From Better Tests to Better Texts: Instructional Design Models for Writing Better Textbooks

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Over the past thirty years or so a tremendous amount of research and development have been devoted to improving our ability to *test* students well. Ironically, during this same period relatively few resources have been expended to improve our ability to *teach* students well. Although considerable resources were allocated to the massive curriculum development projects of the late 1950's and early 1960's, these efforts were concerned more with content (i.e., with **what** to teach) than with strategy (i.e., with **how** to teach it). As a result, they contributed little to our meager knowledge base about methods of instruction. The major thesis of this article is that it is important for educators and trainers to move their attentions *from better tests to better texts*—that we must develop a better knowledge base about methods of instruction in much the same way that we have developed a good knowledge base about tests and measurement. A corollary is that textbooks should be prepared by a team that includes at least one instructional design expert and one subject-matter expert, in much the same way that national achievement tests are prepared by a team that includes at least one test-and-measurement expert and one subject-matter expert.

The Need

During an age which places increasing emphasis on improving the effectiveness and appeal of education—especially for purposes of educational equity for disadvantaged and disabled students—educators are faced with disappointing results in spite of good intentions and hard work.

While such other factors as weak learning skills and low levels of motivation undoubtedly impair the learning process, they may in fact be symptoms of a more fundamental problem: the poor instructional quality of most currently available educational materials. Textbooks and other materials provide a very significant proportion of the instruction in our schools and training centers, yet most of those materials are poorly designed and organized from an instructional or learning perspective. They tend to lack conceptual clarity and integration, and usually do not contain the necessary information for the average student to learn the desired skills and knowledge.

Conceptually ambiguous and badly formatted instructional materials are usually viewed by students as irrelevant, offering them little incentive to grapple with the subject matter. This causes poor learning, low motivation, and negative attitudes toward what is being taught and toward the learning process itself. Because of the poor quality of textbooks and other materials, the teacher or trainer has to provide an unnecessarily large amount of primary instruction (as opposed to motivational, elaborative, or diagnostic-and-remedial instruction) to most students. Providing so much primary instruction takes up valuable class time in unindividualized activities, and it virtually precludes equal educational opportunities for disadvantaged students. Well-designed materials (which must include good motivational components) can assume the prime instructional load, thereby freeing the teacher or instructor to concentrate on such other roles as (1) motivator (e.g., by being supportive and encouraging), (2) manager (e.g., by monitoring progress, assigning faster students as peer tutors for slower ones, and correcting papers and tests), and (3) fallback source of instruction for slower students (e.g., by diagnosing problems and prescribing or providing remediation).

In conclusion, the quality of educational materials has a great impact (either positive or negative) on educational effectiveness, efficiency, and appeal. However, until very recently, we had not learned enough about instructional science—about alternative methods of instruction and conditions for their optimal use—for the team approach (mentioned above) to work effectively. Without a sufficient knowledge base, an intuitive approach to textbook writing is usually superior to a theory-based approach such as the team approach. However, due to some important advances in instructional science over the past five years or so, we believe it is now possible to use the team approach with considerably superior results to the intuitive approach. Although much more work needs to be done to realize the potential of this approach for solving our most fundamental educational problems, by using this approach we can do much right now to alleviate them.

This article briefly summarizes some recent advances in instructional science and indicates how this knowledge can be used to improve the instructional quality of textbooks and other instructional materials. The purpose of this paper is to encourage textbook writers and publishers to begin to use these ideas now to improve the instructional quality of their products. Another perhaps equally important purpose is to encourage instructional scientists and funding agencies to devote more attention and resources to the continued development of an integrated knowledge base about methods of instruction. Federal support has been particularly weak in this area, which offers so much potential for really solving most of our educational problems, whether with respect to unequal educational opportunity for minorities, the poor, and the disabled, or for better me-

ing the needs of gifted children; for improving basic skills programs, or for improving occupational training; for reducing the high cost of education, or for expanding the educational needs which public schools can meet with their present resources; for improving continuing education, or for helping universities to survive; and on and on. The further development of such broadly integrative instructional models as those described below is clearly an area where funding agencies can have a large impact on solving many fundamental educational problems at their roots.

