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The Big Wrench vs. Integrated Approaches: The Great Media Debate

Robert D. Tennyson

This article sums up the current state of the media debate by comparing and contrasting the seven positions presented in the ETR&D special issue (Vol. 42(2), 1994). Presented first is a review of the science-wide conflict between advocates of a given approach versus proponents of integrated approaches to the solving of complex problems. Advocates of a given approach are characterized as offering a "big wrench" (i.e., panacea) solution that can be generalized across problems. While in contrast are integrated approaches (e.g., the Swiss knife) that attempt to solve problems by bringing together a variety of variables and conditions. In section two is presented an example of an integrated approach that deals directly with the role of media in learning. Finally, the positions of the seven authors are compared and contrasted employing eight instructional design variables.

My perspective on this debate represents the view of an unbiased or neutral scientist. I have employed computer technology in much of my research activities on concept learning but have not directly engaged in testing hypotheses investigating the influence of computer attributes on improved learning. Many of my colleagues however have been doing this on a daily basis, so I feel that I have direct access to the research being done. As such, I see myself in this debate as more of a practitioner looking for research findings to support my research agenda that focuses on instructional strategies. Also, in a broader sense, I am interested in media as a piece of the larger instructional system development environment.

In this article I have been asked by ETR&D research editor, Steve Ross, to react to the debate on media influences on learning as offered by the seven authors in the special issue on media and learning (Vol. 42, No. 2, 1994). I will do that in the concluding section of this article. Prior to that I would like to offer my perspective on why there seems to be a debate and, second, to present my view of the role of media in learning and instructional design.

In the first section, I present a scenario of what happens when a scientist becomes an advocate of a given solution. My view of the scientist is that of the person in our society who is charged with both advancing and understanding knowledge. The scientist in this view is unbiased and is constantly seeking advancements that are both modest and profound in nature. A scientist is never satisfied with the current state of affairs but is always and foremost challenged by extending knowledge. In contrast is the scientist who finds a
statistically significant research result and then changes from an unbiased investigator to advocate of the “discovered” finding. What happens in this scenario is that the scientist becomes an advocate of that newly acquired approach and reduces the former complexity of the scientific world to a simpler world that can be rendered safe by the given finding (but now defined by the scientist/advocate as a “solution”).

I refer to this transition from scientist to advocate as the big-wrench approach to complex problem solution: The advocate, with the big wrench in hand, sets out to solve, suddenly, a relatively restricted number of problems. That is, all of the formerly many diverse problems, now seem to be solvable with the new big wrench (or panacea).

What I see in this debate are advocates of big wrenches doing battle with the scientists who are trying to maintain the concept of external validity in a complex world. Following my discussion of the big-wrench approach, I offer an alternative view of the scientist trying to advance knowledge in the mode of assimilation and accommodation. To make this task somewhat easier to do within the scope of this article, I will present my own work as an example of the scientific approach. I have labelled this an integrated approach—an approach which proposes that learning is a complex phenomena, requiring the interaction of many variables including the learner and environmental factors.

THE BIG WRENCH APPROACH

As a scientist, I seek out answers to phenomena and questions. I am interested in confirming a theory through the application of the scientific method; however, I am not trying to shape research methodology to support a given solution. Thus, I will accept any reasonable and rigorous research paradigm to test the theory. Too often in the scientific environment, scientists become too focused and biased towards a theory to accept findings that deviate from their own view. Also, rather than applying a little humility and accepting the findings of other equally competent scientists, proponents of a given theory try to generalize their restricted findings to the more complex “real world.” They try to apply relatively limited findings to larger, more complex situations. Over time, it becomes increasingly apparent that the proposed view does not provide the generalizable answers. At that point, society is ready for a new concept or paradigm.

An example illustrating this boom-and-bust approach to science is the paradigm shifts in the past several decades in learning theories. Radical behaviorists (e.g., Skinner, 1954) proposed by the mid-1950s to have the “total” instructional tools necessary to improve classroom learning. In 1974, McKeachie wrote that behaviorism offered no usable variables for classroom learning and proposed instead the “new” cognitive paradigm as the panacea for classroom learning problems. By the 1990s, the new wave in learning theory to improve classroom learning is coming from the constructivist paradigm. Proponents of this branch of psychology again echo what previous new wave paradigm proponents offered: a systemic change to the learning environment. They rely on an approach to science promotion that concentrates on defining their proposed solutions by attacking the failures of the “established” paradigm. Unfortunately, learning is a complex phenomena, and thus far, the available theories offer explanations of only certain restricted situations.

I call this situation, the big-wrench approach. In this approach, the scientist discovers a solution to a specific problem. The solution is tested and replicated to insure internal validity, thus making it appear to have qualities of generalizability. Because of this internal validating process, the scientist is overcome with a certain euphoria (after all, it is very difficult to get significant results and, when that happens—watch out) that prompts otherwise “wise” persons to overgeneralize their findings. They now have the big wrench to solve problems. Rather than continuing the scientific method (that is, by the way, what Clark really is trying to say) of careful testing and confirming, the scientist ignores objectivity and begins the actually fun task of promoting the new big wrench.

