CONTENTS

2 The Journal Of Instructional Development: Need, Purpose, Scope, Policies, Future, Kenneth H. Silber

4 EXCELLENCE IN INSTRUCTIONAL DEVELOPMENT A SYMPOSIUM

4 Introduction To The Symposium, Kenneth H. Silber

5 Needs Assessments: Internal And External, Roger Kaufman

8 Types Of Capabilities And Learning Hierarchies In Instructional Design, Robert M. Gagné

10 Content Analysis Via Concept Elaboration Theory, M. David Merrill

13 Teaching Conceptual Networks, Susan M. Markle

18 Selecting Instructional Strategies Or Once You’ve Got An Objective, What Do You Do With It?, Gerald W. Faust

Insert, Questionnaire: Future Of The Journal Of Instructional Development, Your Response Is Important

23 Individual Differences And Instructional Design, Richard E. Snow

26 The Dance Of Evaluation: Hustle Or Minuet, Eva L. Baker

28 Can You Really Do Instructional Development On 2¢ A Day? Kent L. Gustafson, Ph.D.

30 Call For Articles

31 A Case Study: Developing Convergent Formative Evaluation Methodology, Thomas M. Schwen And John M. Keller

35 Rural Education In Bolivia And The Potential Of Educational Technology, Larrie E. Gale
The Journal Of Instructional Development: Need, Purpose, Scope, Policies, Future

Kenneth H. Silber
University Professor of Educational Technology
Governors State University
President of DID

Based on the belief that the instructional development process is a viable, but still growing, technique and force for the improvement of education and training at all levels and in all settings, the Journal of Instructional Development has as its purpose to contribute to the analysis and improvement of instructional development in the form of quality, professionally-oriented articles, and to stimulate communication among theoretically- and practically-oriented instructional developers.

Need for the Journal

The idea for the development of the Journal began with a problem symptom communicated to the Division for Instructional Development of the Association for Educational Communications and Technology; the symptom was that there currently existed no vehicle for the dissemination of information about instructional development nor for communication among instructional developers.

A review of currently existing journals indicated that this observation was essentially correct. No journal devoted itself expressly to instructional development and instructional developers. Though many journals contained articles related to instructional development, three problems with current journals were identified: a) some dealt with instructional development as only a minor portion of their total concern; b) some dealt with only the research aspects of instructional development, c) some dealt with instructional development at a very low level of sophistication.

A needs assessment, involving DID members and editors of current journals, was conducted. Ninety percent of those responding agreed that a Journal of Instructional Development was needed.

It is based on this problem identification process that the purpose statement above, and the decisions about the Journal below, are based.

Audience

The primary audience for whom the Journal is designed are practicing instructional developers at all levels and in all settings of education and training. As a professional journal, its readers are expected to have some knowledge of the instructional development process, its vocabulary, and the issues in the field — either through academic training or through experience. A secondary audience for the Journal are instructors of instructional development — those teaching the process to others.

The Journal may also be useful to students studying instructional development. The degree to which they will benefit will depend upon prior training, and the assistance they receive from their instructors interpreting the information contained in the articles.

Scope/Types of Articles

The Journal will carry articles related to instructional development within the following parameters.

Topic Areas
1. theories, models, conceptual frameworks of instructional development;
2. techniques for designing and evaluating instructional systems;
3. reports on evaluations of instructional development projects;
4. case studies of instructional development projects.

Focus
1. the performance of the instructional development process;
2. the management or implementation of the instructional development process;
3. the teaching of the instructional development process.

Location, Setting, Level The Journal will publish articles related to instructional development as it is carried out in any country, in any educational or training setting, and for any level of students.

Instructional Development Materials
The Journal will consider the publication of instructional materials designed to improve the skills of instructional developers. This aspect of the scope of the Journal, while based on the model set by many medical and hospital journals, still needs more delineation.

Policy Regarding Selection of Articles
To ensure that the Journal maintains its quality and professional nature all submissions will be reviewed by an Editorial Board using pre-specified criteria. Only articles which, in the judgement of the Editorial Board, meet the criteria will be published.

Criteria for Selection of Articles The setting of criteria by which to evaluate articles related to instructional development is extremely difficult. In his article "Professional Scholarship in Educational Technology: Criteria for Judging Inquiry" (AVCR, Vol. 25, No. 1, Spring 1977), Schwen set forth eight criteria for judging inquiry, but cited descriptive evaluations, case studies, summaries of development projects, and statements of development models as negative exemplars of articles meeting all these criteria.
While it may be true, at present, that inquiry in instructional development does not meet all of Schwab's criteria, it is the belief of the Journal Editorial Board that articles meeting a subset and slight modification of these criteria are worth publishing due to their utility for instructional developers. Therefore, the following criteria will be used to judge the acceptability of submitted articles for publication:

1. Does the article fall within the Journal's purpose and scope?
2. Is the inquiry described in the article publically verifiable, or, are the activities described in such a manner that others can understand, examine, and to some extent replicate the plan used in the inquiry?
3. Is the inquiry described in the article disciplined, or, is the problem described with precision; are the assumptions and boundaries of the inquiry carefully delineated; is the report explicitly focused on logical consistent outcomes; are the outcomes set forth in language that is descriptive, coherent, and concise?
4. Is the inquiry incorporated within a conceptual structure or theoretical framework; does the inquiry go beyond day-to-day tasks and problem symptoms to address a fundamental question related to the instructional development process?
5. Does the inquiry incorporate what others have already learned; does the article indicate that the author is aware of what others have already reported about the topic being addressed and similar topics?
6. Can the results of the inquiry be generalized; does the article postulate, confirm, uncover, or cast doubt on some generalizations, procedures, heuristics, etc. related to the instructional development process that can be of use to other instructional developers? To judge the ability to generalize results, three criteria will be used:
   a) logical extension: are the general conclusions drawn a logical extension of the problem studied, the activities performed, the conceptual structure and previous inquiry on which the study is based, and the results obtained in the specific situation?
   b) utility: will the general conclusions be useful to other instructional developers? Can they be used by other developers, recognizing limitation, as guidelines or heuristics for work in other settings?
   c) clarity: are the general conclusions stated in a clear enough manner for the reader to understand how they might be applied to other situations?

Editorial Board The role of the Editorial Board will be to read all submissions to the Journal and to evaluate them according to the above criteria. The Editorial Board is, at present, made up of the President, President-Elect, and Past President of the Division for Instructional Development, and three appointees. In the future, it is expected that the composition of the Editorial Board will be expanded to provide a broad range of expertise and a diversity of opinion regarding instructional development.

Future/Evaluation and Openness to Change

Just as the Journal of Instructional Development began with the "identify problem" step of the instructional development process, so will its future be determined by the "evaluate/recycle" step of that process.

All that has been discussed above regarding the Journal at present is open to revision based on responsible feedback from readers of the Journal and others affected by the Journal. We expect that many aspects of the Journal will change, and are open to that change.

To obtain feedback, an extensive questionnaire, covering all aspects of the Journal, is included at the end of this issue. We urge all readers to examine carefully what has been said above, to read the articles included in this issue, and then to fill out and return the questionnaire.

Concluding Thoughts

We believe we have created the new Journal of Instructional Development in response to a real, identified need, and that we have developed the purpose, scope, and policies of the Journal to meet that need. We look forward to the continuation, and possible expansion, of this journal to serve instructional development and developers. But, ultimately, the future of the Journal rests with you — the reader. Your response to the Journal will determine what happens next.
EXCELLENCE IN INSTRUCTIONAL DEVELOPMENT

A SYMPOSIUM

NEEDS ASSESSMENTS: INTERNAL AND EXTERNAL
by Roger Kaufman

TEACHING CONCEPTUAL NETWORKS
by Susan M. Markle

TYPES OF CAPABILITIES AND LEARNING HIERARCHIES IN INSTRUCTIONAL DESIGN
by Robert M. Cagné

SELECTING INSTRUCTIONAL STRATEGIES
Or Once You've Got an Objective, What Do You Do With It?
by Gerald W. Faust

CONTENT ANALYSIS VIA CONCEPT ELABORATION THEORY
by M. David Merrill

INDIVIDUAL DIFFERENCES AND INSTRUCTIONAL DESIGN
by Richard E. Snow

THE DANCE OF EVALUATION:
HUSTLE OR MINUET
by Eva L. Baker

INTRODUCTION TO THE SYMPOSIUM

Kenneth H. Silber

The Journal of Instructional Development is proud to begin its inaugural issue with the papers presented at the Division for Instructional Development's "Excellence in Instructional Development" Symposium during the 1977 AECT Convention. The seven papers presented in this issue were invited addresses by leaders in the field of instructional development on aspects of the instructional development process. Following the presentation of the papers at the symposium, two reactors, Dr. Ivor Davies and Dr. Robert M. Diamond, discussed their impressions of the presentations; their reactions will be published in the next issue of the Journal.

The major purpose of the symposium was to communicate to instructional developers (including practitioners, teachers of the instructional development process, and managers of the instructional development process) the key issues and techniques of each step in the instructional development process as seen and developed by those in the forefront of the instructional development field.

A secondary purpose was to bring together at an AECT Convention, and later in an AECT publication, people who, and ideas which, are not usually available to AECT members.

The people invited to this symposium have theorized about, researched, developed, and implemented the techniques we use today, and, hopefully, will be using in the future to develop instruction. They represent a variety of disciplines, have a variety of interests in different parts of the ID process, and, in some cases, have differences of opinion regarding how certain steps in the process ought to be performed.

The ideas presented in their papers represent what I believe to be the cutting-edge ideas in instructional development — ideas which instructional developers must understand, interpret, and implement in their work if we are to contribute to excellence in education.

The papers are presented in a sequence that somewhat parallels the sequence of the process of instructional development:
Dr. Kaufman, one of the pioneers and leading exponents of the use of needs assessment in the instructional development process, stresses the importance of performing needs assessments as the first step in developing instruction.

Dr. Gagné, the pioneer in the development of the ideas of types of learning and capabilities, and of learning hierarchies, explains their utility in designing and sequencing instruction.

Dr. Merrill, one of the leading exponents of the use of content analysis rather than task analysis and capabilities and hierarchies to structure instruction, explains the technique for using this alternative approach.

Dr. Markee, one of the pioneers in the development of a set of rules for teaching concepts, explains some of those rules, and how to relate concepts to one another.

Dr. Faust, who, along with Dr. Merrill and others, has developed a sophisticated model for instructional strategy and media selection in instructional development, explains the elements of the model, and how it can be applied.

Dr. Snow, who, along with Dr. Chomsky, has just written the definitive book on aptitude-treatment interaction, explains what ATI is, and how it can alter instructional strategy and media selection.

Dr. Baker, who is one of the pioneers in the application of formative evaluation techniques to the instructional development process, explains the what and why of this technique for discovering whether all that has been said before really works.

Dr. Davies, an advocate of humanism in instructional development, and Diamond, instructional development's leading pragmatist, will react to the substance, utility, and appropriateness of the ideas presented from their own, unique, frames of reference.

**NEEDS ASSESSMENTS: INTERNAL AND EXTERNAL**

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A series of professional papers concerned with educational learning technology. Quotations from these papers is permitted with prior approval of author.


Occasional Paper No. 4
April 27, 1977

In recent work, it was suggested (Kaufman, 1977) that there were at least six varieties of needs assessment, one for each of the six steps of a “system approach” model (Kaufman, 1972). Based upon the starting assumptions or the actual data on hand, one could start a needs assessment at any one of the six steps.

One could start with an “alpha” needs assessment, for instance, which had no “givens” or sacred cows, and thus could look at any presenting set of problems or any situation and not have to assume much about currently operating organizations or existing policies or regulations.

A “beta” type needs assessment starts at the second system approach step, and usually assumes the validity and usefulness of the organizations which frequently sponsor or initiate needs assessments.

Four more possible varieties of needs assessments were identified: one for each of the remainder of the six steps of the generic system approach problem identification and problem resolution process. It was intended that this taxonomy of needs assessments would allow educators and other would-be problem solvers to know that different varieties and possibilities for conducting needs assessment were available, and the choice of one over others would be based upon knowledge of the possible array and thus be most responsive to the problems and organizations being addressed.

This paper deals with a possible way of separating these six modes of needs assessments into two “bundles” or types: internal and external.

**Internal View of Education**
—The Way It Is—

Most educators are hired, fired, and nurtured by an organization: a school, a district, or an agency which monitors or oversees these others. Thus any changes and problems which arise naturally tend to be viewed from the perspective of that organization. From this perspective any presenting problem, if we are part of a school district, is seen as an educational problem within the context of that district. If we were in a state educational agency for instance, that educational agency along with its policies, procedures, and history would become the frame of reference for thinking and doing. This might be best viewed as an “inside” view of a problem or problem context, and this perspective assumes that the organization in which the individual finds oneself is the proper starting point for planning, changing, or doing. This further assumes that the organization is basic, unyielding, and is the bedrock for change.
And why not? They pay the salaries, make the promotions, assign the offices, determine success and failure—why should not that organization and those bosses and opinion leaders be the beginning and end for all activity? The value placed upon personal and organizational survival seems to "drive" this perceptual frame.

External View of Education
—The Way It Should Start—

The simple truth is that what the schools do and what the schools accomplish is of concern to those who depend upon the schools, those who pay the bills and those who pass the legislation. We are not in a vacuum, and our results are seen and judged by those outside of the schools—those who are external to it. If educators are unthreatened by the concept, we will admit that the schools are a process, a means to an end for survival and contribution outside of the schools, upon legal exit from the education agency. Graduates and those legally leaving our schools might well be minimally (not maximally) judged by the extent to which they are able to exhibit behaviors and attitudes which result in their being able to survive and contribute in the world of work, world of play, world of families, and world of relationships—an external view of our education and our results (Kaufman, 1972).

This "external" referent should be the starting place for functional and useful educational planning, design, implementation, and evaluation—if education does not allow learners to live better and contribute better, it probably is not worth doing, and will probably end up being attacked and decimated by taxpayers and legislators.

Needs Assessment—Starting off Right

There are many models, varieties and concepts of needs assessment (cf. Gagné, 1977) as pointed out in the previously noted taxonomy suggestion: none are either correct or incorrect. The only question concerns which one is most appropriate for any given application.

The most basic (and useful) form of a needs assessment determines the gaps between current outcomes and required or desired outcomes based upon external survival and contribution. It reconciles differences among the educational partners of learners, educators and society, and places the needs (outcome gaps) in priority order for intended action. This is an "alpha" mode of needs assessment—the mode which takes an "external" view of the world in order to determine needs and their utility.

It is a gap analysis which determines the discrepancies between current results and required results, places these gaps in priority order, and selects those gaps of highest priority for action—for closure.

Since it looks at gaps in outcomes, not in processes, an alpha-type needs assessment is critical if one wants to identify problems before they try to solve them. It is a vital starting place for achieving educational success.

The central point is that an outcome gap analysis, which best starts at the first step in a system approach is a way of determining the problem to be addressed. The starting place, or the assumptions inherent in a selected starting place (e.g. assuming that the organization is the proper context for understanding and solving the problem or assuming that a teaching method is correct and trying to plan its implementation, etc.) is important in determining which problem will be addressed, and thus what the solution will look like and eventually accomplish (or not accomplish).

Much has been written on Needs Assessment, and the interested reader is directed to many of the writings listed in this bibliography and elsewhere.

Internal Needs Assessment
—The Way It Is Usually Done—

When most educational agencies embark upon a needs assessment, they usually start with an analysis of the discrepancies between current student behaviors and accomplishments and goals and objectives for that accomplishment. The current goals, objectives, policies, laws, rules, regulations, and procedures are thus seen as "given", fixed, and generally unchangeable.

Gaps (needs) thus harvested are in relation to the goals and objectives of the organization, and these goals and objectives are assumed to be valid, valuable, and having utility and worth.

In the earlier taxonomy context, this mode of needs assessment is "beta", since it starts with the "givens" of the organizations which sponsor it.

Gamma, Delta, Epsilon, and Zeta needs assessments, in similar fashion, are also seen as "internal" needs assessments since they also operate within the context of existing organizations.

While these modes of needs assessments are necessary to the accomplishment of the system problem-solving approach, and indeed will eventually be performed when using the system approach to problem solving—it should be carefully noted and understood that they begin with the acceptance and understanding of all of the assumptions associated with starting analysis and planning with pre-conceived goals, objectives, policies and rules of an organization already in place and operating. This reduces and limits the degrees of freedom for revision and renewal to the borders of that organization or starting referent. For instance, consider the problems of trying to use needs assessment data to convince the management of a now-defunct railroad that they were not in the correct business in the first place—that they should be moving cargo and people, not running railcars from here to there! Being "locked-in" to an organization usually means that you can only change within that organization, and usually cannot redirect that organization's goals and purposes.