The first section of this paper describes some advances in instructional science that have considerable importance for improving the instructional quality of textbooks, and the second section describes ways in which those advances can be used to improve their instructional quality.

Advances in Instructional Science

During the past fifteen years, substantial knowledge about instruction has been developed in the form of isolated principles of instructional design, and better strategies have been developed for making instruction more effective, efficient, and appealing. But this knowledge has been either too piecemeal or too vague (and sometimes apparently conflicting) to be very useful to textbook writers and instructional designers.

However, during the past five years, two important complementary attempts have been made to integrate a substantial amount of our existing knowledge (and to extend that knowledge where important gaps were found) into prescriptive models for the design of instruction: the *component display theory* (Merrill, in press; Merrill, Reigeluth, & Faust, 1979) and the *elaboration theory* of instruction (Reigeluth, 1979, Reigeluth & Rodgers, 1980). The development of these instructional models (each of which is designed to optimize instruction on a different type of objective or goal) has drawn heavily on such diverse fields as cognitive science (especially information processing theory, artificial intelligence, schema theory, subsumption theory, and the structure of memory), behavioral learning theory, systems theory, communications theory, motivation theory, and educational practice.

An important distinction in instructional design is the difference between macro and micro strategies of instruction. Macro instructional strategies involve aspects of instruction that relate to more than one content topic (e.g., many related concepts, principles, and/or procedures), such as sequencing related topics. Micro strategies focus on instruction for a single topic, such as the use of examples, pictures, and feedback on practice.

Merrill's component display theory was developed to integrate existing knowledge about instruction on the *micro level*, and it also considerably extends that knowledge where deficiencies were found. This prescriptive theory is comprised of (1) *a variety of models*, each of which can be used in varying degrees of richness, and (2) a unique *system for prescribing* those models on the basis of the type of topic and the purpose or objective of the instruction on that topic. The prescribed model can then be used more or less fully, depending on the ability level of the students and the difficulty or complexity level of the topic.

The instruction should start with the most general or simple ideas that are to be taught and should gradually elaborate on those fundamental ideas by adding layers of detail or complexity, one layer at a time.

For the most common type of objective, this theory calls for presenting three major strategy components to the student: (1) a **generality**, such as the statement of a principle, (2) **instances** of that generality, such as demonstration or illustration of the principle, and (3) **practice** in applying that generality in new situations, such as solving a problem. Each of these major strategy components can then be embellished with various secondary strategy components, such as alternative representation forms, practice feedback, matched nonexamples, instance divergence, instance progression of difficulty, and attention-focusing devices. The richest version of this model would include all of these strategy components (plus some that have not been mentioned). But for an easy topic and/or bright students the generality alone, without any secondary strategy components, may be enough. For more information about the component display theory, see Merrill (in-press), Merrill, Reigeluth and Faust (1979), and Merrill, Richards, Schmidt, and Wood (1977).

The elaboration theory of instruction, on the other hand, was developed to integrate existing knowledge about instruction on the *macro level*, and it also considerably extends that knowledge where deficiencies were found. The elaboration theory integrates a wide variety of knowledge about instruction on the macro level (such as subsumptive sequencing, learning prerequisites, the structure of memory, and the structure of knowledge) into *three models* of instruction. It also has a *system for prescribing* those models on the basis of the goals for the whole course.

The most fundamental aspect of the elaboration theory is its prescription of an *elaborative sequence* (or subsumptive sequence) for instruction. The instruction should start with the most general or simple ideas that are to be taught and should gradually elaborate on those fundamental ideas by adding layers of detail or complexity, one layer at a time. However, it is important to note that the simple or general ideas are not a summary of the course content—rather they are an *epitome of the course content*. An epitome differs from a summary in two important ways: (1) an epitome teaches a small number of ideas (i.e., concepts, principles, or procedures) at the application level (referred to as the "use-a-generality" level by Merrill), whereas a summary touches lightly on a large number of ideas at an abstract level (referred to as the "remember-a-generality" level by Merrill).