At this point, the advocate (i.e., the former scientist) with the big wrench does offer a solution, but what is new today is that this advocate of a big wrench offers a means to use (a lot of) little) wrenches to solve a problem, the driving force behind the expert systems has been to handle complex situations, not reduce.

In the field of instructional technology, the big wrench phenomenon (in some important role in the influence) of media and instruction was one of the first big wrenches to be delivered. Simply put, in 1913, Edward Thorndike stated, “Books in the schools . . . [that will be] completely changed in the future.”

As we have here is the advocate of a big wrench that has certainly changed how we learn and is a phenomenon in our society, with implications for the future. It has been minimal (Medley, 1994) and the Thinking Wrenches (e.g., White, 1994) proponents (e.g., White, 1994) have expanded arguments made by advocates of the medium (in particular, interactive software).

It is my view that the difference between the big-wrench advocates and the thinking-wrench advocates who are producing expert systems is that what we have instead of a linear fashion, but rather accommodations for certain situations that are modest while in other contexts, profound paradigm shifts in the former situation. The thinking-wrench advocate may be additions to the existing medium, as in the case of hypermedia.
theory try to generalize lessons to the more complex situations. To apply relatively limited, more complex situations becomes increasingly accurate, and this view does not provide answers. At that point, the concept or paradigm, following this boom-and-bust cycled paradigm shifts in learning theories. B. Skinner (e.g., Skinner, 1954) proposed to have the "total" process to improve classroom. McKeachie wrote that the usable variables for the proposed instead of expert systems as the panacea for problems. By the 1990s, the theory to improve classroom from the constructivist base. One of this branch of psychology is that previous new wave is offered: a systemic approach for learning. They rely on the promotion that connects their proposed solutions with the "established" 1990s, learning is a complex. Thus far, the available solutions of only certain problems.

In conclusion, the big wrench phenomenon continues to play an important role in the debates over the role (or influence) of media in learning. In promoting one of the big wrench phenomenon, motion pictures, Thomas Edison in 1913 stated that, "Books will soon be obsolete in the schools...[the result being that schools will be] completely changed in 10 years." What we have here is the scientist becoming the advocate of a big wrench. Motion pictures certainly changed how we deal with entertainment in our society, but the effect on learning has been minimal. Unfortunately, Kozma (1994) and the Thnkertoools proponents (e.g., White, 1993) offer the same arguments made by Edison that the attributes of the medium (this case computers and interactive software) are the big wrench.

It is my view that the media debate is between the big wrench advocates and the scientists who are promoting a system that expands the solution base. This is not to say that what we have is an evolution of science in a linear fashion, but that assimilates and accommodates new findings as they occur. In certain situations the assimilation may be quite modest while in other situations there may be profound paradigm adjustments. For example, in the former situation a minor accommodation may be additions to content analysis (e.g., Tennyson, Elmore, & Snyder, 1992) while a major assimilation may be from new advancements in software (e.g., hypermedia).

Therefore, my view of the debate on influences of media is not one of yes or no, but rather looking at the whole complex nature of learning and instructional design. I first presented this view at an AEIC conference in 1987, where I participated in a debate on the topic, "...nere vehicles...": Discussion of what the research says by those who are doing the saying. My view was that media provided enhancements to instructional design strategies. I proposed that various learning theories should be integrated to cover a range of learning goals (much like Gagné has done since the 1960s) and that the learning systems should be directly linked to specific instructional strategies (prescriptions). Since that time, I have published refinements of this concept of linking media enhancements to learning systems in numerous journals and books (e.g., Tennyson, 1987, 1990a, 1990b, 1991, 1993; Tennyson & Breuer, 1991; Tennyson & Rasch, 1988).

THE INTEGRATED APPROACH

In this section I will present a brief summary of my view that science is a means for advancing our understanding of phenomena, not the advocates of a particular (and limited) overgeneralization of a given view. I will do this in reference to the theme of the special issue. After presenting this overview, I will then be able to make a critical review of the seven views presented in this debate on media and learning.

My view is that media prescriptions for improvements in learning are founded on principles of learning. And, that a direct trace between media prescriptions and learning outcomes includes reference to learning objectives and instructional strategies. This seems necessary because the distance between the fields of instructional design and learning theory leaves open opportunities to ignore or disregard the importance of maintaining a foundation in application based on theory and empirical verification. Therefore, I am presenting an example of a model which I have used in my research on computer-based prescriptions.