So acute is this problem that Reusch (1975) warned that in our society deviations in means are considered to be only misbehaviors, while deviations in goals are considered to be subversion.

Changes to the organization other than "tinkering" with the means, the how-to-do-its, have serious consequences. The implementation of an external needs assessment, then, is a serious proposition which should be undertaken knowing that there is a distinct possibility that the people in power might not look kindly toward the results, or the major changes it might suggest.

External Needs Assessment
—The Rational Starting Place—

As we noted earlier, the external view of education starts with looking outside of educational agencies for the "payoffs" of the education enterprise and endeavors. Do children learn anything which they can use when they go to the outside world? Do learners have anything which is worthwhile when they leave the
school? Does the educational intervention have any utility when the halls of education are passed through and life outside begins? It is to this life outside, now and in the future, that an external needs assessment is addressed. Do the results outside of education have validity as well as utility?  

In an external needs assessment, criteria from actual performance (now and in the future) is used as a template for designing the goals and objectives of education (to form the basis for internal needs assessment and thus internal criteria for validity and utility) and for then selecting the best methods and means for achieving these outcomes.

Thus there seems to be a natural, logical, even rational progression for design and accomplishment which would lead us, in the planning, design, implementation, evaluation and revision of education in this manner:

Seen in this way, the starting point for educational planning and accomplishment are the realities outside of schools and school districts (and this concept is equally important in business and industry, the military, and government in order that the effort does more than seek its own continuance and makes a contribution, and in the case of business and industry, shows a proper return on investment).

Some Arguments Against an External Needs Assessment

Most people feel that they can only do what they were directed to do within the confines of good sense and judgment within their organization. This is good sense in a world which, as Reusch (1975) pointed out, tends to reinforce the status quo, and to look at even deviations in means as misbehaviors. Survival, some argue, requires that we do not "rock the boat". If one does rock the boat, then one risks, so that argument goes, losing the job.

3It is tempting to form a new word "utility" to identify the dual components of validity (accomplishing stated outcomes) and utility (having recognized worth). Thus, outcomes having internal utility would be prized within an educational agency, while outcomes having external utility would be valued in the society and community within which the schools operate in terms of making a contribution to that external community. Most educational efforts today are striving for internal utility while this presentation intends to encourage the addition of external utility to the efforts and accomplishments.

Others feel that the world will not understand basic and major shifts and redirections that changes should be made piecemeal (cf. Kaufman, 1976b), rather than a dramatic, all-at-once shift which could result in what Festinger called "cognitive dissonance".

A third argument goes "we cannot safely and completely predict the future, so it is very risky, perhaps even wrong to go ahead and change the world and the goals and objectives of those social agencies which are now operating." Lack of predictability is seen as reason for not changing.

There is some merit to these positions: it is not fun to get fired, and making errors, especially with large numbers of people, can be tragic. Change is usually more successful if it is seen by those affected as appropriate and at a pace they can "handle". Let's look at these briefly.

Is a job which is destructive, wrong or even unproductive, worth having? What are the individual job-holders' value systems relative to contributing to their fellow citizens and getting a regular paycheck? This unwillingness to recommend change, no matter how critical the change, is one which is often observed, but not often admired when seen in this light.

Moving slowly has much more merit than moving quickly and failing—if that is the choice. We do not want to change so quickly that the change attempt is abortive, and the changes never get accomplished. But an external needs assessment, if done with skill and objectivity, will yield information relative to change requirements, including the discovery of possible blocks to change so that the change, whenever required and necessary (but never for its own sake) may be phased and "gentled" in order for it to be valid, have utility, and be accepted.

The most troublesome argument is the one relating to the lack of predictability of the future. There are no crystal balls which seem to work well. Is this reason, however, not to try to predict and control the future so that future change will not be destructive? We make some predictions every day (how to drive, where to work, what to eat and not to eat—all based upon predictions of the future) and we must in order to survive. Change in our world is inevitable, the only question is whether we will be the masters or the victims of change. If we have a responsive and responsible method of planning, doing and revising, then we can see where our predictions are becoming incorrect and change in mid-course. Because we cannot completely predict the future is not a rational reason for the maintenance of the status quo. It would seem to make some sense to try to predict the requirements for survival and contribution in the future, and with sensitivity and analysis be willing to, and when required, shift what we are doing as well as how we are doing the job. As things stand now, not using an external needs assessment referent (and thus not obtaining external validity and utility criteria) means that we will just continue that which is now going on, or only find more efficient ways and means to do what it is we are already accomplishing.

The arguments against an external needs assessment might be looked into in terms of resistance to change resulting from a shift from the known and comfortable to the unknown and the possible discomfort which comes with change. The arguments are not without merit, and one tempted to conduct an external needs assessment should attend carefully to the risks before proceeding.

4In earlier works, this distinction has been referred to as one between a "system approach" (which takes the external view before progressing with the internal), and the "systems approach" which starts with the internal view (cf. Kaufman, 1972).
Summary

There are two possible overarching referents for needs assessment: one which looks at needs from the point of view outside of the organization doing the study, and one which looks at needs from within that organization. The external view is here called, unsurprisingly, "external needs assessment" and the other is termed "internal needs assessment". Most current activities in needs assessment are of the internal variety. The external needs assessment is suggested as a rational and logical starting place for organizational effort (including learning design) in that it studies and identifies the skills, knowledges and attitudes which are important outside of the school (or organization) and uses that information as the basis for educational design and effort. The internal needs assessment goes from that point forward to identify internally useful and worthy goals, objectives, methods and means to meet those required and desired outcomes. Most current effort in needs assessment is of the internal variety, and it is strongly urged that this referent be augmented with the external needs assessment data and information.

References


TYPES OF CAPABILITIES AND LEARNING HIERARCHIES IN INSTRUCTIONAL DESIGN

Robert M. Gagné
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As I understood my assigned task as a speaker, I was to describe what kinds of skills and competencies should be aimed for in the training of specialists in instructional development, and also to describe how the concept of the learning hierarchy might be used in planning such programs. I realize that I need to speak more generally about capabilities as they might occur in any field of study, not just that of instructional development itself. I hope that my remarks will serve both the narrow and the broad purposes.

The initial thought to be expressed here, it seems to me, is that one has to deal with appropriate levels of generality and specificity. At the more general level, learning hierarchies suggest the techniques of task analysis and classification of program objectives, both of which are technologies I believe to be of definite relevance to the design of educational programs. Stating this idea in another way, there are some general decisions to be made in the design of a program of training for instructional development specialists. These have to do with, first, the analysis of projected occupational activities to reveal the kinds of tasks required of people in this field. Once this has been done, a further step is to analyze the tasks to see what kinds of learnable human capabilities (sometimes called competencies) are involved. These competencies are then classified, in order to identify the general nature of conditions needed for instruction. At that point, the technique of learning hierarchies may indeed come into play. What this technique is designed to reveal is the prerequisites for learning the kinds of performances required. Specifically, these are the intellectual skills—the enabling skills, as they are sometimes called—which may be expected to form a major portion of the objectives of a training program.

Task analysis. Let me then say a few more words about these more general approaches to the design of instructional programs for instructional designers. The first job is, as I have said, making an analysis of what instructional development people do, in order to arrive at a basic list of human tasks.

Methods of conducting investigations of job tasks are rather well known, and have been widely employed in recent years. Some good examples exist in the closely related field of "Educational Research and Development." This field is not simply closely related, but in fact contains many overlapping sets of human tasks, since "educational development" and "educational technology"
are really not always viewed as distinguishable job areas from "instructional development." For these reasons, I believe that studies of tasks required in Educational R & D are excellent models for the analysis of tasks required in instructional development. Three major efforts have been undertaken in this field. One is by a task force of the American Educational Research Association, reported by Worthen and his associates (1971). A second, directed by Schulack (1972), is titled The Oregon Studies: Research, Development, Diffusion, Evaluation. And a third is a project of the Far West Regional Laboratory, under the direction of Paul Hood (1973).

These three studies, independently conducted, drew highly similar conclusions about the tasks involved in jobs having responsibility for educational R & D, including instructional development. One study identified 69 task categories, another 197, and the third 260; of course, these represent different levels of specificity, which can nevertheless be made comparable in terms of their content. I cannot, of course, repeat the substance of these lists here. According to the Far West Laboratory report (Hood, et al., 1973), they tend to fall into the following general categories:

1. Collecting information on development techniques
2. Analyzing alternative development solutions
3. Planning and designing for product development
4. Developing a product
5. Implementing the product
6. Evaluating the development process
7. Communicating the development process.

Analyzing and classifying learning objectives. Once we know what the tasks are that are performed by instructional technologists, the next step is to see what they contain in terms of their learnable capabilities (or "trainable competencies"). A certain amount of psychological sophistication is apparently required at this stage. In particular, one is interested in distinguishing competencies that can be learned in an educational program from several other categories: (1) those that cannot be learned; (2) those that can only be learned over a lengthy period of time; and (3) those that are so simple they can be learned at once without a period of training.

In making this kind of a competency analysis, I believe it is helpful to conceive of competencies in terms of certain broad categories of learning outcomes, which I call intellectual skills, verbal information, and attitudes. For the moment I ignore consideration of the two additional categories—cognitive strategies and motor skills. A brief definition of these categories—five in all—is shown in Figure 1.

Figure 1. Learned Capabilities

<table>
<thead>
<tr>
<th>TYPE</th>
<th>EXAMPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verbal info</td>
<td>Stating a fact</td>
</tr>
<tr>
<td>Intellectual</td>
<td>Applying a rule</td>
</tr>
<tr>
<td>Cognitive</td>
<td>Originating a novel plan</td>
</tr>
<tr>
<td>Strategy</td>
<td>Choosing a preferred activity</td>
</tr>
<tr>
<td>Motor skill</td>
<td>Executing a motor performance</td>
</tr>
</tbody>
</table>

The three categories of greatest relevance are, as I have said, intellectual skills, verbal information, and attitudes.

Each of these varieties of competency would seem to be valuable for the instructional developer. Obviously, he or she must possess many intellectual skills, of the sort involved in analyzing human tasks, identifying requirements for instruction, matching characteristics of media, and evaluating the outcomes of new instructional programs. Perhaps not quite as obviously, such a person needs to have considerable knowledge—knowledge about the content of the variety of subjects to be taught, and also about theories which relate such subjects to the changes in human performance which are to be brought about by learning.

I have been interested to note that an article I contributed eight years ago, entitled "Characteristics of instructional technologists" (Gagné, 1969) did not fail to mention the importance of values for the instructional developer. (Values are equivalent to attitudes). In particular, I mentioned as a desirable attitude for instructional developers "a belief in empirical evidence as a source of truth and a preferred basis for action." I would therefore reaffirm the idea that appropriate attitudes, along with intellectual skills and verbal knowledge, are valuable for the instructional developer.

I emphasize again that the five categories I have mentioned represent important distinctions primarily because they imply different requirements for the design of instruction. The next four speakers in this symposium will be talking about instructional design strategies, so I will leave that topic to them.

Prerequisites and learning hierarchies. Now if one has arrived at the point of identifying the tasks for which instruction is to be provided, identifying those that can be learned within a reasonable time, and classifying them so as to know what instructional strategies are needed, much of the work of planning the production of instructional developers has been done. Where then, do learning hierarchies come into the picture?

It is notable that they do not enter into the planning process up to this point. A learning hierarchy is not a tool for planning a total curriculum, or even a total course of study. Instead, learning hierarchies are likely to be useful in determining prerequisites for individual tasks, and for the intellectual skills that these involve. For example, suppose that one of the specific tasks involved in the area of analyzing alternative development solutions is a task such as "combining cost and benefit factors to obtain weighted averages." Obviously, this is an intellectual skill which requires the learning of some prerequisite skills (computing cost factors, computing benefit factors, using an expression to obtain averages, etc.). Certainly, the development of learning hierarchies to identify prerequisite skills can be of benefit to the planning of instruction, for a task such as I have mentioned, and for many others having similar characteristics.

Notice that I say (Gagné, 1968) that learning hierarchies are only applicable to the learning of intellectual skills, not to verbal knowledge or attitudes. Nevertheless, as I have just previously stated, I believe that these categories of learning outcomes are at least equally important for the instructional developer to acquire.

Learning hierarchies are often considered to be guides to the sequencing of instruction. However, they also have some other implications for the design of instruction. Basically, a learning hierarchy identifies essential prerequisite skills for any given intellectual skill. A prerequisite skill is a capability that must be immediately accessible in the learner's
memory at the time new learning of the targeted skill is to occur. If it is not immediately accessible, learning may be delayed until the prerequisite skill is learned or recalled. If all the necessary prerequisite skills are accessible at the time of new learning, that learning will be very rapid. Evidently, then, this particular set of implications of learning hierarchies for instructional design pertains to the assurance of mastery and ready accessibility of prerequisite intellectual skills.

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CONTENT ANALYSIS VIA CONCEPT ELABORATION THEORY

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Presentation at AECT
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Early in my career as an instructional design consultant I took the position that my concern was not “what to teach?” but rather “how to teach?” During the past several years it has become evident that subject matter experts may know what there is to teach but that they usually do not know what to teach. It is even less likely that having decided what to teach they know how to structure and sequence this content for maximally effective acquisition on the part of the student.

Robert Gagné has probably had more influence than any other person on current methodology for structuring and sequencing instructional materials. His position has come to be called “cumulative learning theory” (Gagné, 1968). The construction of “learning hierarchies” is often standard procedure in many of the systematic approaches to instructional design and development.

The purpose of this presentation is to propose a distinctive alternative to learning hierarchies and the frequently used procedures for sequencing and organizing subject matter content which are based on this approach. For identification purposes our position will be called “concept elaboration theory” and the content structure proposed will be called a “concept elaboration network”.

A Review of Learning Hierarchies
How does one construct a learning hierarchy? “Beginning with the final task, I found it was possible to identify...subordinate capabilities related to each other in an ordered way by successively asking the question concerning each task, “What would the individual already have to know how to do in order to learn this new capability simply by being given verbal instruction?” (Gagné, 1968).

What is a learning hierarchy? “A learning hierarchy...represents...the most probable expectation of greatest positive transfer for an entire sample of learners concerning whom we know nothing more than what specifically relevant skills they start with.”...one is searching for subordinate tasks which will transfer positively to the learning of the task in question.”...what are these...capabilities that make up a learning hierarchy?...They are intellectual skills...not entities of verbalizable knowledge...one must carefully record statements of ‘what the individual can do’, and just as
carefully avoid statements about ‘what the individual knows.’” (Gagné, 1968).

“How does one know of the order assigned to the skills in the hierarchy is correct?...A general guide to such ordering is one...in which sample responses are subordinate to chains or multiple discriminations, which in turn are subordinate to classifying which in turn is subordinate to using principles or rules.” (Gagné, 1968)

How is a learning hierarchy used to sequence instruction? “A learning hierarchy...in the present state of our knowledge, cannot represent a unique or most efficient route for any given learner.”...I am not sure that a learning hierarchy is supposed to represent a presentation sequence for instruction in an entirely uncomplicated way...”...learners can acquire verbalizable knowledge, and even intellectual skills, from sequences of presentation that are altered in various ways from what may be considered ‘highly organized’...”...regardless of presentation sequence, if one is able to identify the intellectual skills that are learned, he will find them to generate positive transfer in an ordered fashion.” (Gagné, 1968)
In spite of Gagné's statement that hierarchies are not necessarily devices for sequencing subject matter, as currently used in systematic instructional development they are frequently used to determine instructional sequence. A student is usually taught each capability in turn progressing upward through the hierarchy.

A second use of a Gagné-type learning hierarchy is as an organizing device for the student. Hierarchy diagrams are often represented on the lead page of instructional segments. The box representing the content of the segment is often shaded or marked in some other way supposedly to let the student know where he is in the structure of the content.

Based on the quotations above, the use of hierarchies for sequencing or representing content structure for the student may be unwarranted extrapolations of Gagné's original intentions. What is Concept Elaboration Theory?

Concept elaboration theory is first, a procedure for representing the content structure of complex subject matter. Second, it is a procedure for determining an optimal sequence for teaching complex subject matter. And third, it is a procedure for determining an optimal presentation strategy for complex subject matter. It was created specifically as a design tool for instructional development.

Concept elaboration theory was created for teaching subject matter which requires the student to use a set of interrelated procedures or principles to produce some kind of product or solve some class of problems.

The fundamental premise of elaboration theory is that the underlying principle should be taught first. A principle is a statement of relationship between two or more concepts and most often explains why some event occurs. The principle should first be represented in its simplest form and should be illustrated via the complete procedure which can be derived. A procedure is a series of steps which must be followed in order to cause some event to occur or to derive some solution. Procedures most often indicate how to cause some event to occur. There are usually many procedures which can be derived from a single principle. In other words, first teach the principle which is fundamental to the complex procedure to be taught. Second, illustrate this principle with the most restricted but complete procedure which can be derived. Third, introduce layers of complexity by elaborating (i.e., making more complicated) the procedures involved until the student can carry out the procedure in its most complex form.