Another important aspect of an elaborative sequence is that it entails elaborating on a *single type of content* (either concepts, principles, or procedures—hence the three models, one for each type of content). The elaboration of a single type of content provides the "skeleton" or basic structure of the textbook, and the other two types of content are nested within related parts of the skeleton. For more information about the elaboration theory's elaborative sequencing, see Reigeluth (1979), Reigeluth, Merrill, Wilson, and Spiller (in press), and Reigeluth and Rodgers (1980).

Other aspects of the elaboration theory of instruction include its prescriptions for systematic review, explicit synthesis (or integration), periodic descriptions of the context of what is being learned, and the regular use of analogies to relate what is being learned to similar knowledge that the student has already acquired. For more information about these aspects of elaboration theory, see the previously cited articles plus Reigeluth (1980).

Improving the Instructional Quality of Textbooks

There are two basic activities for improving the instructional quality of textbooks: (1) developing new textbooks and (2) evaluating and revising existing textbooks. Figure 1 outlines a procedure that can be used to *develop* a new textbook, so as to implement the elaboration theory and the component display theory; and Figure 2 outlines a procedure that can be used to *evaluate* an existing textbook on the basis of those two sets of instructional principles. (Revision would be done by using isolated parts of the development procedure.) Since we have recently completed an article on procedures for developing instruction according to the elaboration theory and component display theory (Reigeluth & Rdogers, 1980), the remainder of this article will focus on the evaluation procedure. The following is a discussion of the steps shown in Figure 2.

1. Analyze the Organizing Content: Its Selection and Its Chapter-level Sequencing:

1.1 Select the kind of organizing content:

One important way in which the elaboration theory extends previous knowledge is that it hypothesizes that the instruction will be better if the process of elaborating is based on a *single type of content*, called the "organizing" content. There are three fundamental types of content, any one of which can be used as the organizing content: concepts, principles, and procedures (Reigeluth & Merrill, 1979; Reigeluth, Merrill, Wilson, & Spiller, in press). A concept is a set of objects, events, or ideas that share certain characteristics. A principle is a change relationship, usually a cause-and-effect relationship. And a procedure (or technique, method, skill) is an ordered set of actions for achieving a predetermined goal.

To the best of our knowledge, *all* subjects include all three types of content, and therefore *all* subjects can have an elaborative sequence that is based on *any* of these three content types. For instance, the goals of a course in English Composition might emphasize concepts: kinds of compositions and parts of compositions. Or they might emphasize procedures: how to write good compositions. Or they might emphasize principles: ways in which certain factors influence the effects or quality of a good composition.

Development Procedure

1. Select and sequence the organizing content.
   - 1.1 Select the kind of organizing content.
   - 1.2 List all of the important organizing content ideas.
   - 1.3 Arrange the organizing-content ideas into a subsumptive sequence and group into chapters.
2. Select the supporting content for each chapter and sequence all content within each chapter.
   - 2.1 List all of the important supporting content ideas for each chapter.
   - 2.2 Sequence both the organizing and supporting content within each chapter.
3. Select the review strategies
   - 3.1 Decide which supporting content ideas should be included with the organizing content ideas in the within-chapter reviews.
   - 3.2 Decide where to put cumulative reviews and decide which supporting content ideas should be included with the organizing content ideas in each cumulative review.
4. Select strategies for relating new knowledge to prior student knowledge.
   - 4.1 Decide what within-chapter synthesizers to include and where.
   - 4.2 Decide what cumulative synthesizers to include and where.
   - 4.3 Decide what student experiences can be used as (or in) instances.
   - 4.4 Decide what analogies to include and where.
5. Select micro strategies for each idea.
   - 5.1 Select the appropriate micro model.
   - 5.2 Decide on the appropriate level of richness for that model.
   - 5.3 Write the primary and secondary strategy components for each idea.
6. Decide how to format all of the instruction.
   - 6.1 Separate and label all ideas and strategy components.
   - 6.2 Format other aspects of the instruction.