To illustrate this concept of linking com-
Table 1  □ Linking Cognitive Processes to Computer-Based Prescriptions

<table>
<thead>
<tr>
<th>Cognitive Processes</th>
<th>Learning Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEARNING:</td>
<td>Verbal/Visual Information (being aware of and understanding of content [i.e., facts, concepts, rules &amp; principles and their connections])</td>
</tr>
<tr>
<td>Declarative Knowledge (knowing that)</td>
<td></td>
</tr>
<tr>
<td>Procedural Knowledge (knowing how)</td>
<td>Intellectual Skills (being able to use content with newly encountered problems)</td>
</tr>
<tr>
<td>Contextual Knowledge (knowing why, when and where)</td>
<td>Contextual Skills (being capable of content decision-making, problem-solving, and trouble-shooting in complex situations)</td>
</tr>
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| THINKING:                                    |                                                                                     |
| Cognitive Complexity (differentiation & integration of knowledge) | Cognitive Strategies (ability to employ cognitive complexity within novel situations) |
| Cognitive Constructivism (Creation of knowledge) | Creative Processes (ability to construct knowledge within novel situations) |

<table>
<thead>
<tr>
<th>Instructional Strategies</th>
<th>Computer-Based Prescriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONVENTIONAL (branching)</td>
<td>INTELLIGENT (rule-based)</td>
</tr>
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</table>

| EXPOSITORY                |                                                                                     |
| Context                   | Screen Display                                                                     |
| Label/Definition          | Advisement                                                                          |
| Best Example              | Density                                                                             |
| Matched/divergent Examples | Embedded                                                                            |
| Worked Examples           | Graphics (dynamic)                                                                  |
|                          | Refreshment & Remediation                                                          |

| PRACTICE                  |                                                                                     |
| Problem Examples          | Tutorial                                                                           |
| Attribute Isolation/Elaboration | Amount/sequence of Information                                                     |
| Feedback (strategy information) | Learning Time                                                                    |
|                          | Drill & Practice                                                                    |
|                          | Corrective Error Analysis                                                           |
|                          | Process Feedback                                                                    |

| PROBLEM-ORIENTED          |                                                                                     |
| Contextual Modules (simulations, case studies, role playing) | Simulations & Virtual Reality (Modules)                                             |
| Cooperative Learning      | Adaptive Error Analysis                                                             |

| COMPLEX-DYNAMIC           |                                                                                     |
| Situational Units (simulations, case studies, role playing) | Simulations (Dynamic: Adjusts Variables and conditions)                             |
|                          | Elaborates & Extends                                                                |
|                          | Variables & Conditions                                                              |
|                          | Virtual Reality                                                                     |

| SELF-DIRECTED EXPERIENCES | Learner Control                                                                     |
|                          | Mixed Initiative                                                                    |

Computer-based prescriptions to improvements in learning, I will present a model (see Table 1) that links prescriptions with specific learning outcomes through four main educational components (cognitive processes, learning objectives, instructional strategies, and computer-based prescriptions) (cf., Tennyson & Rasch, 1988).

The linking model (see Table 1) that I am proposing should help one understand why certain computer-based prescriptions may improve learning and also encourage computer-based instructional designers and researchers to look beyond the technology to determine effective possibilities of new computer developments. It is proposed that computer-assisted instruction (i.e., mindtools) can improve learning, but they are viewed as an integral part of the entire instructional design. The model indicates a direct interaction between computer-based prescriptions and the conditions of cognitive learning.

Components of Linking Model

I will now discuss the components of the linking model by first presenting a brief overview of a learning model. As part of this discussion, see Tennyson & Rasch (1988). In this brief presentation, I will define the component, learning objectives, and validate version of Gagné’s (1970) instructional conditions. The instructional strategies are computer-based prescriptions, and they support the own research programs and strategies and computer-based those strategies.

Cognitive processes. For the moment, I have limited my discussion of cognitive processes to those associated with acquisition and employment (Tennyson, 1970). This condition refers to the level of learning, or the cognitive skills. Concerns with a given domain’s facts, principles but also the relationship of these elements (i.e., differentiation of knowledge; Tennyson & Breuer, 1985). Cognitive skills are content, strategies associated with use content with new (i.e., procedural knowledge, conditions under which content in problem situations (i.e., conditions)...

Employment of higher-level thinking abilities of learners (i.e., differentiation of knowledge; Tennyson & Breuer, 1985). Cognitive constructivism (i.e., Tennyson & Breuer, 1985) is generally defined as consists...
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Computer-based prescriptions (i.e., ranging from computer-assisted instruction to simulations to mindtools) can improve learning when they are viewed as an integral component of the entire instructional design. The model indicates a direct interactive link between specific computer-based prescriptions and basic foundations of cognitive learning theory.

Components of Linking Model

I will now discuss the four components of the linking model by first starting with a summary of a learning model that I have employed in my research program (for a more complete discussion, see Tennyson 1991). Following that brief presentation, I present the next component, learning objectives, employing a modified version of Gagné’s (1985) hierarchy of learning conditions. Components three, instructional strategies, and four, computer-based prescriptions, are taken directly from my own research programs on instructional strategies and computer-based enhancements of those strategies.

Cognitive processes. For purposes of this article, I have limited my discussion of cognitive processes to those associated with knowledge acquisition and employment (and improvement) (Tennyson, 1991). Knowledge acquisition refers to the learning of content and cognitive skills. Content refers not only to a given domain’s facts, concepts, rules, and principles but also the meaningful connections of those elements (i.e., declarative knowledge). Cognitive skills are domain-specific cognitive strategies associated with (a) knowing how to use content with newly encountered problems (i.e., procedural knowledge) and (b) knowing the conditions (i.e., why, when and where) under which content is used in complex problem situations (i.e., contextual knowledge).