Concept elaboration theory is based on several hypotheses. First, that understanding why an event occurs, the principle, facilitates learning how to cause an event to occur or to predict its occurrence, the procedure. Second, that learning a complete procedure that is limited in scope and then elaborating this procedure by adding dimensions of complexity is more efficient and effective than mastering each step of a more complex procedure before moving on to the next step.

How is a concept elaboration network derived?

Step 1. Identify the terminal task. This is the same as step 1 in developing a learning hierarchy. This task should be represented via a carefully stated objective or via the test item(s) which will be used to assess performance.

Example. In order to briefly illustrate this procedure, consider the topic, "the accounting cycle", one of the first units in an introductory accounting course.

Objective. Given a packet of business documents such as cancelled checks, invoices, etc., which represent all of the transactions of a business over an accounting period, set up a general journal and a general ledger, enter and post the transactions, make appropriate adjusting entries, and prepare a balance sheet.

Step 2. Specify the complete procedure which is necessary to cause the task event(s) to occur or to produce the task product(s).

Example. A complete specification of the accounting cycle would unnecessarily lengthen this presentation. The following may be sufficient to enable the reader to follow the example. In actually preparing a concept elaboration network, a more complete specification is required.

The accounting cycle is as follows: Basic business documents indicate expenditures and revenue received by the business. The transactions indicated by these documents are entered one-by-one usually in chronological order, in a General Journal. These transactions are later classified as to type and transferred to appropriate accounts in the General Ledger. At the end of a specified period of time the separate ledgers are totaled, a balance sheet prepared which summarizes business activity during the period. For most businesses this summarization is complicated because some of the supplies, or inventory purchased in a given period will not be used up or sold until another period. In order to have a meaningful balance sheet, these unused supplies or unsold inventory must be credited to the accounts. These are called adjustments. Adjustments are entered into the General Journal and thus transferred to the various accounts in the General Ledger in a manner similar to actual transactions. A balance sheet is then prepared which reflects these adjustments and hence provides a more accurate picture of business activity.

Step 3. Identify the underlying principle.

Example. The accounting cycle is based on the principle that equal amounts can be added or subtracted to both sides of an equation without changing its equality or balance. The fundamental equation involved is that:

\[ \text{Assets} - \text{Liabilities} = \text{Owner's Equity} \]

If a business has $1000 in assets and has no liabilities, then the owner's equity is equal to $1000. The equation is in balance. Accounting procedures are designed to record business transactions in a way which will preserve this balance.

Step 4. Derive a procedure based on the principle which is simple as possible.

Example. The simplest procedure for our accounting example is as follows: Step 1 add up the assets. Step 2 add up the liabilities. Step 3 subtract the liabilities from the assets, the remainder is the owner's equity. Step 4 prepare a simple balance sheet to show the results. (Obviously one wants to use a very simple business to illustrate this simple procedure.)

Step 5. Identify the dimensions of complexity which when added to the simple procedure elaborate it until it becomes the complex terminal behavior.

Example. The following seem to be the dimensions of complexity for our "accounting cycle" example. For purposes of this paper they are considerably abbreviated. In a real world application greater detail would be required.

Starting with the terminal task (1) If we consider a business which starts and stops, rather than continues, we can simplify the procedure by making adjustments unnecessary. (2) If we reduce the number of accounts from many separate accounts, which is a necessity of an
actual business, to a single asset account, a single liability account, and a single owner's equity account we can simplify the procedure by entering transactions immediately into one of these three accounts making a general journal unnecessary and making posting to a general ledger unnecessary. (3) If we merely list assets and liabilities rather than recording individual transactions we are back to our simplest procedure identified in Step 4.

Step 6. Identify levels of elaboration. For each level identify the task by specifying an objective or preparing a sample test (parallel to Step 1). For each level specify the complete procedure which is necessary to cause the task event(s) to occur or to produce the task product(s). (Parallel to Step 2)

Example. For level 0 (we call this the episteme because it is the simplest representation of the principle and the procedure which still represents the entire principle).

Objective. Given a list of holdings and amount owned by a simple business, decide which are assets and which are liabilities, calculate the owner's equity, and prepare a simple balance sheet.

Procedure. Step 1 classify items as assets, liabilities or owner's investment or withdrawals; Step 2 add up the assets; Step 3 add up the liabilities. Step 4 calculate owner's equity; Step 5 prepare a simple balance sheet.

For level 1 (the first level of elaboration)

Objective. Given a limited number of transactions enter them directly into single asset, liability, or owner's equity accounts and prepare a balance sheet.

Procedure. Step 1 prepare T-account ledgers for an asset, a liability and an owner's equity account. Step 2 enter each transaction into debit column and a credit column in the accounts. Step 3 total the account. Step 4 prepare a simple balance sheet.

For illustrative purposes it is unnecessary to complete this example for all levels. The procedures provided for illustration are necessarily brief and hence incomplete. In an actual application considerably more detail is desirable.

Step 7. Based on the procedures itemized for the terminal level (Step 2) and the intermediate levels of elaboration (Step 3) identify the concepts, identities and operations involved at each level. Also identify how the principle applies at each level including any extensions which may be necessary in the underlying principle. Diagram the relationships involved.

Example. Figure 1 illustrates such a diagram for "the accounting cycle." The conventions used in this diagram are as follows: A hexagon is used to indicate an identity or set of identities. A large circle is used to indicate a concept. Concepts are included in the network only if a student must learn to classify newly encountered examples and nonexamples of the concept in order to use the operation. Concepts which the student is assumed to know are not included. A small circle is used to indicate a productive operation. Descriptive operations are not included in the network. It is understood that each concept in the diagram can be defined via domain concepts (attributes) and an appropriate descriptive operation.

Arrows are used to link domain concepts and identities to an operation and to link an operation to the resulting range concept(s). A given concept might be required by more than one operation. A range of one operation might be the domain for a subsequent operation.

Dotted lines are used to connect identities, concepts, or operations which are required in some modified form at a more complex level of elaboration. Dashed concentric circles are used to indicate levels of increasing complexity.

The terms used in defining these conventions are defined elsewhere. A repetition of these definitions in this paper would unnecessarily lengthen this presentation. (See Merrill and Boutwell, 1973; Merrill, 1973; Merrill and Wood, 1974, and Merrill and Wood, 1975).

In Figure 1 level 0 indicates that the students must learn to classify instances of three concepts: assets, liabilities, and owner's equity. Further F1.0 is the procedure for adding these separate quantities and displaying them via a simple balance sheet.

At level 1 the three concepts have been modified to include transactions classed as to assets, liabilities, and owner's equity. Also debit and credit conventions have

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List of Operations:

- P1: Balancing Accounts
- P2: Entering Transactions
- P3: Posting to Ledger
- P4: Adjustments

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Figure 1. A concept elaboration network for accounting.
been introduced. P2 is the procedure for entering individual transactions into T-accounts, \( P_{2} \) (which is similar to \( P_{1} \)) is the procedure for totaling accounts and producing a balance sheet. Space prevents our describing the whole diagram.

How is a Concept Elaboration Network Used to Sequence Instruction?

A sequence based on a concept elaboration network consists of an alternating series of integrated and segregated presentations. Starting with level 0, an integrated presentation involves (1) the presentation of the underlying principle and (2) a demonstration of the simple procedure with a specific example while showing the relationships of the procedure to the principle.

Following the integrated presentation (which we call the epitome) each of the separate concepts involved are taught using the rule, example, practice procedures which have been described elsewhere (Merrill & Tennyson, 1977; Merrill, Richards, Schmidt, & Wood, 1977). These rule, example, practice displays constitute a series of segregated presentations.

The epitome is then reviewed and the student is asked to practice the integrated procedure using new examples. This integrated, segregated, integrated cycle is repeated for each level of elaboration. For level 1, the underlying principle is again stated, extended as may be necessary for the new level of elaboration. The elaborated procedure is then demonstrated with a specific example while the steps are explained via the underlying principle. This integrated presentation is followed by segregated presentations for each of the new component concepts. These segregated presentations are followed by integrated practice, and so forth, to expanding levels of elaboration until the student has acquired the task at the terminal level of elaboration.

Summary

This presentation has been necessarily brief. Adequate instruction in the use of elaboration theory as in preparing a learning hierarchy requires considerable practice and can hardly be adequately taught in a short paper. Nevertheless, we have suggested that as used in instructional development for sequencing subject matter content learning hierarchies are a useful step in analysis of component skills but may not provide sufficient synthesis for sequencing instruction in complex interrelated procedures and principles. Concept elaboration theory has been suggested as a more adequate design tool for structuring, sequencing and determining presentation strategies for such complex subject matter. The premise of elaboration theory is that the underlying principle should be taught first accompanied by the simplest complete procedure. This initial presentation of the epitome should then be elaborated with an alternating sequence of segregated and integrated presentations which enable the student to learn the component concepts and to put them together in integrated practice. Each cycle of elaboration introduces more complexity until the student has acquired the terminal procedure.

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TEACHING CONCEPTUAL NETWORKS

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There are some axioms of instructional design that I would like to state and have done with. The data at this point are too overwhelming that designers must abide by them.

**Axiom 1:** It is not what is presented to the student but what the student is led to do that results in learning.

Cognition is back in favor in psychology, with burgeoning discussions and research on task structures, concepts, knowledge structures, and such. Our heads are getting full again. Out of this activity come the next two axioms. Axi-

omms II and III are opposite sides of the same coin.

Axiom II: No concrete instantiation is an example of only one concept.

I demonstrate this axiom to my educational psychology class and to other groups by asking them to classify something with the first label that comes to mind when they see it.

Figure One. An Elicitor of multiple classification responses.

The overwhelming first response is "cow." This kind of almost unanimous vote can be obtained with all sorts of visuals—there is a conventional level of labeling objects (Miller and Johnson-Laird, 1976), and few of us violate the convention when asked to give the first name that comes to mind. But this picture is an example of many concepts, not just "cow." When asked to classify it again, to give another label, most people will move up the hierarchy of labels that apply to this object, and say "animal." When asked to classify it yet again, the answers begin to vary, but almost all of them lie somewhere between the highly generic label "animal" and the more specific label "cow." Responses include "farm animal," "mammal," "quadruped," and so forth. Noticeably missing from my undergraduate data are academic categories such as "ungulate." "Herbivore" turned up once. A smattering of responses elicited in this exercise are simply wrong—it is not a bull, and any farm boy can see it is not a heifer. Students who say "milk" are associating, not classifying; the picture is not an example of "milk." The final challenge is to change completely the semantic field (the frame of reference or universe of discourse) and go beyond these predictable animal kingdom names. Some students can’t do that, but I have had such insightful shifts of field as "asset" from economics, "stirnulus" from psychology, and "line drawing," as well as "bad art." This single concrete example, therefore, can be used as an instantiation of many different concepts some of which are in no way related to each other.

Axiom III follows logically from such multiple class membership.

Axiom III: You cannot teach a concept with a single example.

The past few years of research on single concepts in respectable academic subjects has clarified the role of the rational set of examples as well as the kinds of nonexamples in fostering learning of these complex concepts. (Markle and Tietmann, 1969; Englemann, 1969; Tenneyson, Woolley, and Merrill, 1972; Klausmeier, Ghatala, and Frayer, 1975.) The role of the nonexample has changed in very recent research on the teaching of coordinate concepts—sets of concepts that belong together in a discipline and represent the same level of generality within the structure of the subject matter. (Olsen, Reigeluth, and Merrill, 1977; Tietmann, Kroecker, and Markle, 1977). In real subject matters, a nonexample of one concept is an example of another related concept. The label "horse" names a nonexample of "cow," a negative reinforcer is a nonexample of a positive reinforcer, and so forth. Students who have mastered the conceptual structure of a subject matter can name each coordinate concept, as well as being able to go up and down the hierarchy in which any one of them is embedded. Perhaps no one has captured the essence of this state of mastery more concisely than Miller and Johnson-Laird (1976). They say "When a language user masters his vocabulary, he organizes it into memory structures in such a way that whenever a particular concept in that structure is activated, the whole structure becomes activated and available to attention. It is as if every word in the structure were a part of the meaning of every other word." Figure Two illustrates such a hypothetical activation when concept F is activated.

Cognitive psychologists searching into our memory structures are more concerned with the organization of our storage systems as finished products and less concerned with how this structuring comes about. The problem for instructional designers is to find procedures for bringing such structures into being as efficiently as possible.

Using the all-time favorite example of what a concept is, the concept of "dog," let us embed it in a knowledge structure.

It is a class that can be broken into several subsets, the names of the breeds, or into functional classifications such as "hunting dog." It is also a subset of many other concepts, such as "mammal" and "vertebrate" and "animal." These relations are hierarchical, within the animal kingdom. Some examples of "dog" may turn up in other semantic fields—such as "winner" at the race track, or

Figure Three. A part of the well-known hierarchy of the animal kingdom.

The terms "generic" and "specific" refer to the relative size of the sets involved, with "generic" labeling the more inclusive set. Any example of "animal" is equally as concrete as an example of "cow." Thus, we are not dealing with abstract versus concrete, but rather with inclusiveness.
"means of transportation" in some cultures. Part of the knowledge structure that people acquire is the hierarchical structure of the animal kingdom, but "dog" occurs in other structures as well.

How do you build such a structure? If the learner has acquired the kind of visual literacy that would make a hierarchy diagram meaningful (Olson and Bruner, 1974), practice in classifying and reclassifying relatively concrete items — such as line drawings of cows, cats, squirrels, and so forth — would satisfy the processing requirements of my first axiom. If the learner does not have such diagramatic literacy, this intellectual skill could become a prerequisite to be taught first.

The same rational approach to selecting cases found in concept analysis techniques (Markle and Tiemann, 1974) can be generated in programing a learner through such a hierarchy. The appropriate learner activity is classifying cases in all applicable categories. As with test cases for algorithms, one simply checks that all or most pathways through the network have been covered by the student. Although many of us have made the point that reciting definitions does not provide evidence of concept mastery (Gagné, 1965; Merrill, 1971; Tiemann and Markle, 1973), I think verbalizing would be helpful here. Students should not only be able to classify an instance of a dog as both a mammal and a vertebrate but should also be able to state that all mammals are vertebrates. In some ways, these knowledge structures are examples of Gagné's category of verbal information (1974) for which verbalizing is an appropriate outcome.

For instructional designers, these knowledge structures differ in key ways from the hierarchical structures illustrated in the work of Gagné and his colleagues (Gagné and Paradiso, 1961; White and Gagné, 1974) and Resnick and her colleagues (Resnick, Wang, and Kaplan, 1973). A valid hierarchy of intellectual skills immediately locks an instructional designer into a sequential approach to teaching. Skills at lower levels must be taught first. No such locked-in sequencing is dictated by a knowledge structure. In the ordinary course of learning this animal hierarchy in the unplanned bombardment of preschool, youngsters acquire the concept of "dog" first, followed by "animal." The breed names might come next, while the more technical terms "mammal" and "vertebrate" are mastered in school. Order does not seem to matter.

A second key difference between the two kinds of hierarchies lies in the need for the designer to assure completeness. Many of my college students have never heard of the technical term "canine" for the class immediately above "dog" but these students do not feel culturally deprived by this gap in their knowledge structure. Any professor of biology can, and usually does, further increase the complexity by adding intermediate sets to the progression shown here. A missing piece in a skills hierarchy can lead to disaster. Not so with a knowledge structure; it can stand at many levels of elaboration, with new pieces to be fitted in where they belong as knowledge grows.

A third difference between knowledge structures and skill hierarchies was suggested in Bruner's (1960) remark that concepts can be taught "effectively in some intellectually honest form to any child at any age." In a skill-hierarchy, a half-mastered skill is of no use in progressing to the next level of complexity, but in a knowledge hierarchy, a concept which has not been mastered to its fullest extent can still fall into place. So an instructional designer faced with such a knowledge structure has considerable leeway for creativity in sequencing within the hierarchy, in editing out unnecessary elaboration where technical distinctions are not needed, and in limiting the range of tangential concepts.

The animal hierarchy is so familiar that the complexity of getting the pieces fitted together may not be apparent. Piagetian scholars tell us that beyond a certain stage of intellectual development, the logic of such hierarchies is known to youngsters. Class inclusion and multiple classification have been mastered. But a student confronted with an unfamiliar subject matter is in the same position as a youngster confronting this earlier material. In my educational psychology classes, the first topic is behavior modification in the classroom. The knowledge structure that lies behind the behaviorist school generates a hierarchical scheme for environmental events.

