Current Trends In Task Analysis

The Integration of Task Analysis and Instructional Design

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This paper is about some major trends that are occurring with respect to the development of task analysis methodology. One clear trend is that better methodologies are being developed to analyze **cognitive** tasks (e.g., Greeno, 1976; Gregg, 1976; Resnick, 1976; Landa, 1983; Scandura, 1983). Among the most promising developments here are methodologies for analyzing ways in which knowledge should be structured within a student's head in order to most facilitate given types of performance (e.g., Reigeluth, D. Merrill, & Bunderson, 1978; Rummelhart & Norman, 1978; Wildman, 1981; Winn, 1978). Much as been written lately about this trend, so it will not be the focus of this paper.

Another prominent trend is that **computers** are increasingly being used as a powerful tool in helping to perform task analyses. However, many recognize that the important technology here is task analysis methodology itself. The computer is merely a tool for using whatever methodologies we are able to develop. Hence, this trend will also not be the focus of this paper.

Perhaps the single most important trend in task analysis methodology is the integration of task analysis with instructional design; and this trend will be the focus of this paper. But first, it may be helpful to clarify what we mean by task analysis and what we mean be instructional design. **Instructional design** is the process of prescribing what a specific instructional system should be like. It entails selecting the instructional strategies, including strategies for sequencing the instructional content and strategies for presenting the individual skills and knowledges that make up that content. Therefore, the term "instructional design" is used here in the more common sense of *one* phase within the entire instructional systems development (ISD) process rather than in the less common, broader sense of the *entire* ISD process itself. **Task analysis** is the process of analyzing all the skills and knowledges that should be taught. The purpose of a task analysis is to provide information about the instructional content. Such information may be used for purposes of describing a task, for purposes of designing a test on the instructional content, or for purposes of prescribing instructional strategies (including the selection of enabling skills and knowledges.

Two ways in which task analysis can be integrated with instructional design are: substantive integration and temporal integration. **Substantive** integration means that the type of task analysis which you conduct is determined by the type of design that you are planning to use, because different types of task analysis provide different kinds of information, and different designs require different kinds of information. **Temporal** integration refers primarily to having an instructional development procedure in which analysis activities are interspersed among design activities and vice versa, rather than doing all of the analysis and then doing all of the design.

Substantive Integration

With substantive integration, the substance lies in the kind of information that the task analysis produces. The kind of information that is needed as input for instructional design differs depending on the kind of design activity that you are undertaking. For **selecting** the content that should be taught, you need a type of task analysis that yields the appropriate information for selection to be done well. For deciding how to **sequence** that content, you need a type of task analysis that yield appropriate information for that purpose. For deciding how to **synthesize** the content (i.e., to teach important interrelationships), you first need to identify the interrelationships that need to be taught, and this requires an entirely different kind of task analysis. (As will be discussed later, this is an aspect of task analysis that has been almost totally ignored, and it is my hope and belief that investigators will begin to address the need for methods of identifying relationships that should be taught. Finally, for prescribing **micro strategies** (i.e., for deciding what strategies to use to teach a single concept or a single principle, such as the use of generalities, examples, and practice with feedback), a still different kind of task analysis needs to be done to categorize objectives for purposes of prescribing different combinations of micro strategies.

A second aspect of substantive integration is that, with respect to sequencing strategies, it has been found that the selection of a hierarchical sequence (Gagne, 1977) requires one type of task analysis, whereas the selection of a forward chaining sequence (Skinner, 1965) requires a different type of task analysis, and the selection of an elaboration sequence (Reigeluth, 1979a) requires still a different type of task analysis. Therefore, in addition to the fact that each design activity (e.g., selection, sequencing, synthesis) requires some differences in task analysis methodology, the **particular instructional strategy** that is selected within each of those activities also has important implications for the type of task analysis.

It used to be that most instructional developers would adopt a certain task analysis methodology and use it for all instructional development work they did. One trend with respect to substantive integration is that instructional developers are realizing the importance of having a variety of task analysis methodologies within their "tool kits" and choosing the type of task analysis based on the information needs for each design activity (e.g., sequence, synthesis) and of each particular strategy selected during each activity (e.g., hierarchical sequence, elaboration sequence).