Employment of knowledge refers to the thinking abilities of (a) cognitive complexity (i.e., differentiation and integration of knowledge; Tennyson & Breuer, 1984) and (b) cognitive constructivism (i.e., creating knowledge; Tennyson & Breuer, in press). Content is usually defined as consisting of declarative knowledge while cognitive skill implies procedural and contextual knowledge; with the three forming a learner’s knowledge base. Cognitive strategies are the cognitive processes of differentiation, integration and construction.

Learning objectives. A main goal of education is the promotion of objectives to improve both learner-knowledge acquisition and employment. Objectives are necessary to identify the type of learning and thinking that is desired in each instructional situation. (In this area, although I incorporate much of the constructivist theory of learning, I differ from their application in instructional design.) As such, objectives should be linked to specific learning processes. Learning objectives listed in Table 1 are linked to the two cognitive processes as follows: In the learning category, the objectives include acquisition of verbal/visual information, intellectual skills, and contextual skills; in the thinking category, the objectives include elaboration and improvement of cognitive strategies and development of creative processes. The labels used here are modified from Gagné’s (1985) hierarchy of learning conditions.

Instructional strategies. The means of instruction are the variables and conditions manipulated by the instructional designer to improve learning. In Table 1, I present basic variables which have been empirically tested to improve learning. The variables are directly linked to their respective primary cognitive processes. Certain variables may also have secondary links to other processes. The instructional variables are organized into five primary strategies: expository, practice, problem-oriented, complex-dynamic, and self-directed experiences.

Computer-based prescriptions. The computer-based prescriptions listed in Table 1 are subdivided into categories according to their programming design methods for adapting instruction to individual learning needs. Conventional programming methods use branching techniques that are determined in the design stage and are preset in the program. Intelligent methods use rule-based programs that make decisions on learner-prescription
needs based on a model of the learner in reference to a cumulative record of learning progress and at-that-moment instructional need. Thus, the instruction is uniquely adjusted moment to moment based on real-time assessments during learning (Tennyson & Park, 1987). In other words, intelligent prescriptions offer dynamic adaptive instruction in contrast to the static nature of conventional prescriptions. In contrast to the article by Kozma (1994), although not as direct as Clark (1994), I view intelligent systems as enhancing certain methods of instruction—I do not consider intelligent prescriptions (e.g., mindtools) a big wrench.

Linking Components

In this section I illustrate the direct linkages between the four components such that it is possible to trace a specific computer-based prescription variable to a given cognitive process. In this way, I can predict a given learning outcome from the employment of a specific computer-based prescription. This section forms the heart of my perspective on the issue of media influence in learning. From my reading of the other articles, it differs significantly in that it follows the concept of an integrated approach to a complex situation.

Linking declarative knowledge. Declarative knowledge is the foundation of content and implies knowing that. For example, the student knows the definition of a given concept and knows the connections of the concept within the domain. The learning objective states that the student learns the verbal and visual information about the domain (i.e., the content [facts, concepts, rules and principles] and the structure of the domain).

According to cognitive theory, visual information may be represented in memory differently than verbal information (Rasco, Tennyson, & Boutwell, 1975). In terms of objectives, this implies more than the use of visual information during instruction but the recognition that certain information is primarily visual. For example, the student is aware that certain geometric shapes represent structural strength while others represent perceptual illusions.

Learning objectives are usually stated to reflect learning outcomes so they serve the purpose of identifying the appropriate instructional strategy and the type of performance for evaluation. In Table 1, specific instructional variables and conditions prescribed for declarative knowledge acquisition are listed under the expository instructional strategy category. The objectives for employment of declarative knowledge are embedded within higher-order cognitive activities. Certainly, automatic performance is desirable but within the context of higher-order processing. Objectives that just imply acquisition of declarative knowledge are rarely suitable for most learning situations.

The instructional strategies for improving this cognitive process include variables and conditions directed to (a) extending and elaborating current knowledge and (b) the acquisition of entirely new domains of information. If it is assumed or known that learners are extending and elaborating their current knowledge, the instructional strategy can proceed to the problem-oriented strategy category (Tennyson & Bagley, 1992). For the learning of a new domain of information, a more structured approach to learning must be developed.

Linking procedural knowledge. Procedural knowledge is the cognitive skill of knowing how to use content with newly encountered problems (Tennyson, Welsh, & Christensen, 1985). The learning objective refers to this process as an intellectual skill, in which the students learn how to use specific content facts, concepts, rules and principles to solve previously unencountered problems.

The primary instructional variables at this level focus on practice of the information in problem situations. To help students learn how to use content, practice problems should provide information that shows the working form of the required skill by using attribute isolation and elaboration. Another instructional variable for practice is feedback on the cognitive skill required to solve problems associated with the information being learned. Feedback presents strategy information following the attribution isolation/elaboration information. The purpose is first to help learners solve the problem and then help them develop the skills that will be used to solve additional problems (Boutwell, 1975).