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3 An exhaustive classification exercise requiring learners to classify as mammals and vertebrates every specific subset of mammals known to them would be exhausting. Not only would such an exercise be excessive, but also it would not prove the rule. The danger of inducing such a rule from what is known can be easily demonstrated by considering the relation between "dog" and "pet." If learners do not know of wild dogs, they could erroneously conclude that "dog" is a subset of "pet" — that all dogs are pets, although not all pets are dogs. In selecting cases for students to consider, the designer, of course, can ensure that such erroneous conclusions are made untenable. A student who has verbalized the class inclusion rule "All mammals are vertebrates" should be able to apply it in the future. Confronted with a totally new exotic species from some far-off land, the whole structure would "become activated," as implied in Figure Two above.

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![Diagram](image-url)  
**Figure Four.** Classification structure of environmental events in behavior modification.
The generic term “stimulus” can be subdivided into “antecedents” and “consequences” of a particular behavior, and each of these intermediate categories can be further subdivided by subject matter experts in ways mystifying to students. Mastery of the lower level concepts can be measured by classification and principle-applying exercises. In the past two years, I have asked a delayed question on this material immediately before showing a film on Piagetian multiple classification tasks. In the film, a child, confronted with pictures of four ducks and two songbirds, is asked “Are there more birds or more ducks?” Being young, the child says there are more ducks. I ask my students to look at the classification scheme they learned earlier (the lowest level in Figure Four, including only the two antecedents and the four consequences) and answer the parallel question “Are there more stimuli or more consequences?” At least half will reply that there are more consequences — four, of course. The subject matter structure has not come through although the lower level concepts have been sorted out and mastered.4

In this subject matter, as in many others, the concepts may be grouped differently when the topic changes. Skinner is known for his arguments against the use of aversive control (1954). The concept of aversive control as a superordinate rearranges the grouping of the earlier hierarchy into a new configuration, moving one of the reinforcers into the same set with the two punishers.

For students to understand this change, I ask them to work it out themselves on the basis of what they know about the properties of the four consequences. Telling them the answer does not make the point.

There is more than one explanation for this finding in many subject matters. It is simple to show that many textbooks leave these coordinate relationships implicit, treating one of the concepts in one chapter and others in another. Students rarely get them together. The phenomenon noted with the “cow” example, the typical labeling level, is also a factor in this case. As with the Piagetian “duck” example, a reinforcer is usually called just that, rather than being called a stimulus, even though it is typically symbolized with an S. Further, in lay terms, a stimulus is an antecedent of a response, much as the childish concept of “animal” includes only a limited set of furry mammals.

Piagetian ideas are becoming popular in discussions of how to teach physics, (Griffiths, 1976) and similar phenomena have been noted in that discipline. The knowledge structures ingrained in subject matter experts are not yet available to beginners, even though these beginners are adults who have achieved the highest level of intellectual development in manipulating common knowledge structures such as the animal hierarchy.

Memory researchers (Collins and Quillian, 1972) have demonstrated some intriguing relationships between such hierarchical structures assumed to be in our memories and the response time for confirming or denying propositions which state various properties of various classes. They assume that we know that animals breathe, that birds are animals, and that canaries are birds. College students take longer to determine whether the sentence “Canaries can breathe” is true than to determine whether the sentence “Canaries can sing” is true. The property of breathing is filed high up in the hierarchy, with our concept of “animal”, while singing is very much connected with songbirds such as canaries. What does this mean to instructional design, if anything? It suggests that most of us have been given insufficient practice in manipulating the knowledge we have on file. Designers should put more emphasis on deliberate training in flexible thinking, being fully aware that an instructional sentence such as “Animals breathe” is not likely to generalize automatically to all the cases to which it applies. As with the general principles for leading students to full mastery of a single concept, rational planning to cover a rich variety of cases will be required in making the knowledge that is filed in such hierarchical structures available to students when needed.

The importance of facility in negotiating the pathways up and down such structures is suggested in some recent research on problem solving. Landa (1976) in a chapter entitled “He couldn’t figure it out because he couldn’t figure it out” described the difficulty Russian students have with geometric proofs. When a particular figure is classified in one way, dredging up one approach to the problem, the learner is unable to shift levels of classification which might suggest another approach, although it can be shown that the learner does know the appropriate principles. Those principles are simply filed elsewhere in memory and are not, in the words of Miller and Johnson-Laird, “activated” when one level of the memory structure is activated by the way the learner classifies the figure in the problem.5 Jill Larkin (1977) has observed a phenomenon of a similar nature in her investigations of the difference between subject matter experts and novices when confronted with a physics problem to be solved. As with Landa’s geometry students, Larkin’s novices knew the appropriate principles, but their approach to the problems differed from the experts in the amount of time it took novices to retrieve the information relevant to the problem. When

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problems move beyond the ordinary algorithmic types which can be immediately classified as requiring one or another procedure that a learner has mastered, the knowledge structure underlying the discipline becomes an important factor in success. Our job will be to find these structures in various subject matter areas and to redesign materials so that they become more accessible to beginners in a new discipline.

Although I have not collected data from whole classes, this phenomenon should be readily demonstrable in the college population. Confront such a population with a figure which is clearly a square and ask a group to classify and reclassify as was done with the figure of a cow. A square is a square is a square. From other less direct measures, I have data indicating that a square is rarely seen or labeled as a rectangle (an equilateral subset of that class), and is only with difficulty accepted as a parallelogram (having four sides with opposing sides parallel, it surely is an example of the latter class). The animal hierarchy which is favored by memory researchers is far more a part of common knowledge than are hierarchies from more academic areas.

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SELECTING INSTRUCTIONAL STRATEGIES

OR ONCE YOU'VE GOT AN OBJECTIVE, WHAT DO YOU DO WITH IT?

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Paper presented at AECT Convention
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Perhaps one of the most difficult aspects of instructional development (ID) is getting on with it. A quick review of systems of ID reveals that they often seem to be a series of discrete steps. Certainly, systematic approaches to ID involve, and are advertised as being, a series of interrelated steps. Still, one has the distinct impression when reading the manuals on ID (when they can be found) that within the ID process once an activity is completed, you know what the next activity is to be, but you aren't entirely sure how to get to it and how to use the output of the last step as input to the next. This is no more true than in that vital phase that comes between the development of objectives and the testing of the first draft of the instructional material.

The area between the production of well stated objectives and developed instructional materials is, generally speaking, a wasteland as far as procedures are concerned. The wasteland is broken only by a few general statements of principles such as “teach one objective at a time”, “have frequent review”, “allow for student practice”, “provide feedback”, etc. What is needed in this area is a systematic method for identifying classes of objectives that can be differentiated by the instructional strategies which are most appropriate to them. That is, there must be, at some level of generality, a finite number of classes of objectives and there must be a finite number of strategies appropriate to each of these classes.

This paper outlines some relatively simple, practical guidelines that can be used to go from objectives to the selection and specification of instructional strategies. The strategies specified in this system are particular and detailed and allow instructional developers to move directly to the production of instruction displays. The procedures to be described in this paper involve four steps: the classification of objectives, the matching of objective classes with optimal strategies, the specification of the components of strategies to be used, and the development and integration of the specific components. The objectives classification, strategy selection, and specification models described in this paper are extensions, modifications, and, in many cases, simplifications of the work of Merrill and Wood (1975), and are the product of many psychologists and technologists working at Courseware, Inc. The extensions, modifications, and simplifications have been made over a considerable length of time, have resulted from a need to do ID in a broad range of real-world settings, and have produced two books (Coldewey and Faust, 1976; Hughes, Faust, and Coldewey, 1976) which detail and teach many of the procedures to be presented here.

First, let us discuss the concept of an instructional strategy. Instructional strategies can be described at two levels. At one level (a micro level) an instructional strategy is a sequence of instructional events that leads to the accomplishment of a single objective. At another level (a macro level) an instructional strategy can be said to be the sequence of instructional events that teaches a group or set of instructional objectives. The instructional strategies discussed in this paper are micro strategies which are directed at the accomplishment of a single objective. Detailed guidance and specification for macro strategies is also possible, but is not within the scope of this article.

An instructional strategy is composed of a series of displays which are presented to students and from which he is supposed to learn. The displays may take many forms. The word “display” here is meant to be a very general term and to include symbols, words and pictures, objects, and events. For example, the displays discussed here may involve presenting words or pictures on pages, or words spoken in front of a group or presented via computer, or even objects to be manipulated or situations in which a student must act. Taken together, the specific types of displays used in a given situation, their sequence, and the relationship among displays make up instructional strategies. This means that by specifying the type of displays to be used, their sequence, their relationship to one another, and how students get from one display to another we can, in fact, specify an instructional strategy. A prescription like “give the student a definition, two examples, and then two practice items” is, in fact, a prescription for a primitive instructional strategy. Please note that a strategy could be specified without reference to content or delivery system. Decisions about these other facets of instruction can, in fact, be made independently from decisions about instructional strategy. But, how do we know which set of displays is best in a given situation?

The answer in this case, as in most cases when questions are asked in instructional situations, is “it depends.” It depends upon the particular learning requirements of the instructional situation. These requirements can be identified by analyzing the instructional objective to be obtained. Objectives can be divided into a finite number of classes. Each class represents a particular set of learning requirements. Several systems have been proposed for classifying objectives (Gagné, 1970; Markle and Tieman, 1970; Merrill and Wood, 1973). This paper presents an admittedly over-simplified adaptation of these systems. In particular, it incorporates several elements from the Merrill and Wood and Markle and Tieman classification systems. The simplifications of these systems was made to accommodate instructional needs most often encountered in a wide variety of ID projects and is the result of considerable tryout and revision. The only distinction between classes of ob-
jectives that are made in this system are those which are needed to identify situations which require specific instructional strategies and for which strategies can be specified. This system has two advantages. It is easy to teach and it results in effective instruction which can be efficiently produced.

It should also be pointed out that not all objectives can be classified by this system. It considers only cognitive objectives and, thus, ignores affective and psychomotor objectives. It also does not treat what Merrill and Wood (1975) call rule-finding objectives. That is, those objectives that would be classed as involving the invention of new rules or very advanced problem-solving. These omissions are by design since objectives of these types are less frequent in most ID situations and since the objective of this system was to be as powerful, yet simple, as possible. The system being discussed can be augmented when other types of objectives are encountered.

It seems that most cognitive objectives can be classified on two dimensions: (1) the type of content they involve and (2) the behavior they require of students. The content dimension can be divided into four basic types (see Figure 1), depending upon the relationship between elements of the content.

Content placed in the FACT category involves one-to-one relationships between objectives, symbols, or events. For example, "r=3.14," is a fact. It is a relationship between the symbol and the number 3.14.

Content falling in the CONCEPT classification involves the relationship between a class name and set of objects, symbols, or events that share common characteristics and, therefore, are identified by that class name. For example, the term "improper fractions" is a class name referring to a set of fractions all of which are expressed as a larger number divided by a smaller number.

A RULE involves a change operation. That is, an operation which changes one set of objects, symbols, or events into another set of objects, symbols, or events. For example, the rule for determining the mean of a set of numbers can be expressed as $\sum X/n$. In determining the mean a set of symbols (numbers) are changed by adding them up and dividing the sum by the number of numbers in the original set. This "operation" produces a new symbol which we call "the mean."

There are actually two types of rules which we have chosen to differentiate between and call RULES and PROCEDURES. Rules meet the requirements of the definition I have just presented, but can be further defined as involving a set of steps which make it possible to solve any of a class of problems and which should be demonstrated using a number of examples. Procedures, on the other hand, are designed to accomplish a specific task and need to be demonstrated in only one way. The recipe for Aunt Abigail's chili and the procedure for initializing a MACROMITE007 computer are procedures in that they are designed to accomplish specific tasks and they need to be demonstrated in only one way.

Objectives can, using these definitions, be classified by the content they involve. They can also be differentiated by the behavior they require of students. Some objectives only require that students remember what they have learned. For example, when asked for the numerical value of $\pi$, the student need only remember what he has read or been told: 3.14. Similarly, a student could be asked to state a definition, a rule, or a procedure. In all of these cases he need only repeat what he has read or been told. Objectives with these requirements are classified as remember level objectives.

Objectives which fall in the concept, rule, and procedure category of content can, however, also require students to use their knowledge under new conditions. For example, a student may be given several fractions which he has not seen before and be asked to identify all which are improper fractions. Thus, he is being asked to generalize his knowledge of improper fractions to new instances. A student may be asked to use the rule for finding a mean of a set of numbers. That is, he is given a previously unencountered set of numbers and is asked to find the mean. Similarly, a student can be asked to make some chili using Aunt Abigail's recipe or to actually initialize a MACROMITE007 computer. All of these levels of behavior would be classified in the USE category.

Using the distinctions of content and behavior we have just described, the instructional designer can place each of the objectives in his program in the appropriate space in the 2x4 objectives matrix. Each cell of this matrix has one or more specific instructional strategies associated with it. The particular strategies that have been developed for this system are the result of the distillation of the research literature, specific research on the effectiveness of various instructional strategies, and years of experience in designing instructional programs. It so happens that all strategies follow a general model. That is, they have the same general types of components which are generally present in the same sequence and generally have the same relationship to one another. This general model is presented in Figure 2.

The model shows the relationship of what we will call lessons and segments of instruction. Segments are chunks of instruction intended to teach a single instructional objective. Lessons are made up of one or more segments that, when taken together, enable the learner to reach a more complicated objective. The model shows components that are used within segments. One of these components, the introduction, is optional and therefore is indicated by the dotted line. Four components are generally used at the lesson level. Again, one of these, the Summary, is optional. A generally effective sequence is indicated by the arrows which lead from the Expected Learner Outcome for the lesson through the components for each segment to the lesson test.
The following definition refers to components in the model diagrammed in Figure 2.

Introduction: An Introduction is always provided for lessons and is seldom, but sometimes, used with segments. It may contain an advanced organizer, a rationale for the topic, or instructions to the learners on how to proceed. The purpose is to prepare the learner for the instruction and provide an overview of the topic being covered.

Expected Learner Outcome: The Expected Learner Outcome presents the instructional objective for the segment of instruction. We do not use the term “objective” to describe this component because the Expected Learner Outcome is not necessarily a complete formal objective with precise statements of actions, conditions, and standards. Complete objectives are certainly necessary for instructional developers. However, learners do not always need, nor will they always understand, complete statements of behavioral objectives. What learners do need is a simple, straightforward statement of what they will be expected to do after a lesson or segment. Statements of Expected Learner Outcomes generally use the action component of a behavioral objective. They do not generally include conditions and standards unless they are needed to make the statement clear to the learner.

Generality: The Generality (which may take the form of a fact statement, a definition, a rule, or a procedure) describes in a clear and concise way what must be learned in order to achieve the objective.

Generality Help: The help following the generality is included as a supplement to the generality. The Generality Help gives special methods for applying the generality or explanations of terms used in the generality which may not be understood by all learners.

Instances: The word “instance” is used to describe examples and nonexamples of concepts and rules, or demonstrations of procedures. They are crucial if learners are to learn how to use concepts, rules, or procedures.

Instance Helps: The helps associated with instances provide an important link between the generality and the instances. They are included to show the learner why a particular instance fits the generality (e.g., why an example meets the requirements of a concept definition, how a particular problem can be solved by a rule, or how a procedure can be used in a particular situation).

Practice: Practice is included in every segment of instruction to give learners an opportunity to judge their own ability to meet the objective. Although the practice items require learners to show what they can remember or how well they can use concepts, rules, or procedures, they should not be considered a test. Practice is a diagnostic tool which helps the learner identify areas where her/his learning is not complete. Practice gives learners an opportunity to evaluate their mastery of the objective in a situation which requires the same behavior as that of the objective.

Feedback: Feedback provides the learner with the correct answer to a practice item and a description of how that answer should have been determined.

Summary: The Summary, typically used only after the last of a series of segments in a lesson, recap the important points covered in the lesson. Summaries may just be short prose descriptions of the content or they may be longer and include a restatement of the generalities and other information.

Lesson Test: The Lesson Test is just that, a test. It provides information to both the learner and the instructor as to how the learner has performed on lesson objectives. It should contain test items which assess the behavior required in the lesson objective. It may also test performance on segment objectives. Feedback for tests is not provided after every item, but rather is provided at a later time after the test has been graded and its results analyzed.

The specific definition used for each component in a given instructional strategy is dependent upon the objectives classification. For example, the generality in a Remember/Fact objective is a statement of the fact itself. For a concept, as either the remember or use level behavior, the generality is a definition. There are no instances in the strategy for Remember/Fact objectives. For Remember/Concept objectives, however, a single, most representative example is used to fill the instance requirement. Whereas, in a Use/Concept strategy the instance set is more extensive and must include a representative sample of examples and nonexamples sufficient to teach students to make the necessary discriminations.