Another trend is that, as new instructional strategies are developed, new types of information are often needed to design the instruction, and therefore new types of task analyses are required. As an example, the unique capabilities of micro computers and videodiscs are requiring the development of a new instructional strategies to take advantage of those capabilities. Among the most important of these new strategies are methods for structuring and sequencing the content. There is increasing recognition of the need to design instruction in such a way that a learner can follow his or her interests. For such a "learner controlled" sequence of content (D. Merrill, 1980; Reigeluth, 1979b), some kind of simple-to-complex arrangement of the content is essential; and even for "system controlled" sequences (i.e., sequences controlled either by the teacher or by the computer), simple-to-complex arrangement also have tremendous advantages over the alternatives.

Given that simple-to-complex sequencing appears to be one direction in which design is moving, the question then arises as to what ways task analysis needs to evolve in order to provide the necessary inputs. One problem in answering this question is that there are many different kinds of simple-to-complex sequences because there are many different dimensions of the content on which one can elaborate in the instructional sequence. Therefore, an important design decision is which dimension to elaborate on. In the elaboration theory (Reigeluth, 1979a, Reigeluth & Stein, 1983) we have identified three different dimensions that we think are promising. Each of these dimensions is based on a different kind of generalizable knowledge which is stored in propositional memory. The three different kinds of knowledge are concerned with the how, the why, and the what, all of which are generalizable to new cases. **Procedural** knowledge provides the how. It is often referred to as operations, procedures, algorithms, rules, skills, and techniques. **Theoretical** knowledge provides the why. It is often referred to as cause-and-effect relationships, principles, laws, hypotheses, rules, and propositions. **Conceptual** knowledge provides the what. It is often referred to as concepts, classes, and categories.

When the goals of the instruction call for an emphasis on the acquisition of **procedural** knowledge, then the simple-to-complex sequence should elaborate on the procedural content. Information processing task analysis and path analysis (P. Merrill, 1978, 1980; Resnick, 1976; Scandura, 1973) provide very important information for designing that kind of simple-to-complex sequence (see Figure 1). After having conducted an analysis of paths through a rule or procedure, you can design the sequence to teach the shortest path first and then to teach progressively longer paths until all desired paths through the procedure have been taught (see Figure 1 also).

On the other hand, there are many situations in which the kind of knowledge you want the learner to gain is more fundamental, more meaningful in nature, and less along the lines of a rote procedure. This is particularly im-