Tutorial instruction is a very convenient method of teaching the student and the tutor, the peer tutor or a computer in a more challenging the student to do the main purpose of eliminating possible mistakes. The tutorial strategy focuses on acquisition, drill-and-practice. It is useful to help develop skill in either content or skills. It is not just efficient procedure but correct behavior within the cognitive strategy.

An important open-ended system is the simulation model that exhibits the behavior of the student. More simulation techniques include the student as well as the student as well as itself (Tennyson & Park, 1987). Additionally, they have extension built-in to the knowledge bases to allow variations during instruction.

Linking contextual knowledge. Context refers to the knowledge of why the skills of why, when, and how the student knows to select different types of problems, evaluating curricula with different instructional objectives, contextual knowledge is to perceive the criteria of appropriateness of using the principles within context. Contextually, contextual skills are procedural knowledge-based, the rules for connections for the learner. Contextual skills are the strategies and creating higher-order cognitive contextual skills it will complex decision-inference and/or trouble-shooting (1991).
is first to help learners with solving the given problem and then help them form intellectual skills that will be useful when attempting to solve additional problems (Tennyson, Steve, & Boutwell, 1975).

Tutorial instructional strategies provide a convenient method of interaction between the student and the tutor, be it either a human peer tutor or a computer-based tutor. The basic format is question/answer with the tutor challenging the student to use the skill. However, the main purpose of a tutor is to prevent or eliminate possible misconceptions. While the tutorial strategy focuses on intellectual skill acquisition, drill-and-practice strategies are useful to help develop automatic behaviors for either content or skills. By automatic, I mean not just efficient processing but, additionally, correct behavior whenever activated by a cognitive strategy.

An important operational feature of intelligent systems is the development of a student model that exhibits the current knowledge base of the student. More recently, student modeling techniques include affective aspects of the student as well as the cognitive (Tennyson & Park, 1987). Additionally, intelligent systems have extended built-in domain-based knowledge bases to allow for student-initiated queries during instruction.

Linking cognitive complexity. Most often cognitive theories of learning focus on knowledge acquisition while basically ignoring employment of knowledge in the service of thinking (i.e., recall, problem-solving, and creativity). However, an important goal of education and training includes not only acquisition of knowledge, but also the improvement and employment of knowledge (see also Jonassen, Campbell, & Davidson’s 1994 argument on this issue). Improvement implies both extending and elaborating the current knowledge. Cognitive retrieval system theory indicates that thinking skills and strategies develop most adequately when working concurrently with the knowledge base.

The computer-based prescriptions enhance the instruction by providing a dynamic environment. Computer-based simulations, for example, can continuously adjust and modify the situation. Intelligent systems can further the adjustments based on each student’s model. This is useful for tracking student knowledge acquisition in the cognitive process of integration. Also, the techniques of virtual reality would contribute in those domains exhibiting three-dimensional knowledge representation.
Linking cognitive constructivism. An important goal of education is the development of learners who can be responsible for not only employing their existing knowledge but for creating new knowledge. One initial concern of cognitive theory (e.g., Bartlett, 1932; Spiro, 1977) as contrasted to behavioral theory, was the ability of the learner to create or construct knowledge. An assumption was that all knowledge in the external world was an artificial representation and domain experts were responsible for translating knowledge into acceptable external representations. Representation ranged from highly structured and concrete representations to widely divergent and abstract representations. The purpose of this instructional strategy category is to provide an environment in which students have defined opportunities to improve their cognitive abilities to construct new knowledge.

For the most part, this process of cognitive constructivism can be improved by instruction that is self-directed (Tennyson & Bagley, 1992), that is, a learning environment that is rich in resources and time for the student to seek out answers to both predefined problems and self-defined problems. Although cognitive constructivism may occur in unplanned environments, planned instructional environments can help create spheres of domain focus. For example, if the area of interest is social studies, the environment may include resources that would benefit creation of knowledge that area as opposed to domains in the physical sciences.

Research in writing has shown improvement in basic writing skills as well as creativity through the use of computer-based word processing systems (Reed, 1992). In less planned environments, such as computer-based interactive games, it is found that individuals create the knowledge necessary to continue improving their performances. Computer-based enhancements provide rich facilities that are under control of the student and, with intelligent systems, allow students to query the system. A mixed initiative learning environment simulates the interaction between a domain expert and a novice learner. Thus, the student can artificially alter the time necessary to create new knowledge. Interest in virtual reality techniques is especially high in this area of cognitive processing because of the total landscape of the artificial environment. Students may have the opportunity to explore just about any avenue of the domain without constraints that may be inherent in the real environment (Tennyson, 1990b).

In the context of the special issue on the debate of the influence of media on learning, I have presented an example of a means by which educators can determine if specific instructional strategies (methods) and corresponding media, and in this case, computer-based prescriptions, may improve learning and thinking. I did not attempt to debate whether or not computer technology improves learning. Rather, I am proposing that media are but one component in a complex instructional design system that includes principles of instructional design as well as methods of instructional delivery. What I have shown is, that for an instructional method to improve learning, the method must have two aspects. First, it must exhibit a direct link to a specific cognitive process. And, second, it must have empirical support to confirm the predictability that learning can be improved by its application.