The helps for generalities differ from strategy to strategy in that remember level generalities help focus on providing memory aids (mnemonics, graphic representations, etc.), while use level generalities help focus on helping the student understand and apply the generality. For example, the help for a Use/Concept objective would provide a model for search strategy for identifying critical characteristics in instances, or it could provide explanations of terms used in the definition. Generality helps for Use/Rule objectives may present an algorithm or flow diagram or mistakes to watch for.

For remember level objectives, the feedback is generally directed as presenting the correct answer. But, for use level objectives it will present the correct answer and detail the process the student should have used to arrive at that answer. A discussion and complete definition of all of the seven basic strategies and their
components that follow from the objectives classification system is beyond the scope of the present paper. However, the basic strategy models for each of the objectives classes are presented in Figures 3 through 9.

The specification for each component of each strategy may be given at several levels of detail. Authors can be trained to various levels of skills, depending upon the level of detail they are taught. The level of those details taught can be varied, depending upon the amount of training time available. Authors trained at one level can increase their knowledge and skill through on-the-job training aided by instructional psychologists and/or detailed referenced guides which provide further detail on component instruction.

The critical point to be made here is that an objectives classification system which leads to specific strategy specifications (including the identification of components and their sequence of presentation) and which is accomplished by detailed guidelines for the production of each of the components in each of the strategies makes it possible for authors to move quickly from objectives to production of skeleton instruction. Once components are produced and sequenced they may be turned over to writers, film-makers, artists, or lay-out specialists who can produce the finished instructional material.

The components that have been described are the components which are necessary no matter what instructional media is being used. The only additional work that needs to be done to convert an instructional strategy from one media to another is to apply the skills that are appropriate to that media. For example, to convert a workbook to a tape-slide presentation the skills of the graphic artists and scriptwriter are needed. However, the basic components and their sequence will be the same. This method insures that the critical, instructionally relevant components and relationships will be maintained while the materials are tailored to insure that they are appealing to students.

Making the road between instructional objectives and instructional materials an easy one to follow is the main goal of the system described in this paper. It has been found that the more precision and clarity given to the procedures for following this road the more productive instructional teams can be. Statements of general principal can be of value, but
statements of specific procedures are immensely more valuable. One of the great benefits of this detailed, specific system for selecting from a finite number of instructional strategies is that it makes it very easy for the instructional developer to "get on with the ID process." Each objective and each component of instruction is not treated as a completely new challenge requiring the invention of a completely new strategy. The efficiencies generated by this one factor alone have proven to be considerable. Such efficiencies produce several major benefits. One of which is that they make time available which may be used to analyze instructional settings and review instructional materials so that one can identify those cases in which it is appropriate to break the rules set down in the procedure. It also provides the time that is needed to come up with good, sound solutions to those problems which do not fit within the structure of the system being used.

References
INDIVIDUAL DIFFERENCES AND INSTRUCTIONAL DESIGN

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One of the oldest facts about human learning in educational settings is that individuals differ, profoundly and multiply, in how they learn. Individual differences in school learning have been apparent since Greco-Roman times, but it is only in recent years (perhaps the last decade or so) that research has begun to show the real significance of this fact for education. Until now, information about individual differences has been used in education primarily to select people out, that is, to reject college applicants, or to identify students needing slower or special education, which often turns out to be no education at all.

However, three points about individual differences in learning from instruction now seem clear:

1. Individual differences are far more complex than the single rank order conception of intelligence usually manifested in popular personal thinking, and they are also more fundamental as human characteristics than usually assumed in popular social and educational policy.

2. Individual differences in various aptitudes not only predict individual differences in learning outcome; they also interact with alternative instructional treatments. That is, they relate differently to learning outcome under different instructional presentations or methods. This kind of interaction between individual differences and instructional conditions is called "ATI", standing for "aptitude-treatment interaction".

3. Individual differences (and ATI) can be used by the instructional developer to understand and improve instruction for everyone.

First, the popular misconception that biological differences do not exist and psychological differences can be easily erased is partly our own fault as instructional communicators. It stems in part from plagiarism among educational illustrators and audiovisualists. Roger Williams (1954; 1967) stressed this point some years ago, but little notice seems to have been taken of it. He showed pictures of a variety of normal stomachs, for example, compared with a typical textbook version. Medical illustrators rarely show this kind of range of individual differences; when asked to make a new picture of a stomach for some instructional purpose, they just copy from existing textbooks. It is a bit frightening to think that our conception of the human stomach is based on the shape of the stomach of a single 17th century murderer. Williams gives many other examples of striking individual differences in livers, kidneys, heart and brain tissue, nerve cells, spiromgrams, blood chemistry, etc. Beyond this, there are now bits of evidence of correlations between biological and psychological measures. One, noted by Cattell (1971) for instance, is between measured intelligence and cortical evoked potential of the brain. Time in milliseconds from onset of the stimulus to the third wave crest is simply and inversely related to IQ. Rimland (1977) has recently noted several other psychobiological correlates.

In short, people are not created equal biologically or psychologically. It is their right to equal opportunity to learn, among other things, in spite of individual differences, that is created. And this makes adaptation of instruction to individual differences among students an imperative. Instructional development thus needs to aim at particular kinds of students, not at the mythical average student.

Now to the second point. Although all of the possibly thousands of individual difference variables are not relevant to instruction, some consistently correlate with learning and also give consistent ATI results. If ATI can be captured and understood, they will make possible the design of adaptive instruction. Only rarely, however, are these underlying ATI ideas properly evaluated in work on individualized instruction. All attempts to individualize instruction, it turns out, rest explicitly or implicitly on some kind of ATI idea.

But what does an ATI look like and how do we find one? Figure 1a shows the traditional outcome of instructional development attempts. Instructional Treatment A is judged better than B because average student achievement is higher after A than after B. A and B could be alternative instructional methods or media, or A or B might represent average effectiveness of the same course, film, program, textbook etc., both before and after some instructional development work. Student individual differences are not considered here.

Adding student aptitude scores (Figure 1b) gives the traditional picture an abscissa. Now we have a regression line, that is, a running average, showing the learning outcome level attained by students who come into instruction at different levels of aptitude. Pretest measures of general mental ability and of prior knowledge often give this kind of positive slope in conventional instruc-
Figure 1. Hypothetical results of a) traditional instructional comparisons b) studies including an aptitude variable and c) studies testing for aptitude-treatment interaction.

It is obtained simply by measuring an aptitude before instruction, achievement or some other valued outcome afterward, and then plotting each student as a point in the graph using his or her two scores. The line can be thought of as the running average across different aptitude levels, but it is usually estimated statistically. When results look like this, attempts at instructional improvement should concentrate on the lower aptitude students, i.e., the question is: What instructional changes will improve things for them particularly? It is possible that iterative instructional developments might raise the lower end of the regression line, realizing more learning for the lower aptitude students while maintaining a high level of learning for high aptitude students.

But much research now suggests that Figure 1c is the more likely result. A new and different instructional treatment often gives a regression line that is sloped differently, even crossing the line for the first treatment. By improving instruction for one kind of student we have reduced its effectiveness for another kind of student. This happens often enough to suggest, only partly in jest, a first law of conservation of instructional effectiveness. It goes like this: “No matter how you try to make instruction better for someone, you will make it worse for someone else.” Findings of this sort indicate ATI. If further attempts at instructional improvement fail to change this pattern, then the best one can do is to assign higher aptitude students to Treatment A and lower aptitude students to Treatment B. The two kinds of students do best with different instruction. This sort of adaptive classification of students into different instructional development that can come from investigating student differences. And there are many variations on this theme, including periodic aptitude monitoring during instruction to decide when to switch each student from Treatment B to Treatment A as aptitude develops or knowledge accumulates. One can even imagine local instructional theories (Snow 1977a) built on such results, after much more research is done to understand the ATI phenomenon fully.

But the instructional designer-developer does not need to wait for an instructional theory of individual differences. His work can even be instrumental in creating such a theory. And this leads into the third and main point of this paper. Enough is now known about individual differences in aptitude and learning to allow the instructional developer to use individual differences to advantage in any instructional development project. At least three steps can be taken in such a project.

The first step would be to choose measures of the most important student aptitudes, based on the accumulated ATI literature as well as on whatever hunches are available about the kinds of students who seem to do well or poorly in the particular instructional condition of interest. A recent book (Cronbach & Snow, 1977; see also Snow, 1977b) that summarizes much of the voluminous ATI literature could serve as one guide, but there are several other sum-maries as well. The aptitude variables recommended for measurement at the start of almost any kind of high school or college instruction are the following:

G is a measure of general mental ability, otherwise known as intelligence (and sometimes divided into fluid, crystallized and visualization ability; see Horn, 1976). G seems to relate to learning increasingly as more of the information processing burden of learning is placed on the student. As the treatment is made to do things for the student that he cannot do for himself, G relations are often reduced. No instructional designer should today fail to include a measure of G in a formative or summative evaluation study, because instructional conditions almost always vary in cognitive processing demands.

A1 + A2 stands for general achievement motivation or orientation, but the distinction between its two parts may be more important. A1 - A2 is achievement via independence vs. achievement via conformity. Many instructional treatments vary in the degree to which they encourage independent student action vs. conformity to instructor-set norms. Relative need for one or the other often turns out to be a critical student difference, particularly at the college level. A3 is anxiety, another student difference that seems to be fundamentally involved in learning, both on its own and in combination with G. That is, there are higher-order ATI between A3, G, and Treatment.

These four aptitude constructs deserve to be included in all instructional evaluations. Measures exist for each, and test administration time totals about one to two hours. There are also other individual differences of special interest. Among these are: MS (memory span), PS (perceptual speed), MV (visual memory), and CS (for various unidifferentiated cognitive style measures). These aptitude variables may be important for some kinds of instruction; they deserve attention, but are optional in this general list.

Finally, a measure of prior achievement is obviously a requirement: one simply has to know what students already know, in order to develop instruction further. These measures may be pretests specific to the content to be taught, or they may be measures reflecting achievement in earlier courses, or even past grade-point-averages. One would hope, in any event, that they reflected not only variations in factual knowledge but in knowledge organization. All such differences in prior knowledge are differences in aptitude.

These are recommendations, but it should be clear that they are only hypotheses. While supported by some strong prior research, they remain to be tested anew in each new instructional situation. For reasons too numerous to detail here, generalizations across diverse instructional settings are difficult, perhaps even impossible to make. Nor should measures of such aptitudes be taken blindly. While measures of G and A1 have been fairly well-developed, any...
specific test may not always fit the student population of local interest. Measures of $A_i$ and $A_x$ have seen less development and validation, and are thus even less trustworthy. But progress should come from cautious iterative exploration. One should not throw out an aptitude measure after a single failure, nor should one institute a rigid instructional prescription after a single success.

The second step is to evaluate instructional effects by drawing scatterplots and regression lines as demonstrated earlier, to determine which students do well and which students do not in a given condition. Take each aptitude-outcome pair and investigate it separately as before. Or, use two or more aptitudes at once in multiple regression. Statistical methods for this are discussed by Cronbach and Snow (1977).

Some example pictures of results involving two aptitudes in each of two or more instructional treatments are given in Snow (1977b) and so are not reproduced here. Each shows a bivariate regression plane for $G$ and $A_x$, or for $A_i + A_C$ and $A_i - A_C$, as joint predictors of achievement in each of several treatments. The findings reported are those of Peterson (1976) and Porteus (1976). They are complicated, but they do make sense. The results suggest that high school students who are able, conforming and anxious, seem to need more step-by-step structure in the progress of instruction. They do better when teachers provide explicit objectives and sequences of instruction, with clear outlines, reviews, and emphasis of the essentials. Students who are able, independent, and non-anxious seem to need less teacher structure of this sort. They seem to provide their own organization for learning. So also, apparently, do less able students who can nonetheless work on their own and are motivated (anxious) to do so.

Consider a hypothetical next step now. Suppose that an instructional designer pursues these earlier findings, administering the same aptitude measures in evaluating a new audio-visual tutorial course in college science. A study is conducted in which the new course is compared with the conventional lecture-demonstration format. Some student sections receive the individualized treatment, going to stalls in the AV library for work with films, tapes, and slides to guide their own study and lab work. Others get the regular treatment. (Or perhaps aptitude and outcome data are available from the conventional treatment of previous years.)

Figures 2 and 3 give the hypothetical results. The ordinate in each case is end-of-course achievement. The aptitudes in Figure 2 are $A_i + A_C$ and $A_i - A_C$; in Figure 3, they are $G$ and $A_x$. Comparison with the previous results shows our instructional developer that his data in the first figure conform closely to Peterson's (1976) and those of the second are only slightly different from some of Porteus's (1976).

With these results, one might think of establishing both kinds of courses and assigning students to whichever course their aptitude scores suggest will be best for them. But our instructional developer is mainly interested in improving the new course. The A11 results also give clues to help understand instructional effects because they focus attention on particular kinds of students who seem not to be well served by some particular condition. Why is the new course not effective for students high in achievement via conformity or either low or high on both ability and anxiety? Students in these groups have aptitude scores falling in the shaded regions of the aptitude base planes of Figures 2 and 3. Notice that in these regions the traditional course is better (higher) than the new course on the achievement outcome. Task analysis can then focus on these groups, and on the parts of instruction that give them trouble. We might for ex-

![Figure 2](image2.png)

**Figure 2.** Hypothetical results of a comparison between a conventional treatment and a new audio visual laboratory treatment, showing a bivariate regression plane for each treatment, with $A_i + A_C$ and $A_i - A_C$ as aptitudes.

![Figure 3](image3.png)

**Figure 3.** Hypothetical results of a comparison between a conventional treatment and a new audio visual laboratory treatment, showing a bivariate regression plane for each treatment, with $G$ and $A_x$ as aptitudes.
ample ask students with these particular aptitude profiles what aspects on instruction bothered them or were helpful. Or we might observe them at work, or conduct item analyses of criterion tests separately in each aptitude group, to identify weak features of the course. Then we can tinker with these aspects of instruction during the revision process. It might turn out that conforming students need a more detailed procedural outline to follow in the AV lab, that able but anxious students need more clearly specified objectives for their individual work, and that less able, nonanxious students need to be checked frequently by a lab assistant to motivate progress. Making such revisions might erase the ATI effects, or perhaps further revisions will be suggested by ATI in further tryouts. Bunde rson (1969) suggested this approach, and has used ATI this way in revising computer-assisted instructional programs. But aptitude-focused task analysis of this sort has not yet seen wide use. This then completes the third step—diagnosis of individual difference effects and focused revision of instruction with these effects as guide.

To summarize, one can use ATI to develop macroadaptations of instruction, assigning different kinds of students to different treatments aimed at the same outcome goal. Treatments are then designed on broadly different models to fit different classes of students optimally. Or, one can use aptitude information to make microadaptations by tinkering with aspects of one treatment during revision, so that it becomes individualized more on a day-to-day or even minute-to-minute level, as is possible in computerized instruction. Or one can do both; microadaptation can proceed within broadly differentiated streams at the macro level. In any event, what I believe one must do is to collect and use aptitude information in all instructional evaluations. This is required because the evaluation question is always—did the instruction work well for the students, that is, for each student, not just for the few who stand in the vicinity of the group average. And an instructional treatment that is best on the average may still serve some students poorly. One can choose to ignore student individual differences, but they will be there influencing instructional effects whether they are measured and used or not. Despite the fact that education is ultimately an aptitude development program, individual differences in aptitudes will never go away.

References

THE DANCE OF EVALUATION: HUSTLE OR MINUET

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The practice of education is poised on an insecure technological base. Despite massive infusions of rhetoric, little progress has been made to transform the operations of instruction into other than blurred attempts at craft. At present, the scientific aspect of education is limited principally to discipline based research conducted with far-term outcomes. In only restricted areas, under highly controlled conditions, have the responsibilities of the education profession derived benefit from scientific analysis.

Dance is an art form with a technological base and a transpositional motive. Although dance and educational practice are both performed en chorale, they display more particular similarities. Consider the references to the hustle and the minuet, two well-known dances. While separated greatly in historical time, they both share common elements. They, for instance, were both popular expressive forms, based on highly controlled progressions of rigidly stylized steps. Thus, their suitability as metaphors for evaluation activities should be immediately perceived. As evaluations, the hustle and minuet differ along other continua, from energetic to passive, or exuberant to reserved. Notice, however, that these dances, as evaluation, both contribute at a marginal level to the serious pursuits of their times.
Emerging technology in the field of education mirrors none of the art but some of the other attributes of these dances. For example, the tendency in education is to codify and stylize operations, e.g., technological procedures, and grind at them insistently either until some higher authority, usually political, questions one's motives, or until a new procedure is proffered. Some procedures are adopted with high hopes and energy and others fit more clearly into the established order. In instructional development, specifically, we have seen almost a mechanism to transform procedures and guidelines: rules for creating, first, linear programs, then, branching instruction, and then, multimedia programs, have been articulated. The field of evaluation, at once older and less mature than that of instructional development, seems destined to continue the same errors. For evaluation, as it became regularized into models, frameworks, and procedures, has spawned a series of rules for action which rarely receive sustained reflection. A review of the role of evaluation in instructional planning and development is suggested, with a focus on the examination of the purpose and utility of evaluation for educational technology.