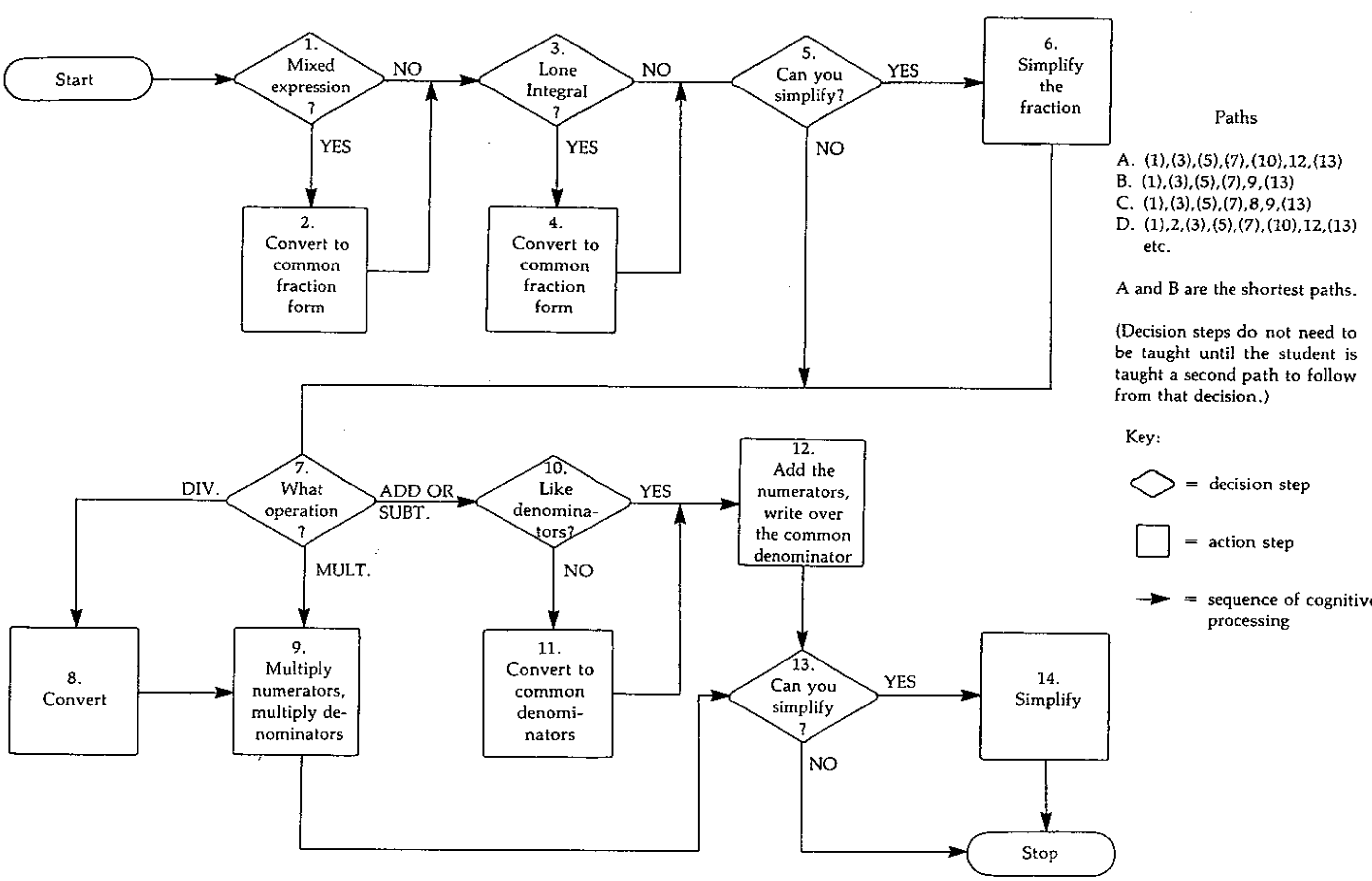


Figure 1. A sample of the results of an analysis of procedural knowledge using an information processing task analysis and path analysis.

portant when there is a lot of variation in the way a task is performed from one situation to another. Such tasks are often called transfer tasks or "soft" skills, and the emphasis in teaching them should be on **principles** rather than procedures— cause-and-effect relationships rather than sequential steps. For this kind of instruction, the simple-to-complex sequence should be based primarily on starting with the most fundamental, basic principles in a manner similar to Bruner's (1960) "spiral curriculum" and elaborating one level at a time to more complex, narrow and local principles (see Figure 2).

There are also situations in which the emphasis of the instruction is not on providing skills. Rather, the emphasis may be on providing a "general education"—an understanding of the important concepts in a discipline. In this case, the simple-to-complex sequence should be based on **conceptual** knowledge, initiating the instruction with the most general and inclusive concepts and proceeding through a process of "progressive differentiation" (Ausubel, 1968) by gradually elaborating, one level at a time, down to the desired level of detail (see Figure 3).

Please do not misunderstand: All three types of generalizable content (procedures, principles, and concepts) are important in practically all courses. It is also true. however, that the goals of a course usually emphasize one of the three types of content, and the elaboration theory merely advocates that *that* content serve as the basis for the simple-to-complex sequence and that the other types of content be plugged into that sequence wherever most relevant.

It can readily be seen that a simple-to-complex sequence for a course will be very different depending on the dimension along which you choose to elaborate: procedural, theoretical, or conceptual. It should also be apparent that the kind of information (about the content or task) needed for designing a simple-to-complex sequence will be very different depending on which of the three "organizations" is chosen. Therefore, you need to pick a different type of task analysis for each type of organization—you need to analyze a different type of content and content structure. The elaboration theory (Reigeluth, 1979a; Reigeluth & Stein, 1983) utilizes and describes all three kinds of simple-to-complex sequences and also describes the kind of task analysis that is appropriate for each sequence.