A REVIEW OF THE SEVEN POSITIONS

The seven positions presented in the special issue on media and learning show both increased sophistication in the debate on media influences and diversity in points of view. In the first part of this article, I defined a major flaw in the academic community when a scientist takes on the role of advocate for a specific solution to a complex world. The advocate tries to apply the solution to problems beyond the scope of the solution. I used the analogy of the big wrench. Examples here are bountiful and offer many wonderful debates. This debate on the role of media in learning is an example. Proponents of media keep offering the latest technology developments as the panacea for a multitude of educational problems. Certainly evangelists like Papert (1990) represent the scientist who advocates the big-wrench fix for learning problems. Constructionists propose a big-wrench fix (by use of so-called mindtools) for improvements in student learning by their seemingly fixated and design.

Fortunately, several special issue rose above the big wrench. They attempting or totally reshaping good and bad. On the study still wondering about the influence of media perhaps the question is at an answer takes in the space. I feel that Kozma keep to the original controversial community went belief. Obviously, if you of this article, you saw as complex—as do Shulz et al. (1994). Morrison tried to stay with the other really not as meaning if the question were pers son looks at the question perspective, in which an answer but a conflict of knowledge. Reiser on the from the practitioner s what are the media given situation?

To present my readers I would like to compare points of view. To do variables that seem presented in the seven Kozma, I have more summary than with case. I presented a len the other commentator s my role as an overview there needed to be a tion of an alternative big-wrench approach pre

Table 2 presents an author on the following:

- Media. This variable is a big-wrench approach in a subs media attributes in can be manipulated ent in learning? do have a profound e
seemingly fixated attack on instructional design.

Fortunately, several of the articles in the special issue rose above the advocacy of the big wrench. They attempted to do this by adjusting or totally reshaping the question. This is good and bad. On the negative side, we are still wondering about the original question of the influence of media. On the positive side, perhaps the question is too simple and arriving at an answer takes much thought and textual space. I feel that Kozma and Clark tried to keep to the original question, but the rest of the community went beyond that simple question. Obviously, if you read the middle portion of this article, you saw that I view the question as complex—as do Shrock (1994) and Jonassen et al. (1994). Morrison (1994) and Reiser (1994) tried to stay with the question but found it really not as meaningful as would be the case if the question were broader in scope. Morrison looks at the question from a researcher's perspective, in which there is no definitive answer but a continuous advancement of knowledge. Reiser on the other hand comes from the practitioner side of the debate; that is, what are the media options available in any given situation?

To present my reaction to the special issue, I would like to compare and contrast the seven points of view. To do this, I have selected eight variables that seem to be more or less presented in the seven articles. With Clark and Kozma, I have more information to make this summary than with the others. In my own case, I presented a lengthier presentation than the other commentators because of the nature of my role as an overall discussant. Plus, I felt there needed to be a more complete description of an alternative approach to the big wrench approach presented by Kozma.

Table 2 presents an overview summary of each author on the following eight variables:

- **Media.** This variable deals directly with the big-wrench approach. Do media influence learning in a substantial way? That is, are media attributes independent variables that can be manipulated to produce improvement in learning? A yes indicates that media have a profound effect on learning.

- **Method.** This category defines the method of the instructional strategy that is employed in the organization of the content. The differences here are based on general methods versus specific (situational-bound) methods. General implies methods without reference to a given delivery system. In contrast, specific implies interaction with attributes of a given delivery system.

- **Content.** Does content exhibit properties that favor various mental representations such that delivery systems may enhance or inhibit the representation? A yes implies that content has attributes that must be considered when selecting a delivery system.

- **Context.** Are there learning environment variables that can be manipulated to achieve greater or less learning? A yes would indicate that there are environmental considerations when selecting a delivery system.

- **Risk.** Although this variable may not influence learning directly, each author mentions risk as an important consideration when debating the influence of media in learning. Classification here implies the level of risk one is willing to place on the value of media. Low risk says that in most situations, the cheapest form of delivery is acceptable. In contrast, high risk says that media directly influence learning outcomes, therefore, additional costs for electronic media are acceptable.

- **Theory.** I find this one of much interest because from an educational psychology perspective, I view learning theory as foundational to instructional design. However, not all technologists or instructional designers consider learning theory important to this debate. A no here implies that there is no link between media and learning theory. In addition to the foundational linkage that I describe in my work is the notion that media are embedded directly in learning theory.

- **Research.** This category reflects the growth of big-wrench advocates who prefer to offer solutions to educational problems while not wanting to exercise rigorous empirical confirmations of their solutions. Rather than
employing scientific standards of theoretical confirmation, they attack the scientific approach as being inadequate to test their solutions. A yes here is strong endorsement for the concept of scientific confirmation and replication. On the other hand, a no presupposes that summative evaluation, pre-experimental or testimonials are sufficient means to support the big wrench.