A critical question, almost lost in the clutter of contending models and procedures of evaluation, must be raised about who is to assume the evaluation role. Functions generate labels and labels have a way of becoming anthropomorphized. Technology created first technicians, then technologists. Development transmuted into developer: evaluation became evaluator. This linguistic fixation is a minor interest except for the connotation such designators suggest. Who is best qualified to evaluate a development project? An evaluator or anyone else? Certainly, any right-minded person would choose the individual who is named with the function, for special expertise is clearly implied. Another problem with anthropomorphic process is that a complex set of activities, which requires participants with diverse preparation and expertise, is reduced to a simple procedure, evaluation, where a simple, all-purpose individual, the evaluator, can handle the entire show.

Should then, development give over the evaluation function to evaluators? If development activity is stripped of its evaluation component, what is left? A pessimistic view of the state of applicable findings from instructional research would suggest that, without evaluation, very little work remains for those charged with development responsibility. They might create instructional design based on a few stable principles of learning. They may base program structuring decisions on rather firm but narrow between findings from cognitive psychology. Development personnel may make media selections by rehearsing any one of a number of sets of arbitrary, and usually, economically inspired rules. They may manage component development and integration by using systems such as PERT, Critical Path Analysis or other planning procedures. But the relinquishment of evaluation functions to another external group gives up the most potent development capability there is, the capacity to detect and manage change. It is evaluation, at least at present, that drives the development act.

Development can be conceived as a continuum where we begin in ambiguity and attempt to move toward clarity. At the outset of a development project, we may only have the sketchiest information about what we will end up with. For example, we will know what age or experience learners we are designing materials or curriculum for... probably. We will know the broad area of subject matter we are to treat... probably. We will know how much we have to spend... definitely. A few overzealous people might even have outcomes to which the curriculum or product is directed specified in advance. During the course of the development effort, we attempt to gain better understanding of our process and what our likely outcomes will be. We learn to identify learners with precise areas of need and history for our products. We determine what settings will form the probable contexts of product use. We design, revise, and redesign component tests of programs in order to formulate a proper effort which embodies appropriate instructional characteristics. In the end, we hope that we can say that the product we have developed is planned for a particular group or groups of respondents for use in a specific class of settings and with results reliable at given levels, when appropriate time and implementation guidelines are met. It should be clear that throughout this process, the need to evaluate is pervasive.

Instructional development staff may have a wide range of expertise in the evaluation area, but they usually share some familiarity with the concepts of formative and summative evaluation. As described by Scriven (1967) and Markle (1967) using slightly different terms, formative and summative evaluation are assumed to have different purposes. Summative evaluation should provide a comparative judgment of merit under conditions as objective as possible. The purpose of this form of evaluation is to make a selection among competing alternatives, a topic we will return to later.

Formative evaluation differs in its purpose for data are collected to improve a program under development, to allow adjustments to be made in order to maximize the desired outcomes of the program. Thus, the formative evaluation contributes to the redefinition and refinement of the product as it shifts along the continuum from ambiguity to precision. It is clear that instructional development must keep the reins on formative evaluation activity.

Rather than guidelines, some simple rules of thumb can be described for formative evaluation. First, one should collect extensive information from relatively few subjects during initial design phases. This suggestion is based on three probable states of the world. First, the early versions of the product and program may be poor. Why expose great numbers of subjects to unreliable instruction? Second, it is likely that significant aspects of the program are susceptible to revision, for instance, the objectives, formats, instructional approaches and so on. Thus, diverse information sources are desirable. Third, the practical matter of processing data from many subjects is a serious impediment. Development momentum can be stopped and the fluidity of the project lost by extensive data analyses and interpretation requirements at the wrong time in a project's life. Another major guideline is that the diversity of data one collects reduces as the project moves toward completion. Essentially one collects less information, but from more different kinds of people. It should be remembered that conservation of resources requires that only usable information be assembled, that is, data which can be employed to revise the program. The need to be comprehensive should be overcome in an effort to make the evaluation act instrumental to the efficient completion of the project.

With regard to the relationship of summative evaluation, that is the program verification, it is probably not in the development staff's or developing agency's interests to conduct a summative or comparative evaluation. Whenever what is known as "summative evaluation" seems
appropriate in a development cycle, the decision for product selection will likely be surrounded by political as well as effectiveness criteria. For this reason, development personnel might seriously consider avoiding the entire prospect of summative evaluation. A brief reflection of the actual conditions of summative or comparative evaluations might make the point more strongly.

First, data from any comparison between curriculum or products are likely to be inclusive. This likelihood, in fact, is the basis of our parametric statistics. Thus, there will be a force for the status quo, and a tendency against innovation when the decision is based purely on empirical data. Second, in a comparison between a commonly formed program, e.g., printed materials, in contrast with multimedia development, the short run utilitarian aspects of the containing programs, when divided by costs, will almost always support the more conservative development effort. The long range benefits, for instance, of introducing stimulating variation in school activities, are, in the first place, almost never assessed by appropriate dependent measures, and in the second place, the amount of time appropriate for such a long term comparison is usually impractical for all participants. In addition, innovative looking materials may be threatening both to the users of instructional programs, teachers, and administrators, and to the funders of education, for example, state legislators.

The paradox is that while development people recognize the importance of comparative product tests in their activity, the summative evaluation has little to recommend itself to product development staff on a strictly practical basis.

Further, unless summative evaluations are contracted externally to the organization of the developed product, they are inevitably suspect. Summative evaluations should be conducted independently by agencies or groups for whom there are no contingencies for supporting the effectiveness of the product under study. (Who really believes the Pepsi challenge advertising campaign, conducted, as it is, by Pepsi-Cola employees. Perhaps if Canada Dry Ginger Ale monitored the comparisons, we would have developed a greater sense of trust in the findings.)

If summative type evaluations are to be conducted by the development agency, however, they should be limited to a few clear purposes. For instance, they seem to be appropriate for promotional materials required for broad implementation. Data from summative evaluations can also be used formatively, perhaps to improve user manuals. But summative evaluation asks potentially to document our failures without recourse. Thus, it must be the minuet of this piece, a contrived exercise of limited practicality for development staff. Formatative evaluation is where the hustle, energy and productivity intersect and continue to contribute to the improvement of instruction. For current evaluation of our government-supported and for-profit efforts as well as for the persisting longevity of instructional development itself, we should subscribe more evaluation models derived more from Motown than from Mozart.

References

Can You Really Do Instructional Development On 2¢ A Day?

It was originally intended to put out a plea for case studies concerning instructional development activities at all levels of education at this point of the first Journal issue. By coincidence Kent Gustafson has presented this plea in much more stirring terms than we could possibly achieve. Notice that Kent is calling for Developers to publicize successful I.D. efforts — what better means than through your own Journal? Kent, say it for us...
cost of ID will put us in the museum somewhere between the dinosaur and the dodo bird.

Perhaps an anecdote will demonstrate the kind of thinking and attitudes about which I am concerned. The incident occurred at the state convention of media and library personnel where a developer from a large university made a presentation on ID. He went on at great length about how ID was done at his institution, with all the accompanying bells and whistles. At the end of his presentation a member of the audience asked how ID might be done at his own school since he didn’t have any learning psychologists or evaluation specialists available, not to mention personnel highly skilled and experienced in ID process. The developer’s response was “Well, you can’t really do ID then”. Most of the audience felt frustrated by the seeming lack of relevance of ID to their situation and their lack of major resources to commit to ID. My reaction was one of shock, partially from the developer’s superior tone, and partially from the fact that the developer’s response was absolutely fraudulent.

There have been, and continue to be, many very respectable instructional development efforts mounted by individuals and small groups of dedicated teachers and media specialists without all the high priced “experts”. For example, documentation of a number of significant development projects was collected by Harris (1975) following conducts of ID training institutes for public school personnel in various parts of the country. This systematic follow-up study found that many substantial projects were successfully conducted. Further, these projects were all conducted without the high cost often associated with ID projects.

At the community college level one can also find numerous examples of systematically designed courses of instruction which really work and didn’t cost the proverbial “arm and a leg”. In fact, some of the most effective and certainly most cost effective instructional development is being conducted at the community college level; public schools would be well advised to look to the community colleges for a relevant ID model before looking to most big name universities.

It would be nice for all of us to have the ID resources of Sesame Street, military or some of our universities. But to my knowledge no economist is predicting an expanding resource base for most segments of the educational community. The hard fact is we are going to have to do more for less (or more for the same). If ID is to have the impact on education we say it can, it must be practiced at a variety of levels of cost and sophistication. I see no inherent conflict between either an individual elementary school teacher or a multidisciplinary team of highly trained university level specialists applying the tools and principles of ID. The knowledgeable individual teacher who is provided with supportive and encouraging environment by administrators and a modest amount of assistance from media and library personnel can make systematic improvements in instruction. These factors of administrator support (especially from the principal) and assistance from other personnel have been documented by UCIDT and others as being critical to ID at the public school level.

Naturally, individual teachers need at least a modest amount of preservice and/or in-service training to improve their ID skills, and some efforts are now being made in this direction. But it seems to me, that if ID people are really interested in improving the entire range of educational activities we should expend more of our efforts in this direction.

So far, only the high cost of teams has been considered, but another and in some ways more insidious factor also drives up development costs. And here the finger must be pointed at both the developers and/or media people (if not the same). In our stimulus oriented society, developers (and everyone else) often become enamored of the vast array of sparkling gadgets placed at our disposal. Hence, we begin to think of what is the glamorous and innovative way of developing the material rather than what is most cost effective and efficient. If any developer doubts this statement, try to recall the last time a development project you know about came in well under budget. Then think of all the projects that have come in well over budget. While poor budgeting and management practices are partially responsible for these results, one of Murphy’s laws is also operating — costs rise to consume available resources. We may not be able to do ID for 24 a day, but we don’t always need millions either.

But enough of this telling everyone what is wrong with the instructional developer’s world. Let’s close on a more positive note. What can be done to insure that ID does help reform education — without millions? The author makes the follow-

1. ID personnel should address themselves directly to pre-service teacher training programs to insulate that the principles of ID are taught in a practical way to prospective teachers for their individual use.

2. ID personnel should address themselves to the in-service training need of teachers for practical skills in applying ID principles in their classrooms.

3. The Division of Instructional Development (DID) of AECT should seek out and publicize the successful ID efforts of Individual teachers at all levels of education.

4. The Division of Instructional Development (DID) of AECT should sponsor a symposium devoted to identifying simple but rigorous tools and strategies for low cost ID activities by individuals or small groups. The results of the symposium should be widely publicized.

5. Media and library personnel who have shied away from ID because of its perceived complexity and cost should seek out new information and begin to develop a minimal competency in the area. DID and AECT should act as a resource for these individuals.

6. Instructional developers should include a disclaimer in their writing and speeches which reminds their audiences that their respective project represents only one way to conduct ID.

I would like to suggest that the Instructional Development Division through its journal and convention sessions, sponsor such a dialogue.

Bibliography
A Case Study: Developing Convergent Formative Evaluation Methodology

The following case study has been severely edited due to space constraints. An effort was made to maintain the flavor of the case study, to ensure the results are presented and to mention the statistical procedures used. A complete report of the project is available from the authors.

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Introduction

This is a case study of the evaluation of a course development project. Our goal was to develop an evaluation design which would provide convergent data in making decisions about revisions in the course materials and exercises. Our initial problem was that no a priori criteria existed to use a basis for a criterion referenced evaluation, nor was it possible to use any comparison groups.

To put the evaluation in perspective, we will present some background information about the human geography course, the early course development work and the instrument development process. Then we will present the design and results of the evaluation after which we will provide a general discussion of the outcomes.

Course Description Human Geography is an introductory course which typically has an enrollment of 150 students, mostly freshmen and sophomores. The first eleven weeks were structured in the typical auto-tutorial manner: a one hour large-group lecture at the beginning of the week; a one to two hour lesson in the auto-tutorial lab; and a one-hour small-group discussion section at the end of the week. The remaining three weeks of the semester the students developed a term paper from raw data and journal articles supplied by the instructor. The students usually attended discussion sections for assistance with the paper. Also, some students reviewed previous lessons. All lecture sessions were cancelled during that three week period.

During the first eleven weeks a typical lesson would be introduced at the large group meeting on Monday with either introductory comments or a film. At the learning lab (the auto-tutorial study center) the lesson was largely self-contained, however, an Associate Instructor (A.I.) was in attendance and performed specific teaching and evaluation functions. The discussion session at the end of the week involved a planned activity. These sessions, which were led by the A.I.s, included games, simulations, and semi-programmed activities designed to extend the concepts of the lesson into an applied or problem solving situation. These discussion sessions were designed to aid in the transfer of the concepts, principles, and skills presented in each auto-tutorial lesson.

In the final three weeks, the concern for transfer of course learning was extended in the Applications Phase of the course. The student was expected to utilize the packet of unfamiliar raw data and journal articles in a manner that demonstrated knowledge of course objectives. The instructions to the students and criteria for judging the paper required specific "applications" of the concepts, principles and skills in treating the new content. We often used the phrase, "the students must think like a geographer," to describe this activity.

Products and Equipment

Large Group Lecture Session The first session was concerned with the usual matters of orientation. The sessions consisted of films, lectures, and testing as follows: (1) five used films which had been selected following an extensive bibliographic search, (2) five were of a traditional lecture format, and (3) three were devoted to testing. There were two weeks in the semester during which no lecture session was held.

Auto-Tutorial Laboratory Each of the eleven weekly sessions consisted of a printed student guide, a tape recorded lesson, and, in all but one case, a filmstrip. Other visual materials such as maps, charts, and graphs were included in each mimeographed student guide. Each student guide had four basic elements: (1) an advanced organizer, (2) behavioral objectives, (3) student work sheets, and (4) selected readings. The tape guided the student through a semi-programmed set of experiences. When played without repetition, the tape ran from 30 to 45 minutes. The filmstrips were developed to illustrate concepts, or to provide stimuli for skill-guiding exercises. The filmstrips were prepared from original slides supplied by the instructor.

Discussion Session The A.I.s led the sessions following a reasonably precise lesson plan. Three of the sessions utilized simulations and games adapted from the High School Geography Project. Three of the remaining sessions were devoted to test preparation. The remaining sessions used a guided inquiry technique in the solution of assigned problems.

Applications Phase The Applications Packet included a newsletter, which listed the objectives for the final paper and the criteria and process by which the paper would be judged. The data in the packet were of two types: (1) census and other demographic information,
and (2) a few journal articles, which contained information that provided a basis for application of the analytic concepts and skills learned during the auto-tutorial lessons.

The Developmental Analysis

During the first four to five months of the project, the behavioral objectives, the test items and the task analyses were revised. The instructor was particularly concerned with assessing "higher order" cognitive outcomes and using the data to improve his instructional materials. Fifty-five behavioral objectives were developed that specified three types of behavior: (1) higher order concepts, (2) five groupings of principles termed organizers, and (3) four skills. All concepts were complex or of a "higher order" in that each definition included at least two subconcepts. The groupings of principles were simple descriptive models (Chorley & Haggart, 1967). The models described the relationships between four or more concepts. The four skills involved three types of mapping and the interpretation of scattergrams.

Development of Achievement Tests The first achievement tests were developed in the Summer of 1973. Three, twenty-five item tests were developed in the tradition of criterion referenced measurement. Test validity was largely a logical process (content validity) in which test items were matched to behavioral objectives. We also analyzed correlational data utilizing aptitude, and grade point average and time in the laboratory in the determination of validity (see discussion below).

The distributions of achievement test scores generally conformed to standards for criterion referenced tests. Considering all forms of course performance, 75% of the students exceeded 80% of the criterion score. Considering the three criterion tests individually, in two of the tests 70% of the students exceeded 80% of the criterion. Early in the process of developing the third test only 45% of the students exceeded 80% of the criterion. The objectives, the lessons, and the test items were modified for this section of the course. In subsequent replications the data were more satisfying, 75% of the students exceeded 80% of the criterion score.

Evaluation Design and Results

Design It was the general goal of the evaluation to develop convergent feedback that would lead to appropriate revisions in the development of the materials and exercises. This general goal was restated in terms of three questions.