Figure 1. A procedure for developing a textbook so as to implement the elaboration theory and the component display theory

Evaluation Procedure

1. Analyze the organizing content: its *selection* and its chapter-level sequencing.
   - 1.1 Select the kind of organizing content.
   - 1.2 Identify the most important organizing-content ideas.
   - 1.3 All important organizing-content included?
   - 1.4 Subsumptive sequence of organizing content?
2. Analyze both the organizing and supporting content: its within-chapter *selection* and *sequencing*.
   - 2.1 No inappropriate organizing content included?
   - 2.2 All important supporting content included?
   - 2.3 No inappropriate supporting content included?
   - 2.4 All content grouped and sequenced well?
3. Analyze the strategies for *reviewing* what has been taught.
   - 3.1 Sufficient within-chapter review?
   - 3.2 Sufficient cumulative review?
4. Analyze the strategies for *relating* new knowledge to prior student knowledge.
   - 4.1 Sufficient within-chapter synthesizers?
   - 4.2 Sufficient cumulative synthesizers?
   - 4.3 Sufficient familiar instances?
   - 4.4 Sufficient analogies?
5. Analyze the *micro* strategies for each idea.
   - 5.1 Select the appropriate micro model.
   - 5.2 Decide on the appropriate level of richness for that model.
   - 5.3 Are the primary and secondary strategy components OK?
6. Analyze the formatting of all strategy components analyzed above.
   - 6.1 Are the ideas of the strategy components separated and labeled?
   - 6.2 Are other aspects of the formatting OK?

Figure 2. A procedure for evaluating a textbook according to the elaboration theory and the component display theory. (Note: this is a procedure for an intrinsic evaluation.)

It is difficult to conceive of a course that is concerned with only one of these three types of knowledge. However, even when all three types of content are important, the goals of the course usually provide sufficient basis for identifying *one* which receives primary emphasis. Once one of the three types of content has been selected as most important, then that kind of content (concepts, principles, or procedures) is the "organizing content." The other two types of content then provide support for the organizing content when necessary and appropriate.

1.2 *Identifying the most important organizing content ideas:*

This step requires a subject-matter expert to list all the organizing content ideas that should be taught in the text. To be able to get effective outcomes from this step, the subject-matter expert should be made explicitly aware that the organizing content (which was selected in step 1.1) has structure. For the *conceptual* organizing content, the subject-matter expert should be aware of the notion of super/co/subordinate relations among concepts and the notions of parts-ordinate and kinds-ordinate varieties of those relations. The subject-matter expert should develop those structures to make sure that no important concepts have been overlooked. For the *procedural organizing content*, the subject-matter expert should be aware of the notions of procedural-prerequisite relations and procedural-decision relations. The subject-matter expert should make sure that no steps and no branches (in those structures) that are important have been overlooked. For the *theoretical organizing content*, the subject-matter expert should make sure that no important causal relationships from the theoretical structures have been overlooked. (See Reigeluth, Merrill, Wilson, and Spiller [in press] for details.)

All organizing content ideas that are taught in the text should be listed by chapter.

1.3 *Is all important organizing content included?*

This step requires a subject-matter expert and an experienced teacher to decide whether or not *all* of the important organizing-content ideas listed in step 1.2 (either concepts, principles, or procedures) have been included in the text. A subject-matter expert is needed to prioritize the important organizing-content ideas, and an experienced teacher (for the target population of students) is needed to identify, in consideration of time limitations for the course, a reasonable cut-off point on that prioritized list. The cut-off process is based primarily on the ability level of the students (e.g., average high school juniors) and the length of the course (e.g., one-hour meetings three times a week for 32 weeks).

1.4 *Subsumptive sequence of organizing content?*

This step requires an instructional-design expert, with the help of a subject-matter expert or an experienced teacher, to decide whether or not the chapters are sequenced in a *subsumptive* way with respect to the organizing content. A subsumptive sequence is one in which superordinate organizing content is taught first—no organizing content idea is taught before its superordinate idea has been taught (unless it is already known).

To meet adequacy on this criterion, the organizing content ideas in the first chapter should be superordinate to those in all succeeding chapters; and each succeeding chapter should present more complex or more detailed versions of (elaborations on) the organizing content ideas presented in an earlier chapter. Due to space limitations, we refer you to Reigeluth (1980) for details.