To maintain a high level of objectivity, I will offer my summary of the seven authors in alphabetical order. And, as it turns out, I am last. The order follows as in Table 2.

Richard Clark. Even if Clark were not first in the alphabet, it would be appropriate to start with his position because of his initiative in starting the debate in 1983. Of course, given the titles of his articles it is easy to summarize his position. Clark makes it quite clear that he separates media from instructional method and that media exert no influence in learning improvements. He supports his position using the empirical research literature. Thus, he feels that any confirmation for the effect of media must come through true-experimental research. This puts him in conflict with much of the contemporary work offered by technologists and constructivists who view laboratory research as outmoded and of no value. Clark also does not directly enter into the debate any notions of learning theories. He does make use of instructional theory as related to methods of instruction.

The strong part of Clark’s criticism of media influences is the lack of empirical support at this point. He approaches this debate from the view of the scientist, and is not going to be easily swayed by media advocates. However, Clark is very much an advocate of instructional design and would be a good person in those situations where real-world risk is important. Because he does not favor a given medium, his approach to the question centers on risk. That is, instruction is best when it is the most cost-effective. He is not against media as delivery systems, but against the big wrench approach.

David Jonassen and associates. Of the six positions presented in this issue, I am most closely associated with the integrated approach offered by Jonassen and associates. They see media (especially computer-based systems) as definitely influencing learning but within the somewhat narrow guidelines proposed by the advocates of constructivism. I agree with their view concerning the role of context in the learning environment; including media, method, content, and the learner. Jonassen et al. are strong advocates of constructivism as a learning theory for debating the question on media. But they view the debate as narrow because of the limited reference to the learner. Of the seven authors, Jonassen et al. are the strongest supporters of the learner variable. This is consistent with the constructivist philosophy that empowers the learner with enormous achievement motivation and self-regulation.

Robert Kozma. We have debated because of his realization of the big wrench criticism. By taking on Clark’s position, Kozma must take on Clark’s argument. What is the focus for those who are going to look at what he writes. And, in this case, six others as well. In the academic world that one must publish in open and print.

From my reading I am saying that media effects are dependent variable that...
Given this learning theory perspective, Jonassen et al. see media as offering the means for empowerment. They actually advocate a systemic influence from media. Media are not mere vehicles for the approach proposed by Jonassen et al. and others in the constructivist camp. One important clue when sorting out whether the scientist is an advocate with a big wrench is the literature referenced. For example, Clark looks at and references a complete cross-section of the literature on media. In fact, it is an unbiased review of the literature that maintains credibility of this debate. Jonassen et al., in contrast, shape their argument by citing literature that supports their thesis. If you agree with that thesis, then there is no problem. For example, in advocating the constructivist theory, Jonassen et al.’s research base is fundamentally pre-experimental. They cite as evidence for support of constructivism, the writings of Seymour Papert—hardly a scientist in search of unbiased truth.

Jonassen et al. are “high tech” advocates that see risk and cost-effectiveness as non-issues (except when debating the high cost of computer-based instruction versus mindtools). A learning environment for Jonassen et al. is a media-world in which the learner is seeking knowledge unencumbered by a teacher. Whereas Clark maintains that teachers can do anything media can (and actually better), Jonassen et al. want to free the learner from the controlling grasps of teachers. The importance of Jonassen et al. in this debate is their strong learning theory base and the integration of the learner with the other variables of media, method, content, and context.

Robert Kozma. We have to admire Kozma in this debate because of his unflinching exposure to criticism. By taking on the task of contradicting Clark, Kozma must try to cover every aspect of his argument. What he faces is people like me who are going to look at each and every thing he writes. And, in this case, not just one but six others as well. It is not often in the academic world that one’s work gets to be grilled in an open and printed format.

From my reading of Kozma’s article, he is saying that media comprise a separate independent variable that can be found to profoundly influence learning. And, if the media are well controlled and/or employed, they can result in improved learning over conventional forms of classroom teaching. Therefore, in Kozma’s column, I put a yes for media. In contrast to Clark, he can do this because he views media as having attributes that are specific, media-bound. Kozma especially likes the power offered by computers such that no other medium can match the unique capabilities inherent in computer technology. After all, his main source of empirical verification is research on mindtools.

To support his thesis, he uses without qualms two cross-media comparison studies. Each of the other authors take Kozma to task for this. But, I think Kozma is unmoved by their criticisms. If he really bought into Clark’s argument against using cross-media methods for research on effects of media, he would have no basis for his view. He was in no way critical of the two studies that show computer software as better than non-computer based instruction. Without question, Kozma is an advocate of the big-wrench approach. This is further shown by his acceptance of the high risk of such delivery systems for classrooms. And, although he favors a constructivist learning theory for his broader view of education, he does not include the concept of context that Jonassen et al. propose. Kozma mentions content as being influenced by media attributes but leaves out the learner and context.

Kozma’s main thesis is that as media become increasingly sophisticated in terms of user manipulation control, they will have more direct influence on learning. Thus, he views media and method blending together as one entity. The computer will become more than a Socrates because the learner will have eminent power. Rather than the tutor being the source of power, the tutee will hold the ultimate power.