Listing of Principles for Parts of a Physics Course Related to the Behavior of Light

The most important dimension of complexity for a course on the behavior of light is that the behavior of waves and of particles are respectively less complex than, yet similar in important ways to, the behavior of light. Hence, the simple-to-complex listing of principles is:

How particles behave
How waves behave
How light behaves

The next most important dimension of complexity is that the behavior of light is progressively less complex when it is refracted, reflected, and merely propagated. This progression of complexity can occur within the previous one:

How Particles Behave

- *Linear Movement*. They move in straight line, unless acted upon by something.
- *Reflection*. They bounce off of a surface.
- *Refraction*. They change direction and speed when the inclination of the surface is changed.
  (Other behaviors like absorption also come here.)

How Waves Behave

- *Rectlinear Movement*. They move in a straight line perpendicular to the wave, unless acted upon by something.
- *Reflection*. They bounce off of a surface.
- Similar to *Refraction*. They change direction and speed when the density of the fluid changes.
  (Behaviors like interference, transmission, and absorption appear in turn here.)

How Light Behaves

- *Linear Movement*. Light moves in a straight line unless acted upon by something.
- *Reflection*. Light bounces off things.
- *Refraction*. Light bends as it passes from one medium to another.
  (Other behaviors like diffraction, interference, transmission, and absorption appear in turn here.)

Just as "How waves behave" and "How light behaves" both elaborate on "How particles behave," and just as reflection and refraction both elaborate on propagation (movement), so the above-listed principles can also be elaborated upon. Space prohibits pursuing elaborations for all of the principles indicated above, so we will pick just one. In pursuing the "Refraction" avenue, the following principles are arranged in a simple-to-complex sequence:

More Detail on Refraction

- Effects when light passes from one medium into another
  - image remains the same but apparent position changes
  - rays bend out but remain parallel to each other
- Effects when light passes frcm one medium into and out of another
  - plane glass
    image remains the same
    rays continue in same direction and parallel to each other
  - prism
    image remains the same
    apparent location of the image is different
    rays go off in a different direction but are basically parallel to each other
    white light is broken into colors (diffraction)
  - concave lens
    no image or enlarged image
    rays disperse

Figure 2. (Cont.)

- convex lens
    smaller image before 2FP
    inverted image after FP
    rays converge at a point, then disperse

Finally, space also prohibits pursuing all of the directions indicated within the above avenue, one further direction is indicated below. In pursuing this avenue, we elaborate by asking the questions, "What else happens?" and "Why, which way, and how much does the change occur?"

More Detail on "Into a Medium"

What else happens?

a. A portion of each ray is reflected off of the surface, while the rest is refracted into the new medium.

b. The sharper the angle between the ray and the surface, the more of each ray that is reflected and the less that is refracted.

c. When the angle is equal to or sharper that the critical angle, all of the ray is reflected.

Why, which way, and how much do light rays bend at the interface?

d. The higher the optical density, the lower the speed of light.

e. If they pass into a denser medium, the rays bend towards the normal.

f. The greater the difference in optical density between two media, the more the light rays bend.

g. Index of refraction (n) = c(i)/c(r) = (sin i)/(sin r).

h. Relationship between critical angle and index of refraction: sin i(c) = 1/n.

Why and which way does the apparent size of the object change?

i. When the rays bend, they change their distance from each other.

j. When the rays bend toward the normal, they become farther apart.

Why does the change in the apparent size of the object differ with the angle of the surface?

k. The more slanted the surface, the more the light rays bend from their initial direction.

Principles a through k in Lesson 1 remain of importance, but we can also add: Why, which way, and how much do rays converge to a point, cross, and then disperse?