2. *Analyze Both the Organizing and Supporting Content: Its Within-Chapter Selection and Sequencing:*

Supporting content provides support for the organizing content when necessary and appropriate. Supporting content includes (1) the two kinds of content that were not selected as the organizing content (e.g., concepts and procedures when principles are the organizing content) and (2) the learning prerequisites for all three types of content selected. *Conceptual supporting content* specifies useful super/co/subordinate contextual knowledge that relates to the organizing content; *procedural supporting content* specifies useful procedural knowledge that relates to the organizing content; and *theoretical supporting content* specifies explanatory underlying processes or useful change relations that are related to the organizing content (Reigeluth & Merrill, 1979; Reigeluth, Merrill, Wilson, & Spiller, in press).

Conceptual organizations are often supported by (additional) conceptual supporting content; procedural organizations are often supported by conceptual supporting content (concept-classification is an important part of most procedures—hence the usefulness of showing coordinate relations and sometimes even super/subordinate relations); and theoretical organizations are often supported both by procedural supporting content (to teach an efficient way to implement a principle) and by conceptual supporting content.

Also, any unmastered learning prerequisites for either organizing or supporting content are an additional type of supporting content. For more details, see Reigeluth, Merrill, Wilson, and Spiller (in press).

2.1. *No inappropriate organizing content included?*

This step requires that a subject-matter expert or experienced teacher, by referring back to the prioritized list of organizing-content ideas and its cut-off point, decides whether or not any inappropriate organizing content has been included within each chapter.

2.2. *All important supporting content included?*

This step requires an experienced teacher to decide whether or not *all* of the important supporting-content ideas have been included within the same chapter as the organizing-content ideas which they support (or in the case of learning prerequisites perhaps prior to that chapter).

2.3. *No inappropriate supporting content included?*

This step requires an experienced teacher to decide whether or not any inappropriate or unimportant supporting content has been included in each chapter. This decision will depend primarily on the degree of importance and the degree of relevance of the supporting content to the organizing content.

2.4. *Organizing and supporting content sequenced well?*

This step requires an instructional-design expert and an experienced teacher to decide whether or not the organizing-content ideas and supporting-content ideas are grouped and sequenced in the way that most facilitates learning. Specific criteria include (as a small sample): presenting a learning prerequisite before the idea for which it is prerequisite, presenting meaningful knowledge (e.g., a principle) before related algorithmic knowledge (e.g., a procedure based on that principle), and presenting coordinate concepts together (in a group).

3. *Analyze the Strategies for Reviewing What has been Taught.*

3.1. *Sufficient within-chapter review?*

This step requires an experienced teacher to analyze the chapter summaries to determine whether or not sufficient *within-chapter review* is provided. Such

review (1) should provide a *concise statement* of each idea (i.e., each concept, principle, and procedure) and each fact that was taught in that chapter and (2) should require *practice* in using the new knowledge at the desired level of performance (recognize, recall, identify, or produce). This practice should not be used for assessment purposes and should be accompanied by immediate feedback from the teacher.

3.2. Cumulative review:

This step requires an experienced teacher to analyze the unit summaries to determine whether or not sufficient *cumulative review* is provided. Cumulative review should periodically and systematically review the organizing content and the most important supporting content from *all* previous chapters. The frequency of such review depends on the difficulty and novelty of the content in relation to the ability level of the students. Like within-chapter review, cumulative review should provide a *concise statement* of each important idea and fact and should require *practice* in using the new knowledge.

4. Analyze the Strategies for Relating new knowledge to Prior Student Knowledge:

It has been recognized that making new knowledge meaningful to the learner is important for optimizing acquisition, organization, and retrieval; and more recently it has become clear that this is done primarily by relating the new knowledge to what a student already knows (Reigeluth, 1980). One way of "making new knowledge meaningful" is to relate it to a *superordinate idea* (that the learning already possesses) *within* the content area of immediate interest. Another way is to relate new knowledge to *parallel knowledge* (that the learner already possesses) *outside* of the content area of immediate interest. An additional, largely overlooked, way to make new knowledge meaningful is to relate it to real (specific) *sensori-motor events or actions* stored in what we refer to as a student's "experiential" data base (see Reigeluth, 1980, for details).

