delta S}{C \times T}$	$I_A = \frac{\Delta S}{C \times T}$
$= \frac{80.0}{.166 \times .800}$	$= \frac{86.7}{.227 \times .700}$	$= \frac{88.3}{.377 \times .943}$
= 603	= 546	= 248

7. INTERPRETATION AND ANALYSIS OF THE THREE I_A VALUES: According to the results above the first module represented the best instructional accomplishment. It must be noted however, that it did well because of its low cost. This first module failed to yield a posttest mean of 90% during the test period; if a criterion level of 90% were being employed, then a large number of students who used this version would not be attaining the criterion level by the time of their first attempt at a posttest. Forcing all students scoring below 90% on the posttest to continue studying the module until they could score at that level would result in the time factor increasing sufficiently to reduce the I_A value well below that of the second version.

Both the second and third versions resulted in sufficient learning to yield mean posttest scores above 90%, but the excessive dollar and time costs associated with version three resulted in its much lower I_A index. Although version three resulted in a two per cent higher posttest score, the vast difference in the I_A index for versions two and three suggest that the approach used in version three should probably be abandoned in favor of slight but hopefully effective refinements of versions one or two.

It is obvious that great economies can result in an extremely low denominator, especially in the dollar cost factor. For example, a version might consist of materials limited to only mimeographed pages of print. The cost would be only a few cents per student, and with even modest learning on the part of the students, the I_A value could become very high. This tends to happen because the first points scored on tests usually come easily while it becomes increasingly difficult to attain an increasingly higher score. Cheap and less effective materials may result in a disproportionately high score level on the posttest, up to a sufficient level to provide enough numerator value in the I_A expression so that the I_A value can become high, and yet ΔS will still not reach a satisfactory level of learning. The performance of version one in the previous example is an instance of this phenomenon. The solution is either to impose a criterion level on the mean posttest score using first-attempt scores, or to force all students to make the criterion level score prior to computing the I_A value so that their extra time spent in re-cycling is reflected in an increased time factor in the denominator.

B. COMPARISON OF SUCCESSIVE EDITIONS OF A MODULE

An instructional organization which is producing and utilizing modules of instruction should constantly be collecting data on the performance of its modules and turning out new editions of them on the basis of that feedback. The use of the I_A index permits a comparison of each new edition with that of the older ones to see if the desired improvement has resulted.

C. CONTESTING FOR FUNDS

Much instructional development is funded by government agencies, foundations, or other granting institutions, and competition for the funds is frequently strong. An agency may be confronted with similar proposals from two or more sources each claiming to be both competent and efficient in the design of instruction. The agency could simply grant each competitor a small sum to produce their version of a test module for which the granting agency would specify the behavioral objectives. A reasonable time limit could be set, and the agency could supervise an independent test of the resultant versions. The resulting I_A values could be used as an indication of the competence of the competitors with subsequent substantial grants going to those who demonstrated their superior abilities. In this way, for the expenditure of a few months time and a few thousand dollars, an agency could have a far more fair and objective way of determining to whom it should give its money. The cost of such a test is small compared to the many instructional development grants which range into the hundreds of thousands of dollars.

D. VARIABILITY OF THE I_A VALUE FOR A GIVEN VERSION

The I_A value associated with a version of a module is not an intrinsic property of that version, but is instead associated with a particular situation involving its use. From one situation to another there may be changes in the nature of the target population which will result in significantly different ΔS values and (T) values. There may also be different factors entering into a determination of the cost per student. For example, one organization may develop a version and have to amortize the development costs; later it may sell some copies to another institution which would compute its cost per student on the basis of an amortization of the purchase price. The development and purchase costs may be very different. Thus the I_A of a version must be recomputed for the situation of its current use or concern, but such necessary data as might remain relevant can be carried forward and included in any new calculation of the I_A value.