More Detail on "Into and Out of a Convex Lens"

Principles a through k above remain of importance, but we can also add: Why, which way, and how much do rays converge to a point, cross, and then disperse?

a. If it passes into a less dense medium, the light rays bend away from the normal.

b. On entering glass, rays bend towards the normal by a certain amount, and on leaving the glass they bend away from the the normal by the same amount.

c. Since the entering and exiting surfaces are not parallel, the normals are not parallel, and hence the ray is not returned to its original direction.

d. Since the difference in angle between the two normals increases with distance from the center of the lens, the amount that rays change their direction increases with distance from the center of the lens.

e. The more curved the lens, the more sharply the rays converge. The image will therefore be larger as long as it is beyond the focal length. Also, the focal length will be shorter.

f. Relationship between object size and distance, and image size and distance:

s(o)/s(i) = d(o)/d(i).

g. Relationship between object distance, image distance, and focal length:

1/d(o) + 1d/(i) = 1/F.

Figure 2. A sample of the results of an analysis of theoretical knowledge (principles) using the elaboration theory's theoretical analysis procedure.

The following is a brief description of the kind of task analysis prescribed for each of the three organizations of the elaboration theory. Our purpose in describing them here is to illustrate the vastly different kinds of information that a task analysis must yield in order to meet the needs for designing simple-to-complex sequences of instruction.

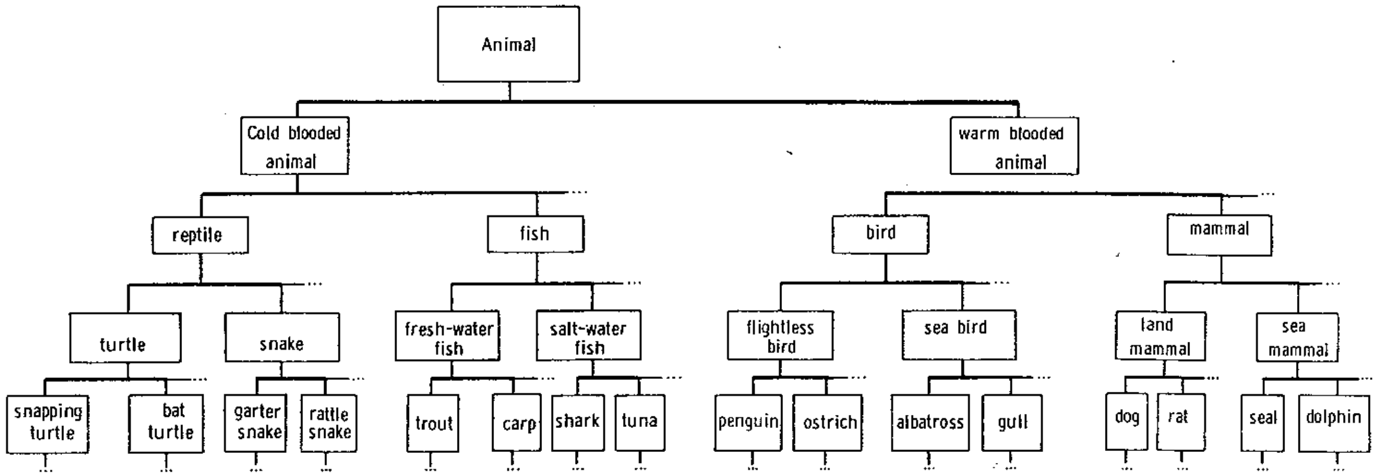
Three Kinds of Task Analysis

Two years ago, the Army's TRADOC commissioned us to try to integrate state-of-the-art knowledge about how to analyze procedural tasks. What we did in that project was to take a look at what kinds of information were required to both select and sequence procedural content. We found that hierarchical analysis provided one very useful kind of information and that information processing analysis provided another very useful kind of information. Therefore, we developed a procedure that integrated appropriate aspects of both of those methodologies. The resulting product (Reigeluth & Merrill, 1981) is called the Extended Task Analysis Procedure (ETAP) because it extended the existing procedures that were being used in the Army.

Since the Army also expressed some interest in the area of "soft skills," we also extended this task analysis procedure into the area of soft skills or transfer tasks, those kinds of tasks which are not easy to proceduralize, like counseling a subordinate. How do you counsel a subordinate? If you tried to proceduralize the task, you would end up with such an overwhelming maze of decision steps and branches that it would be virtually impossible, not to mention highly cost-ineffective, to use it or teach it.