The first question: Do student perceptions regarding the first eleven weeks of the course lead to meaningful corrections in the materials and exercises?

The second question: What student individual differences and task related behaviors are correlated with success in the course? This question was posed with two general consequences in mind. Our attempt to correlate individual difference measures with success would allow us to examine the expected pattern of academic aptitudes being positively correlated with achievement. Our interest in task related behaviors such as repetition in the lesson, reading objectives, etc., allowed us to empirically examine the effectiveness of these tasks. We felt that empirical confirmation of these data would allow us to be more confident in our advise to students and in cross checking our other sources of information. Finally, the sources of information (individual differences and task related behaviors) used in the same analysis allowed us to assess the effects of individual differences versus instructional tactics. We expected the variance accounted for to be somewhat independent in a criterion referenced learning situation. Individual differences in academic aptitude will invariably predict success to some extent. However, we anticipated that the use of our instructional strategies should account for independent variance in achievement. In other words, the strength of the treatments would, partially, overcome the effects of aptitude or previous learning.

The third question: Can the students articulate the relationship between the first eleven weeks and the Applications phase of the course? A major portion of our effort was directed to this question because the question reflects the most important objective of the course. Our rationale was, if the students were to "think like geographers" then, they must understand or be able to articulate the relationship between the two major phases of the course.

Since each of the questions involved a primary methodology and the resulting activities were independent of the others, they will be treated separately in the following descriptions. However, we were able to examine the validity of our observations by comparing the results from each type of instrumentation and by comparing these results with other data such as the intuitive judgments of the instructor. We came to regard the intuitive judgments of the instructor as a useful, semi-formal source of information. As the case proceeded we would seek his opinion while minimizing information that would bias his response. We subsequently felt this procedure sharpened our evaluation process. The process of creating overlap among the types of instrumentation was viewed as an informal extension of the concept of convergent validation (Campbell and Fiske, 1959).

Question 1: Lesson by Lesson As previously discussed, the Introductory Phase of the course included eleven weekly lessons and each lesson consisted of a large group lecture, an auto-tutorial lesson, and a small group discussion section. The weekly evaluations were concerned with the auto-tutorial portion of each lesson. During the fall semester, 1973, the first six lessons, and lessons 10 and 11 were evaluated by each student responding to a questionnaire immediately following each lesson. The questionnaires included 10 Likert-type items with five response choices ranging from strongly agree to strongly disagree. Items were worded in a manner designed to counteract positive or negative response bias.

Each weekly questionnaire contained ten questions on a variety of topics. Some topics were included in each questionnaire, while others were included in only one or two of the weekly evaluations. The complete list of topics follows:

1. Repeated portions of the tape: This category sought to determine whether the students did replay portions of the tape recording used in each lesson.
2. Student guide: The student guide includes instructions to the student, the objectives of the lesson, brief skill-building "mini-lessons," readings, and exercises. Questions in this category concern evaluations of the student guide.
3. Orientation value of introductory outline: Beginning with Lesson five, an introductory outline was added to the student guide. Students were asked their opinions on the usefulness of this outline as an orienting device.
4. Relationship between performance objectives and content: Students were asked whether the performance objectives were clearly stated, and whether the content of each lesson was clearly related to the performance objectives.
5. Student self-assessment: Students were asked to indicate the degree to which they felt they had understood and accomplished the objectives of the lesson.
5. Tape/voice quality: Since poor tape quality can interfere with learning, this characteristic was evaluated independently of the tape content.

6. Auto-tutorial instructor: At some point during a lesson the student was asked to check, or discuss, his results with the learning center instructor. This category evaluated the students' attitudes toward this part of the instruction.

7. Instructional techniques: A variety of instructional techniques were used, and the students were asked to evaluate their effectiveness.

The responses to each item in each category were presented in tables by percentages. Some tests of statistical significance would not provide a strictly objective, probabilistic basis for decision making. We decided to formulate a set of arbitrary decision rules to use as a guide to interpreting what actions to take on the basis of the results. We decided that if the total percentage of responses to the Agree and Strongly Agree responses fell below 50% for a given item, two actions were taken: (1) the item was re-examined for possible sources of ambiguity, and (2) if the item appeared to be reliable, further inquiry into the problem represented by the item was recommended. If the average agreement to all items in a category fell below 50%, then further inquiry into problems associated with that category was recommended. Total agreement between 50% and 70% was considered to be satisfactory support, and total agreement above 70% was considered to be strong support for an item.

Question 2: Achievement Correlates
The purpose of this phase of the evaluation was to identify individual differences in the students' behavior that were correlated with success in the course. Fourteen behaviors were identified as possibly contributing to differences in achievement measures. The relationships between these variables and test scores were analyzed while controlling for several aptitude and status variables.

In this phase, 36 of the 156 students in the course were used in the evaluation. Twelve students were randomly selected from each of the high, medium, and low scoring thirds on the first test. They were interviewed by telephone during the fifth week of the course. Data were also obtained from class records at the conclusion of the course. The data from the interview were analyzed by means of crosstabulation with test score group using the Crosstab program in Statistical Packages for the Social Sciences (Nie, Bent, & Hull, 1970). The data obtained from class records were of a nominal order, therefore, product-moment correlations and, in a few cases, multiple regressions were used for the analysis, again using programs from SPSS (Nie et al., 1970).

Question 3: Follow-up Evaluation The client wanted to know, independently of the actual results of the assignment, whether the students felt that they understood the applications assignment and its purpose. Another closely related aspect of this question was whether the students perceived and understood what the relationship was between the first eleven weeks and Application Phase of the course. A third aspect of this question was with the students' general reaction to the auto-tutorial method of teaching the lessons. An effort was made to determine the extent to which the students regarded it as having been effective, efficient, and interesting. Of course, the interview information overlapped the other sources.

Results
To present the results in their entirety would be lengthy, tedious, and beyond the primary purpose of this report. It is our purpose to present some of the more interesting findings in a manner which illustrates the design of each phase of the evaluation, and which demonstrates the potential contribution which these procedures can make to a development project.

Question 1: Lesson-by-Lesson The results of the first six lessons indicated that the content of the lessons was well-organized, the objectives were clear, the instructional material was clearly related to the objectives, and the instructional techniques were effective. However, the results from Lessons 10 and 12 were not so positive. In these lessons a substantial percentage (50%) of the students indicated that they did not have a complete understanding of some of the concepts, and that the lesson content was not always clearly related to the objectives. This feedback was interesting for several reasons. First, it isolated a source of confusion in the material from the students' point of view (they performed satisfactorily on the achievement test, but we were also concerned with the students' perception of the lesson objectives, and that they perceived that the lesson strategies were consistent with the objectives). The second point of interest is that these results confirmed the intuitive reaction of the instructor with regard to these lessons. He had felt that these difficulties still existed, and that further revisions were necessary. The final point of interest is that these results tended to validate the successful reactions to the first six lessons. We concluded that the apparent honesty of the students in critically evaluating their reactions to the materials in this case supported our assumption that they were being honest in their more positive responses to the earlier lessons. The client indicated that the confirmation of his perceptions which these evaluations provided gave him a firmer grasp of the lesson design techniques which led to successful lessons.

These weekly evaluations also allowed us to identify an additional area of weakness in the course. One function which the A.I.s were expected to perform in the learning lab was to give the students feedback and assistance with specific exercises in the auto-tutorial lessons. The students were instructed at specific points in the lesson to show their responses to an exercise to the A.I.s and discuss their results with them. The responses to this item when it was included in the weekly evaluations indicated a balance of agreement with disagreement, with fully a third of the respondents undecided as to whether or not the learning center instructor was helpful. With this feedback it was possible to conduct further inquiry aimed at the specific problem of determining whether (1) the students felt that they did not need any help, or (2) the learning center instructors were either unclear as to their role, unprepared, or unwilling to provide the appropriate, helpful assistance which was desired.

Question 2: Achievement Correlates
The most significant finding from this portion of the evaluation was that almost all of the high and medium scorers on the first test read the objectives for each of the first three lessons before turning on the tape, while less than half of the low scorers did so. Most of the low scorers read the objectives only occasionally. The higher scorers were also slightly more likely than the low scorers to read the outline of the lesson before beginning, to discuss their work with the A.I., in the lab, and do advance preparation for the discussion group meeting. There were no noticeable differences among score groups on any of the remaining variables included in the interview. One reason for this was simply that there was no variance on several of the items. Over 85% of the subjects, regardless of test score, indicated that they (1) took notes in the student guide, (2) performed the activities indicated in the
lesson. (3) repeated portions of the tape. (4) did not skip portions of the tape. (5) completed each lesson before the discussion group met, (6) attended all the discussion groups, and (7) participated in the discussion groups. Also, 90% of the students attended the lab when a G110 A.I. was on duty. There was a variance as to whether or not the students perceived that the discussion group provided practice of the lesson's objectives (70% said yes, and 30% no), but the differences between score groups are difficult to interpret. There was actually a greater tendency for lower scorers to have responded positively. The greater tendency to respond negatively on the part of the higher scorers could be a result of their being more critical as a result of greater study and greater familiarity with the objectives.

In the remaining portion of this phase of the evaluation, several objective measures of the students' behaviors were taken from class records and the university data file, and compared with achievement in the class. This was done during the fifth week—one and one-half weeks after the first test, and at the end of the semester after final grades had been posted.

The first part of this analysis was concerned with the relationship between attendance and participation in discussion groups and total test score. Points were assigned to each student by the A.I.'s for attendance and participation. It was found that attendance was not an effective predictor because almost everyone got the maximum number of points (the maximum possible was 13, and the mean was 12). On the other hand, participation was significantly (p < .01) correlated with total test score (r = .24). When SAT scores were partialled out of the correlation, the coefficient increased slightly (r = .27). This means that participation in the discussion groups is positively related to test score and independently of ability as measured by SAT.

The major part of this analysis was concerned with the relationships between time-in-lab, SAT, GPA, and test score. These relationships were studied after the first test, and at the end of the semester. Scores on the first test were found to correlate significantly (p < .10) with time-in-lab, SAT, and GPA. The correlation between time-in-lab and test score increased from .35 to .40 when the correlation due to SAT was partialled out of the equation, but it decreased to .22 when GPA was partialled out. This suggested that while time-in-lab and SAT are both correlated with achievement, their relationships are independent; that is, effort expended on the developed materials appears to have a correlation with achievement which is independent of, and greater than ability as measured by SAT. However, time-in-lab is not independent of GPA, which itself is probably more of an indication of effort than ability.

At the end of the semester, these relationships did not hold up. Although all three independent variables were still significantly correlated with test score, the time-in-lab correlation had shrunk while the other two increased. Time-in-lab was still significantly correlated with test score after SAT had been partialled out, but there was no correlation when GPA was partialled out. Therefore, time-in-lab appears to be independent of ability, as measured by SAT, but not independent of other attitudes, personality characteristics, or efforts which have been employed by the higher achievers in other courses.

Question 3: Follow-up Interview The results of this interview, obtained six weeks after the end of the semester, indicated that over 80% of the students recalled what the final assignment was, and what its purpose was. Only 58% of the students sought the aid of the A.I.'s while working on the final paper, but all of those who did seek help said that the A.I.'s were helpful. The positiveness of this response was an improvement over the Introductory Phase when the students often perceived that the A.I.'s were not helpful. It may be that the A.I.'s had a more useful function to serve during the Applications Phase.

Over 90% of the students recalled that there was an instructional relationship between the Introductory and Applications Phases of the course, and they were able to describe what this relationship was. And, over two-thirds of the students expressed a favorable attitude toward the way in which the course was organized.

Again, over 90% of the students expressed a favorable attitude toward the individual, auto-tutorial lab as a means of teaching the lessons. An even greater percentage (97%) indicated that the auto-tutorial lab provided an effective and efficient means of learning the material. However, when asked if working in the lab was enjoyable, 47% said yes, while 43% were indifferent, and 10% said no. Even so, over 90% said that they would not have preferred another method of presenting the lessons.

Discussion
We interpreted these results as indicating both strong positive support for (1) the auto-tutorial instructional technique, (2) the other instructional techniques used in the course, and (3) the overall instructional quality of the materials which had been developed for the course. We were impressed by the ability of the randomly selected students who were interviewed in the Follow-Up evaluation to recall specific goals and objectives of the course, as well as its general structure.

With respect to the primary goal of the evaluation, we were able to identify some specific problem areas in the course which aided in the development, and we were able to identify several correlates of successful achievement, which were related to effort within the course. One example of a problem area consisted of the student evaluation of Lessons 10 and 11. The weekly evaluations of Lessons 10 and 11 indicated that the students saw a lack of relationship between some of the exercises and the objectives of the lesson, and that some of the concepts were not clear to them. There were two possible explanations for these results. One was that the students were correct, and the other was that they were being highly critical due to having had considerably lower grades on Test 2 than Test 1. We were able to make a decision by considering two additional sources of information. It may be recalled that time-in-lab, which presumably is a measure of the amount of time spent studying the materials lost some of its predictive power between the first and third tests. This could indicate that during Lessons 10 and 11, the students had to fall back on learning strategies which they had acquired prior to entering the course. The other source of information was the instructor. When these results were presented to him, he indicated that he had suspected that there might still be difficulties in these lessons. He then undertook revisions on the basis of the evaluative data.

Achievement in the course was found to be positively correlated to several behaviors which were measures of effort within the course. These included studying the objectives before beginning the lesson, participating (rather than just attending) the discussion groups, and amount of time spent in the auto-tutorial lab. The correlation of amount of time spent in the lab and achievement was in-
dependent of SAT throughout the course, and partially independent of GPA on the first test. These relationships were reported to subsequent students who were enrolled.

Our primary goal seems to have been met. Our information seemed to converge on meaningful corrections in materials or exercises. As has already been mentioned, the methodology provided the instructor with a means of validating his perceptions of the outcomes of the materials he had developed, in combination with multiple sources of validation of several findings. An additional outcome is that the design used here is proving to be generalizable to other course development projects. The combination of (1) weekly student evaluations, (2) midterm telephone interviews with a random sample of students, (3) a follow-up telephone interview with a random selection of students, (4) achievement data, and (5) careful use of intuitive observations of the instructor and associate instructors is not expensive and does not require elaborate or sophisticated technology to implement. It does provide a basis for multiple, or convergent, methods of validating given outcomes, and for making comparisons of outcomes over time as the course is repeated in successive semesters.

References

Rural Education In Bolivia & The Potential Of Educational Technology

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Introduction
This paper describes the present status of rural education in Bolivia including the constraints to improvement and proposes strategies for attenuating those constraints. Data were collected from site visits, from earlier experiences in Bolivia, and from studies performed by a variety of agencies. The major recommendations include the application of instructional technology in the systematic design of instruction, in the production of instructional materials, and in the use of media devices.

The Problem
This paper reports part of an investigation to describe the rural Bolivian educational system in terms of the major constraints impeding improvement. The data collected from the investigation provided a base from which alternative strategies could be suggested for minimizing those constraints. The research model employed followed the investigation class of inquiry and consisted of an observation or assessment of a single subject. It was essentially a capture and record activity. An investigation has much less control concern than does the pure experimental classes of inquiry and no practical claim to external validity. However, even a brief study of the different classes of inquiry available to the researcher will reveal that control for internal validity in an investigation is substantially the same as a two-cell study or a carefully conducted survey.1

Data Collection
Data were collected from three general sources. The first source consisted of the researcher’s earlier experiences and studies in Bolivia. The second major source was a 30 day series of site visits to rural schools and rural normal schools in eight of the nine “Departamentos” or states of Bolivia, and a data collection trip to ISER, the Institute Supremo de Educacion Rural (The Superior Institute of Rural Education). The third source was studies previously conducted by the Government of Bolivia, UNESCO, and the United States Agency for International Development.2

A General Description of Bolivia
Bolivia is roughly the size of the United States east of the Mississippi River, excluding Maine and Florida. It’s 520,000 square miles is populated with an estimated six million people. It’s population density is very uneven with 20% to 30% living in urban centers and 70% to 80% living in rural areas. Population density varies from 100 to less than 4 persons per square mile.

The country is physically divided into three major regions; a high plateau area called the “Altiplano” nestled between two mountain ranges running the full length of the country on a curved north-south axis, the eastern foothills of the Andes called “Valles” (Valleys), and the eastern grassland plains and jungle areas referred to as the “Oriente”.

Bolivia is located entirely in the tropical zone, but the spread of altitude from 400 feet to 21,000 feet above sea level produces an extreme variation in climate from the continuously moist heat of the amazonian rain forest to the glacial slopes of the Andes.