4.1 Sufficient within-chapter synthesis?

Synthesis refers to the explicit teaching of relationships among individual ideas (e.g., among concepts, principles, or procedures). The most important kinds of relationships are: *conceptual*, which are super/co/subordinate relations among concepts, wherein the subordinate concept may be either a kind or a part of the superordinate concept; *procedural*, which are order or decision relations among procedures (or steps); and *theoretical*, which are chains of interrelated change relations (usually cause-and-effect) based on individual principles. Making these kinds of relationships explicit helps the student to form stable cognitive structures (i.e., stable configurations of stored knowledge in memory), which in turn improves long-term retention and transfer. It also helps to improve motivation by making the new knowledge more meaningful. (For more information about these type of synthesizers, see Reigeluth, 1980; Reigeluth, Merrill, & Bunderson, 1978; and Reigeluth, Merrill, Wilson, & Spiller, in press).

This step requires the design expert and a subject-matter expert to determine whether or not there is sufficient synthesis (in each chapter) of the within-chapter content.

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4.2 Sufficient cumulative synthesis?

This step requires the design expert and a subject-matter expert to determine whether or not there is sufficient explicit teaching of relationships between content in one chapter and content in earlier chapters. Such explicit synthesis is likely to come at the end of each chapter or at the end of each unit.

4.3 Sufficient familiar instances?

Familiar instances are examples of a content, applications of a principle, or performances of a procedure that are closely related to the previous experience of the learner. Using familiar instances facilitates learning and increases motivation. This step requires an experienced teacher to determine whether or not there are sufficient familiar instances within each chapter.

4.4 Sufficient analogies?

Analogies relate new knowledge to closely-related knowledge that the student has already acquired *outside* of the subject-matter content of the course. This step requires the design expert a subject-matter expert or teacher to termine whether or not suffic analogies have been presented wi each chapter.

5. Analyze the Micro Strategies Each Idea:

After the "macro" evaluation q tions have been answered (select sequencing, synthesizing, and s marizing), equally important are th structional components that actu teach each idea—the "micro" strate Micro strategies are strategies for te ing a single idea (e.g., a concept, pri ple, or procedure) or fact. Micro st gies are the domain of Merrill's con nent display theory (Merrill, in p and the procedure for evalua textbooks is summarized in Mer Reigeluth, and Faust (1979) and is scribed in detail in the *Instructi Strategy Diagnostic Profile Trai Manual* (Merrill, Richards, Schmid Wood, 1977). The following is a b (revised) summary of what should done for each important fact, conc principle, and procedure that is tau (Note: the content labeled "inappro ate" in Step 2 above should be omi from this analysis.) Remember th *generality* is a statement that applie more than one instance. It is a defini of a concept or a statement of a princ or procedure. And an *example* is an stance of that generality (concept, p ciple, procedure, or fact.)

5.1. Select the appropriate m model for each idea or fac

This step first requires the design pert and a teacher to classify the des level of performance for the idea or as one of the following: (1) *remembe instance*, at which the student is quired to remember a specific cas either recall or recognition and ei verbatim or paraphrased—(2) *remem a generality*, at which the student is quired to remember a generality—a either recall or recognition and ei verbatim or paraphrased—or (3) us *generality*, at which the student is quired to apply a generality to "n instances—either to identify new stances or to produce new instances

The desired level of performanc the fact or idea determines which of three instructional models is appro ate. (An instructional model is an i grated set of strategy components f given type of learning outcome.) example, the most common kind objective—"applying a generality new instances"—is at the use generality level. For this level, the c

ponent display theory prescribes a model that is comprised of three major strategy components: (1) a *generality*, such as the statement of a principle or the definition of a concept, (2) *instances* of the application of that generality, such as demonstrations of the principle or examples of the concept, and (3) *practice* in applying that generality to new instances, such as solving a new problem or classifying a new example of the concept. For an objective at a different level, other strategy components are required to optimize learning.

5.2. *Decide on the richness of the model:*

This step requires an experienced teacher to decide on the appropriate level of richness of that model. This depends on the difficulty of learning the fact or idea (at the desired level of performance) given the students' general ability level and prior knowledge. In order to increase the richness of each model, the number of instances and practice items can be increased. Also each of the major strategy components (e.g., the generality or the examples) can be embellished with secondary strategy components. The richest version of any of these models would be appropriate either for a very complex topic or very slow (or low ability) learners or both. But for an easy topic/objective in relation to student ability, the generality alone might be enough. (The student will be able to create instances in his or her own mind.)