Therefore, what ETAP does is to prescribe a methodology for identifying the underlying knowledge—the principles—that can be used to generate the right procedure for each situation. Given that underlying knowledge, someone can counsel a subordinate about whatever kind of problem he or she happens to have. In addition to identifying the underlying knowledge (principles), ETAP also provides mechanisms for identifying decision rules and guidelines to help the user decide which principles are appropriate to use at which points in time.

For analysis of procedural tasks, ETAP first prescribes that a "process" or "substep" analysis be conducted, using



The instructional sequence follows a "top-down" approach, teaching each concept at the application (concept-classification) level of learning.

Figure 3. A sample of the results of an analysis of conceptual knowledge using the elaboration theory's conceptual analysis procedure.

an information processing analysis similar to that described by Resnick and Ford (1982). This entails breaking the task down into about six (plus or minus four) steps, including decision steps if appropriate. It then entails deciding if any of those steps are described at the minimum level of entry behavior—in other words if any operations are "atomic" (Scandura, 1983) or "elementary" (Landa, 1983). Note that it is only the *operation* (or action) that must be at the minimum entry level, not the concepts or facts that are being operated with or upon. For each step whose operation is not at the minimum entry level, ETAP further directs the analyst to continue to break it into about six (plus or minus four) substeps until all steps and substeps have been analyzed down to the minimum entry level of description. The final activity in the "process" analysis entails preparing a unified description of the entire procedure at its entry level of description.

Then ETAP prescribes that a "knowledge" analysis be conducted. This entails identifying any and all concepts and facts that are unmastered learning prerequisites for each step. Again, this analysis continues down to the level of minimum entering knowledge. This is basically a hierarchical analysis, except that "rules" are not one of the kinds of prerequisites that you are looking for now—all prerequisite rules have already been identified as a part of the process analysis. This leaves defined and concrete concepts and discriminations to identify, but discriminations and concrete concepts are seldom analyzed because they are usually part of the students' entering knowledge. Also, we have added facts (Gagne's verbal information) as a category or prerequisite knowledge because it is not uncommon for such knowledge (e.g., pi = 3.14) to be prerequisite for being able to perform a rule (e.g., the area of a circle equals pi times the radius squared.)

This completes the analysis of procedural content as prescribed by ETAP. Path analysis is not specifically discussed because it is necessary for one kind of procedural sequence (an elaboration sequence) but not for others (e.g., forward and backward chaining sequences and hierarchical sequences). Hence, ETAP is not specifically tied to elaboration theory. A description of how to continue an ETAP analysis on into a path analysis and the design of a simple-to-complex sequence is described by Reigeluth and Rodgers (1980).

For the analysis of **transfer** tasks, ETAP describes a process for helping a subject matter expert (SME) to identify the principles that he or she consciously or more often unconsciously uses to generate the right procedure (performance) for each situation. As mentioned above, all necessary decision rules and guidelines are also identified. Once all the necessary principles are identified, they must be analyzed for prerequisite **principles** down to the minimum entry level of knowledge. Finally, a knowledge analysis is performed to identify all prerequisite concepts and facts, using the same procedures as for the procedural analysis. This completes the transfer task analysis part of ETAP.

The process for identifying the principles and their prerequisite principles also results in the identification of how fundamental or basic each principle is. Therefore, this process serves the same function as a path analysis does for procedural content, because it identifies which principles are simpler "relatives" of other principles. The analysis of levels of complexity is certainly an essential type of analysis for designing this kind of simple-to-complex sequence, and it is described further in Reigeluth (Note 1) and Sari and Reigeluth (1982).

To summarize with respect to substantive integration of task analysis with the design of sequences, new approaches are needed, especially given such developments in delivery systems as the advent of microcomputers and videodiscs. We need new approaches to sequencing instruction that are able to take advantage of the new capabilities and their requirements for good instructional design. And as those new designs are developed, it is essential that we have task analysis procedures that provide us with the right kind of information for being able to design the instruction properly and efficiently.

Task Analysis for Synthesis

Synthesis is another major area that requires substantive integration of task analysis with instructional design. Synthesis is the process of teaching relationships. The major purposes of synthesis are to make learning more meaningful and to improve retention by creating more connections within one's cognitive structure. You may have had experiences in your own learning where all of a sudden it all seems to fit together; that is a level of understanding that far exceeds the learning of the discrete elements that are taught.