Bolivia’s resources are varied and considerable but largely undeveloped. The country’s foremost industry is mining. Bolivia mines tin, antimony, tungsten,
lead, silver, zinc, bismuth, copper, sulfur, gold, and iron. Bolivia also has a substantial petroleum and natural gas industry. The processing of meat and other animal products is a minor industry in Bolivia as is the production of textiles and cement. The country is extremely poor economically, as evidenced by the estimated average annual income of four thousand pesos Bolivianos ($200 U.S. currency). Most of the rural population relies heavily on bartering systems.

Because of Bolivia's diversity of climate, vegetation, and topography (including some of the tallest mountains in this hemisphere), communication and transportation are difficult and unpredictable. Large sections of the country are inaccessible during certain seasons of the year and even the major cities are accessible primarily by air. In jungle regions, rivers and machete trails are still used by travelers, and in the valley areas it is not unusual for student teachers to travel, with provisions and bed rolls, four days by horseback to arrive at their student teaching assignment.

Culturally, Bolivia is divided into three main groups and a variety of smaller subcultures. An estimated 35% of the population speaks Spanish as their native or second tongue. Spanish speaking people are generally of European or mixed European descent who live in the urban areas and in the eastern plains. Another 30% of the population speaks Quechua, the language of the ancient Incas. These Quechua-speaking Indians live primarily in the valleys, usually in the rural areas, and are a separate culture in terms of food, dress and values. The third large cultural group is known as the Ayamara Indians and comprises approximately 30% of Bolivia's population. The Ayamara are descendants of a pre-Inca culture which probably developed the Tiahuanaco civilization thousands of years ago. They live in the Altiplano areas of the country, their ancestral lands, where they doggedly maintained their language and cultural identity through both Inca and Spanish conquests. The remaining 5% of the population belongs to over twenty three different language and cultural groups that live principally in the eastern part of the country.

A Description of Bolivian Rural Education

Description of Resources: Finances: The total annual budget for both rural and rural normal schools in Bolivia is smaller than the budget of most school districts in the United States. Of that limited amount approximately 90% is used to pay salaries. There is, practically speaking, no money available for construction, for maintenance of existing facilities, for purchasing supplies, for research, for the development of instructional materials or anything other than administrative costs. The predictable result of the severe limitation of resources is a very high attrition or drop-out rate. Approximately 87% of the students of the rural educational system leave school by the third year. Ten percent leave by the end of the sixth year and another 2% leave by the end of the ninth year.

Duplication of educational systems in Bolivia is a drain on her limited resources. Education in Bolivia consists of two formal systems: the Urban Educational System, which is designed and intended to serve urban centers, and the Rural Educational System, which is a complete duplication of the first system in terms of teachers, administrators, and government officials. The history of the two systems is unequal; urban education has consistently received more attention in terms of budget, buildings, training, and personnel incentives.

A Description of Bolivian Rural Education

Description of Resources: Instructional Materials: Instructional materials of any kind, including textbooks, are hardly in existence in rural Bolivia. Where they do exist, they are generally created or purchased by the teachers. Texts used in Bolivia are produced for use in Spain, Mexico, or Argentina and are frequently 20 or 30 years old. Clearly, such materials are not readily adaptable to the multicultural, multi-lingual reality of rural Bolivia. Of the few instructional materials that do exist, most are print.

Description of Resources: Personnel: Many of the administrators and teachers involved in Bolivian rural education are dedicated individuals interested in improving themselves and the system in which they work. However, a major constraint to improvement of Bolivian rural education is the lack of competence — the lack of individual expertise. This is largely due to the fact that teachers and administrators are themselves products of the rural education system where the mode of instruction is primarily dictation, the learning activity being memorization-recitation. Other causes for undeveloped competence are reflected in the student demographics. Most of the students preparing to become teachers have had one or perhaps two years of high school before they enter the normal school (73%); many normal school students are graduates of the sixth or eighth grades (15%); a small percentage (3%) have only completed their primary education (5 grades); and a scant 11% have completed high school. The outcome is that rural normal schools produce teachers that are ill prepared to effectively handle the peculiar and demanding needs of rural education.

Administrators generally do not receive any special preparation or training and are chosen from among the teacher ranks as political appointees. Both teachers
and administrators are frequently required to live in the isolated rural schools away from their families, enjoying only limited contact with the outside world for months at a time. The lack of preparation, of instructional resources and facilities, the spartan living conditions and separation from family and urban centers tend to discourage and demoralize even the most devoted, the most committed teachers and administrators.

**A Description of the Constraints to Development and Improvement**

**Political Atmosphere** Until recently, Bolivia has been a very unstable country experiencing nearly 150 revolutions or coups in nearly as many years. This lack of stability has, in the past, made long-range planning and concentrated, longitudinal efforts impossible. With each new coup came a new set of administrators, new goals, new policies and a redirection of effort.

**Top Heavy Administration and Resource Constraints** Education in Bolivia is organized with a top-heavy, centralized administration. This centralized, bureaucratic maze makes it virtually impossible for schools in remote areas to receive needed attention and support.

Rural education is supported with government monies. The rural education budget for all of Bolivia for 1976 totaled slightly less than one million dollars. As was noted, 90% of the rural education budget is typically expended on salaries, leaving a scant 10% for administrative costs and none for building maintenance, purchase of materials, research, remodeling, or new construction.

**Geography and Communication-Transportation Systems** As pointed out earlier, the geography of Bolivia varies drastically and includes major mountain ranges. The country does not have sufficient resources to build hard surfaced, well graded roads, the result being that major regions of the country are isolated or inaccessible during different seasons of the year. The communication system within the country reaches limited areas with teletype terminals only. Transportation within the country exists primarily between larger urban centers.

**Instructional Materials and Equipment** As suggested above, the availability of instructional materials and equipment is, for all practical purposes, nonexistent. Where instructional materials do exist these generally consist of out-dated maps and texts or teacher produced graphics. Three of the rural normal schools had audio-visual equipment and 5 or 6 filmstrips or audio tapes. However, because of the lack of electricity and technical support of AV equipment (in terms of trained repair technicians, spare parts inventories and supplies) the equipment is seldom used. The distance to urban centers where self-trained repair technicians may exist, the difficulty in securing spare parts, the inaccessibility of electricity, the extreme climatic conditions, and the inability to produce software, all combine against the use of audio-visual equipment in rural Bolivia.

**Language and Cultural Differences** There are a number of distinct cultures and languages in Bolivia which makes communication and dissemination of materials and methods difficult. Any instructional materials produced for use in Bolivian elementary grades should be prepared in Aymara, Quechua and Spanish. An multi-lingual attempts to produce instructional materials should also be multi-cultural attempts that will take into account the diversity of taboos, symbolism, value systems, etc., of the three main cultures.

**Personnel Competence** Without question, the most serious constraint to improvement of instruction in Bolivia is the lack of competence on the part of rural educational personnel. With very few exceptions, the teachers and administrators in the rural educational system have not had the opportunity, experiences or training that would enable them to successfully execute their roles. Most are products of the rural education system, have had limited schooling, limited access to out-dated resources, and have had very limited experience with any special purpose tools or facilities such as laboratories or audio-visual equipment. From personal visits to rural schools it was determined that a substantial portion of the subject matter content communicated by teachers was inaccurate. These limitations, combined with the isolation that many rural teachers face, make motivation and the overcoming of negative attitudes a constant concern.

Teachers tend to teach as they were taught and the primary mode of instruction is recitation-dictation-memorization and recall of fact. With the exception of one rural normal school (Calzada D.), no other methodology was in evidence. Teachers are not prepared in instructional methodologies, curriculum development, systematic instructional design, nor in the design and production of instructional materials. The local development of curricula and the local or regional development and production of instructional materials is non-existent.

**The Major Constraints Summarized**

To summarize the constraints it may be useful to view them as being grouped in general areas. These general areas were derived from: the fact that Bolivia is an underdeveloped country with severely limited resources; the fact that Bolivia has severe environmental/situational limitations; and the fact that a combination of limitations produce still other constraints, many of which tend to be self-perpetuating. Viewing limitations by their respective groups we have:

Bolivia, An Underdeveloped Country with Limited Resources

1. The existence of inadequate, inappropriate facilities, furniture, support supplies and specialized equipment.
2. Centrally controlled, severely limited budgets.
3. The lack of systematically designed curricula, of instructional materials and of equipment and supplies for producing instructional materials.
4. The lack of audio-visual instructional equipment (the indigenous cultures have strong aural-visual communication traditions).

Situational or Environmental Limitations

1. The existence of a diverse and difficult terrain in Bolivia which makes for very poor transportation and communication.
2. The existence of a largely rural population scattered unevenly throughout remote areas.
3. The existence of a diversity of languages and cultures.
4. The existence of strongly centralized administration of education.

The Results of Combined Constraints

1. Insufficiently prepared personnel in terms of their subject matter expertise and their instructional competence.
2. The wide spread demoralization of personnel.
3. The very high student attrition rates.
4. The existence of a vast reservoir of undeveloped human resources — of untapped human potential.
The Conclusions and Recommendations Derived From the Study

The study revealed the above listed problem areas and proposed the following general strategies.

1. That the administrative, budgetary and communications organization directing education in Bolivia be decentralized. With the decentralization of resources and authority, the difficulty with communication, transportation and dissemination will be reduced.

2. Substantially increase budgets for instructional purposes. If individuals are to be trained, instruction planned for and instructional materials designed, produced or purchased, resources will need to be made available. Here, the Government of Bolivia has begun to reassess priorities with the hope for and result of reassigning some of the limited resources to rural education. In addition, Bolivia has sought grants and loans from foreign powers to assist in improving their rural educational system.

3. There is a need to develop appropriate curricular content for rural students as well as inservice curricula for rural teachers and rural normal school teachers. Such curricula should emphasize both subject matter content and methodologies for communicating that content.

4. There is a need to develop appropriate rural curricula, methods and instructional models. These curricular methods and models should be developed consistent with the needs of rural Bolivia and should become a part of inservice training for rural teachers.

5. There is a need for intensive, thorough and appropriate training of rural education staff. This includes administrators, rural normal teachers and rural teachers. This training would need to be planned and carefully coordinated with the development of curricular content and methods mentioned above.

6. There is an obvious need to design, develop and produce instructional materials for rural students and teachers. Such instructional materials should be developed consistent with curricular methods such that the content could largely communicate itself. This suggests the development of individualized instructional materials of some sort. The advantage of such materials would be that rural teachers could learn instructional content along with their students as a part of the inservice effort. This would help prevent the communication of inaccurate content.

7. There is a need to disseminate in a practical, regular and comprehensive way the curricula, methods and instructional materials listed above.

The Potential of Educational Technology

It is readily apparent that the above listed problems and general recommendations are the very areas with which the field of educational technology concerns itself. The facts that instructional technology is a systematic approach to solving problems, that it employs expertise from the areas of: instructional research; instructional evaluation; instructional design; production of instructional materials; the logistics of support and supply of instructional materials and equipment; personnel management; organizational management; information retrieval; and instruction; suggest the potential of instructional technology for rural Bolivia.

More specifically, instructional design steps and tools could be applied to very beneficial effect in Bolivia to help solve problems in the areas of: the need for appropriate curriculum content and methods; the need for thorough, intensive and appropriate inservice training; the need for the design, development and production of instructional materials; the need to disseminate curricular content and methods.

The Concept of Competence

Among the different instructional design tools of potential benefit, the theory or concept of competence appears to have considerable promise as a tool of the planning process. When the theory of competence as described in an earlier article is used in the instructional design process, instructional planners are forced to think in terms of competence, in terms of what is required of students. Instructional content and methodologies are then planned in terms of required knowledge, skills, abilities, judgement capabilities, attitudes and values. The concept of competence also requires student application of knowledge, skills and attitudes in order to verify acquisition of competence. The use of the theory of competence with instructional design steps would mitigate against the facts that: most rural and rural normal curricula (both content and methods) are not applicable to real life needs; curricula are not systematically planned; curricula are fact oriented; curricula require of students a recall familiarity of facts only; objectives are usually non-existent or are not expressed in measurable terms; most instruction does not require students to apply their knowledge, skills, abilities, judgement capabilities or attitudes.

Curricular Development and the Need for Instructional Equipment

It appears that a promising solution to many of the problems encountered in rural Bolivian education is the careful design and development of inservice and subject matter curricula, incorporating these in self-instructional packages. Such packages would necessarily need to be combined with regional inservice training and occasional supervisory observation of teachers in their classrooms.

Self instructional packages developed for Bolivia may require the use of instructional equipment (devices) which would need to be uniquely suited to the demands of the rural Bolivian environment. If vehicles of communication (instructional devices) could be discovered or developed that would not be seriously impeded by rural Bolivian constraints, then a possible, partial solution to the communication-education problems of Bolivia may have been found. The constraints that such communication devices would have to satisfy are listed below.

1. Allow for instructional content to be developed or adapted for different language and cultural needs

2. Allow for the use of primarily aural and visual channels of communication (the problems with literacy combined with the indigenous cultures' oral traditions suggests this need.)

3. Allow for the production and mass duplication of instructional content at relatively low cost and within Bolivia

4. Include the use of instructional devices that do not require a large initial expense and whose maintenance would not be expensive or complex

5. Include devices that could operate within and be maintained by the available resources (considering the need for small parts inventories, electricity and repair expertise)

One of the recommendations of this study was that media devices be developed or located that would satisfy these constraints. Some devices presently exist on the market that may satisfy these criteria (with possible modifications). These devices include: Small Talk, a small, battery operated record player with very creative possibilities; Mattell's "See-N-Say" line of toys, adapting these with necessary content and visuals; Fisher-Price's toy camera that is really an 8mm cartridge viewer requiring no
electricity; CAF Sound Viewer; the Vox-Com adaptor for cassette players that allows for the handling of Language Master Cards; the battery operated Language Master; the Sound Page; a combined use of cassette tapes and flipcharts; adapted filmstrip-cassette rear view machines with smaller lamps (and overexposed film to compensate) so that the machines can be operated on batteries. Some of the questions that would need to be answered before such devices could be adapted or used in Bolivia would include:
1. What would the initial cost of such devices be?
2. What would the maintenance costs likely be?
3. What would the cost of producing software for use in the devices be?
4. What is the capability and practicality of local production of software for such devices?
5. Is the local production of masters for the software a possibility?
6. Is the mass duplication of additional copies from the master a local possibility?
7. What problems might be encountered in terms of technical repair expertise, small parts inventories, electricity, etc.?

Personnel Development Another recommendation emerging from the study was that Bolivian personnel should be trained in the production of different media forms, including graphics production, printing, photographic production, and audio production. Such training would not necessarily include sophisticated and advanced techniques, but should treat the basics necessary for producing acceptable printed products, slide or photographs, and audio tapes. The study also recommended that Bolivian personnel be trained in the various aspects of instructional technology including instructional research, instructional design steps and tools, personnel management, organizational management, logistics of support and supply dissemination of instructional materials and equipment, and the development of information retrieval systems for diagnosing need and for long range planning.

Conclusion
The educational needs of Bolivia are great, as are the untapped human resources. The field of educational technology with its multi-disciplinary expertise and its emphasis on systematic problem solving could play a major, beneficial role in the improvement of Bolivian rural education.

Implications for Instructional Developers
Two major implications for other instructional developers were generated by this study. There is a definite need to use a comprehensive, thorough, and practical theoretical construct (some prefer the term “conceptual framework”) that will provide continuity and a foundation for the complete instructional development process. A conceptual framework should be employed that is capable, because of its simplicity, logic and practical applicability, of being woven through all of the instructional development steps. Such a conceptual framework would be the base from which need is assessed, would provide the tinted glasses through which subject matter specialists would work in developing curricular content, would allow for practical ways of implementing methodologies, and would be the foundation from which most, if not all, evaluation would be planned. The conceptualization of competence mentioned above proved itself to be just such a tool, providing a valuable perspective during the study. This conceptualization of competence appears to be a very practical generalizable tool.

The second generalization affecting instructional developers is the obvious fact that need assessments are crucial to successful ID efforts. When carefully considered, assessments of need generally collect subjective data. On occasion, educators fool themselves applying procedures that give subjective data the appearance of objectivity. Rather than designing and following elaborate procedures which give the appearance of objectivity, but which, in fact, collect only subjective data, it would appear more useful to use a need assessment technique that would collect opinionnaire data and organize them into practical and logical categories from which in-service, preserve, and subject matter curricular program could be prioritized, planned, implemented and evaluated. The quadrant assessment model (QAM) does just this. In earlier applications in Bolivia, it has shown itself to be applicable to distinct situations. Implications related to ID work abroad include the probability that the collection and use of need assessment data may help stabilize educational programs, their planning and implementation, in countries where change (through coups, etc.) is a regular occurrence. Also, apparent from working with foreign countries, is the fact that the more unknown the situation, (regardless of the cause of the lack of information), the more necessary a complete need assessment.

End Notes
2. Some of the reports, monographs, studies and correspondence researched:
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