5.3. *Primary and secondary strategy components OK?*

This step requires comparing the "primary" and "secondary" strategy components that are used in the textbook with those that are prescribed by the appropriate instructional model at the appropriate level of richness. The *primary strategy components* are generality, example, generality practice, and instance practice. *Secondary strategy components* include feedback, isolation, mnemonic aids, attention-focusing devices, algorithms, progression of difficulty, alternative representation form, etc. (See Merrill, Reigeluth, & Faust, 1979, for more details.)

For practical reasons, you will probably want to *sample* the important facts and ideas that are taught, rather than rating each and every one of them. The process for sampling should be stratified random sampling to the extent of appropriate proportions of organizing versus supporting content and of easy versus difficult ideas.

6. *Analyze the Formatting of all Strategy Components Analyzed Above.*

One purpose of formatting is to make a textbook more *attractive* and more *communicative*. Principles of message design are relevant here. Another purpose is to make explicit for the student what is the *important content* to be learned versus what is primarily elaborative, motivational, or simply "nice-to-know" material. A third purpose of formatting is to facilitate *learner control* (Merrill, 1979), which allows individualization of the instruction based on learner differences. Learner control is a strategy whereby learners skip over some strategy components, refer back to earlier strategy components, and/or simply study the various strategy components in a different order. For example, a brighter student might look at a generality, think "I understand that!" and go to a hard practice item to test himself or herself. On the other hand, a slower student might spend considerable time looking at examples after studying a generality. Then he or she might look at the generality again before trying any practice items.

In order for a student to be able to exercise learner control easily and efficiently, each strategy component must be: (1) *separated* from other strategy components and other kinds of displays, and (2) *labelled* for the student so that there is no ambiguity as to what is the main idea and what is illustration, elaboration, or clarification. For example, generalities should be labelled as such and should be separated from say, examples; practice should be labelled as such and should be separated from generalities and examples; review and feedback components should be labeled and separated; synthesis components and analogies should be separated and labelled; etc. With such separation and labelling of strategy components, brighter students will be able to skip over examples and secondary strategy components more easily and without fear of having missed something important; and slower students will find it easier to refer back to generalities, reviews, and synthesizers to compensate for the extra time they find they need to spend on examples, practice, and secondary strategy components.

Proper student use of learner-control formatting requires some brief student training in (1) the nature of each strategy component and (2) the way in which each component helps the student learn (i.e., to overcome a different kind of learning problem). With such knowledge, the student is well equipped to pick and choose from the "menu" of strategy components to make his or her own optimal, individualized, instructional design.

6.1. *Are the ideas and strategy components separated and labelled?*

This step requires a design expert to decide how well the strategy components are separated and labelled so as to facilitate learner control.

6.2. *Are other aspects of the formatting OK?*

This step requires a design expert to decide how attractive and communicative the page layout is. This is done primarily on the basis of principles of message design. (Advertisers also have much to contribute here!)

Conclusion

The quality of educational materials has a great impact on educational effectiveness, efficiency, and appeal. Hence, it is important for educators, researchers, and funding agencies to devote more attention and resources to developing a better knowledge base about instruction in much the same way that such has already been done for testing and measurement. Similarly, textbooks should be prepared by a team that includes at least one instructional-design expert and one subject-matter expert, in much the same way that national achievement tests are prepared by a team that includes at least one test-and-measurement expert and one subject-matter expert.

The first section of this paper described some advances in instructional science that have considerable importance for improving the instructional quality of textbooks: the *component display theory*, which prescribes instructional design strategies that relate to a single topic (such as generality, examples, and practice), and the *elaboration theory*, which prescribes instructional design strategies that relate to many topics (such as subsumptive sequencing, systematic review, and periodic synthesis).

The second section of this paper described some ways in which those advances can be used to improve the instructional quality of textbooks: (1) the *development* of new textbooks and (2) the evaluation and revision of existing textbooks. Reigeluth, Merrill, Wilson, and Spiller (1978) and Reigeluth and Rodgers (1980) have described development procedures; and this article overviewed a procedure for evaluating existing textbooks for purposes of revision.

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