A challenge for instructional design in the future is to figure out good strategies for helping to make it all fit together. In order for that to happen, we've got to be able to identify what relationships need to be taught, and task analysis is the only way to do that. Currently, to my knowledge, there are no analysis procedures adequate to the task. Elaboration theory has identified some kinds of relationships: conceptual relationships, procedural relationships, and theoretical relationships. However, these are not even the tip of the iceberg—they are grossly inadequate for what can and usually should be done in this area. The work of Gordon Pask (1975) and several other cognitive psychologists provide some promise, but as yet such work has not to my knowledge reached the stage of prescribing what different kinds of relationships should be taught to facilitate the achievement of different kinds of goals.

We must know *which* kinds of relationships are important to teach *when*, before the methods for analyzing those relationships will be of any use to instructional developers. Much more work needs to be done in this area.

Micro Strategies

Micro strategies was the third major area that I mentioned earlier. In this area, task analysis is done for the purpose of prescribing the best possible combination of micro strategies, including primary components (such as generalities, examples, and practice) and secondary components (such as what characteristics the generality, examples, and practice should have, including visual representations, attention-focusing devices, instance divergence, content attributes presented, and so forth). Those prescriptions are likely to vary depending on whether you are teaching remember-level information or application-level skills; and if they are application- level skills, they are likely to vary depending on the type of content involved: concept, principle, or procedure.

Therefore, what is necessary for good instructional design at the micro-strategy level is to *classify* the various skills and knowledges that are going to be taught. The classification that you use must be one whose categories require different kinds of instructional strategies. Again, returning to our major theme, there is a need to substantively integrate analysis with design: to choose the type of task analysis on the basis of the kinds of information that are needed to design quality instruction.

Temporal Integration

We have discussed how task analysis and instructional design should be integrated *substantively*—with different approaches for selecting content, for sequencing content, for synthesizing content, and for prescribing micro strategies. The second major way that task analysis and instructional design should be integrated is **temporally**; that is, instructional design should be initiated *before* all the task analysis has been completed. Gagne and Briggs (1979) describe a top-down approach to design in which there are four levels of sequencing decisions: curriculum, course, unit, and lesson, in that order. We have recently integrated this notion with our previous analysis and design procedures (Reigeluth & Darwazeh, 1982; Reigeluth & Rogers, 1980; Reigeluth & Stein, 1983; Sari & Reigeluth, 1982) to produce an even more comprehensive integration of analysis and design (see Reigeluth, Doughty, Sari, Powell, Frey, & Sweeny, 1982).

These temporally integrated task analysis and design procedures (summarized in Figure 4) start at the **curriculum** level by (1) identifying the goals and scope of your development effort. This should result in approximately six (plus or minus four) subgoals for each curriculum goal. These will become the course goals as soon as they are (2) grouped into **courses.** (3) The third step entails grouping the goals into courses

*1 . Identify the goals and scope of the *curriculum*.
*2 . Identify the goals for each *course*.
3 . Select the scope and organization for each *course*, and design a simple-to-complex sequence of courses.
For each *course*:
    *4. Identify the goals for each *unit*.
    5. Select the scope and organization for each *unit*, and design a simple-to-complex sequence of units.
    For each *unit*:
        *6. Identify the goals for each *lesson*.
        7. Select the scope and organization for each *lesson* and design a simple-to-complex sequence of lessons.
        For each *lesson*:
            *8. Analyze the *organizing content*.
            9. Design a simple-to-complex sequence of the *organizing content ideas*.
            For each *organizing content idea*:
                *10.Analyze the *supporting content*.
                11. Plug each *supporting content* idea into the simple-to-complex sequence of organizing content.
            For each *organizing/supporting content idea:*
                *12.Analyze all unmastered *prerequisites*.
                13. Design mini-hierarchical sequences by plugging each *prerequisite* into the lesson sequence just prior to the idea for which it is prerequisite.
                Next organizing/supporting content idea.
            For each *idea and fact:*
                *14.Classify its *performance level* and *content type*.
                15. Prescribe *micro strategies*.
                Next idea or fact.
            Next lesson.
        Next unit.
    Next course.
*Analysis steps. All others design steps.

Figure 4. Part of an instructional development procedure that illustrates the temporal integration of task analysis and instructional design.

and sequencing those courses. It requires identifying the organization (procedural, theoretical, or conceptual) for the curriculum as a whole (to be used in sequencing the courses) and delimiting the scope of each course. The third step usually results in the allocation of about six goals to each course.

(4) In the fourth step, you analyze each course goal into about six more detailed and specific goals, which will become the unit goals after they are allocated to units (next step). You can now (5) group the goals into **units** and sequence the units. Similar to step 3, step 5 requires identifying the organization for the course as a whole (which will often be the same as the organization for the curriculum) and delimiting the scope and size of each unit. Step 5 usually results in the allocation of about six goals to each unit.

(6) In the sixth step you analyze each unit goal into about six more detailed and specific goals, which will become the lesson goals after they are allocated to lessons (next step). Then you can (7) group the goals into **lessons** (about six goals per lesson) and sequence the lessons. Similar to steps 3 and 5, step 7 requires identifying the organization for the unit as a whole (which will often be the same as the organization for the course) and delimiting the scope and size of each lesson.

At this point the goal analysis has reached a sufficient level of detail, and the **task analysis** (or content analysis, depending on organization) begins—but only only part of it. (8) Step 8 directs you to analyze the **organizing content** for each unit. For example, if you selected organization for a unit, then step 8 entails analyzing and identifying the concepts to be taught in that unit. (9) Then step 9 entails designing a simple-to-complex sequence for the organizing content and modifying the scope of the unit, if necessary.

Once that basic structure or sequence has been identified for each unit (in step 9), you (10) analyze the **supporting content.** If concepts had been chosen as the dimension for elaboration (the organizing content), then you would need to identify any principles, procedures, and facts that should be learned as well. (11) In step 11, those supporting content ideas are plugged in wherever they are most relevant within the overall simple-to-complex sequence, usually right after the organizing content idea to which each is most highly related.

Now you are ready to (12) analyze the unmastered **prerequisites** for each piece of organizing and supporting content. A Gagne-type hierarchical analysis such as ETAP's knowledge analysis is most appropriate for this type of task/content analysis. (13) Then in step 13 you plug those learning prerequisites into the overall sequence that has been designed to date, with each prerequisite being included immediately prior to the content for which it is prerequisite.

Finally, you move on to a (14) classification of each of the individual pieces of content that have been selected and sequenced at this point. the purpose of this type of task/content analysis is to prescribe the best combination of micro strategies, such as generalities, examples, practice, feedback, visuals, mnemonics, nonexample, instance characteristics, and so forth. We have found the Component Display Theory's two-dimensional classification based on task level and content type to be most useful for this purpose. (15) Then, of course, you select the appropriate micro strategies to use for teaching each piece of content.

It can be seen in Figure 4 that this development procedure entails frequent alternating between analysis steps and design steps and therefore serves to illustrate the kind of temporal integration of design and analysis that we feel is so important.

Summary

Perhaps the most important trend in task analysis today is the substantive and temporal integration of task analysis with instructional design. Task analysis and instructional design are being integrated **substantively** by using design *activities* (such as sequencing and synthesis) as a basis for selecting different types of task analysis, and by using specific *strategies* (such as a procedurally-based simple-to-complex sequence) as another basis for selecting different task analysis methodologies. The area of synthesis is one that deserves to receive considerable attention in the near future. Also, as new instructional strategies are developed to utilize the capabilities of new delivery systems (such as new strategies for sequencing and synthesis), new task analysis methodologies will be needed to provide the information necessary to design those strategies into the instruction.

Finally, task analysis and instructional design are being integrated **temporally** by interspersing different task and content analysis methodologies with different kinds of design activities in the instructional development process. It appears that both substantive and temporal integration of analysis and design are very helpful for producing quality courseware.

> The unique capabilities of microcomputers and videodiscs require the development of new instructional strategies.

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