The Final Four

The final four authors (except Tennyson) wrote entirely different articles from Clark, Jonassen, and Kozma. For the most part, they limited their comments to the specific task of respond-
ing to the debate offered by Clark and Kozma. Therefore, my reaction to their individual positions on the influence of media is somewhat less complete. I am more familiar with Morrison’s extensive research work than with Reiser’s or Shrock’s writings which deal more directly with issues of instructional design.

Gary Morrison. Morrison’s response to this debate is much like my own. He comes from a strong research perspective that is not trying to promote a specific medium or theory of learning. From his comments, it is clear that he does not at this point see media as a direct variable resulting in improved learning. He represents that group of instructional designers that favors an integrated approach between a number of variables associated with instructional design. His integrated approach looks at a three-way interaction between media, method, and context, with learner characteristics adjusting that interaction.

Important contributions from Morrison’s research work are his continued empirical findings that are in many cases totally contradictory to established practice. This is valuable information given the attack by certain big-wrench advocates that research is too limited and cannot answer “big” questions. The anti-research fever of many big-wrench advocates is certainly suspect given Morrison’s work.

Robert Reiser. Reiser’s writings clearly support the influence of media in learning. He represents, in contrast to Morrison, the practitioner in instructional design. That is, the big wrench of media is a stable part of any instructional design activity. Risk is high with Reiser, but when using an evaluation approach to assess worth and value, the politics of supporting a mediated approach will most often look positive. There are aspects of this approach that seem reasonable because of Reiser’s concern for the individual learner in the design process. From his article, his stand on instructional theory is unclear but he definitely does bring learning theory into questions of instructional design. Obviously, he is not alone in this regard. From what Reiser has written, he really is not worried or concerned about the significance of research findings in media studies.

Media have certain attributes, and in certain situations those attributes are unique and are not readily independent of methods.

Sharon Shrock. Shrock approaches the media debate from a philosophical view that favors the scientific method. She feels that Clark’s 1983 article raised important issues about the study of media influences in learning. Unlike many instructional designers (and technologists) who felt that Clark was attacking media based on outdated research methodologies, Shrock supports the need for a strong research base to test hypotheses about media influences in improving learning. However, she seems to think that Clark’s somewhat vague attack on media research as offering nothing for instructional design is incorrect. Although the media research may not directly confirm the independent role of media as the contributor to improved learning, the research has contributed to the general methods of instructional design. I agree with Shrock on this point.

Shrock does not feel that media improve learning (thus, she is not a big-wrench proponent) but that it is part of the more complex process of instructional design. In her view, media should be selected to minimize risk while including learner variables and adjusting to both content and context. And, although a supporter of a strong research base for instructional design, she does not indicate a preference for a given learning or instructional theory. In this sense she comes from the practical side of instructional design (much like Reiser) that sees value in various learning theories. This is in contrast to Jonassen et al. who let the learning theory drive the entire instructional design process.

Robert Tennyson. My view is that media do not improve learning but when linked to a given method within specific situations can contribute to improved learning. This was my point in the first round of this debate (Petkovitch & Tennyson, 1984; Tennyson, 1987) and my argument updated in the middle section of this article. To summarize my position as listed in Table 2, I support a highly integrated instructional design philosophy that maintains that learner variables interact with content and con-

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text. For media selection and design in the classroom that tries to do as much as possible with the lower-order objectives, there is some sort of media that can be used to favor a cognitive learning activity. By addition to instructional design, the constructivist theory generates knowledge as well as a general theory of understanding (Breuer, in press). This integrated approach is more complex and that design and implementation of intervention rather than attacking methodologies, I feel, is necessary to support both empirical research. So called "tools to help investigate" or “tools to help the design” can not shape or limit what is possible. The issue for researchers is that if these tools are inadequate, then new ones must be developed. One does not judge a phenomenon by limitations of the current methodology.

CONCLUSIONS

In this article I have emphasized the limited general problem in some instances of components of a given solution to their paradigm to a complex solution. I have emphasized this approach as an alternative to the big-wrench approach that integrated approaches offer solutions of multiple solutions. Thus, my comments on media influences in the discussion (or the future), media with their limitations, a complex association of designs, methods, learner variables, and context of risk.

In the second section, I summarized my argument for an integrated approach with an emphasis on the model that links media...
text. For media selection, I am in the low-risk camp that tries to deliver instruction as economically as possible. However, many of the higher-order objectives are best served with some sort of media (see Table 1). Although I favor a cognitive learning theory as foundational to instructional design, I embrace both the constructivist theory that the learner creates knowledge as well as the radical behavioral theory of automaticity (Tennyson & Breuer, in press). The very heart of the integrated approach is that learning is highly complex and that design of instruction requires employment of interactive variables. Finally, rather than attacking or ignoring research methodologies, I feel that the field should continue to support both the use and growth of empirical research. Scientists employ research tools to help investigate phenomena: research tools help in the discovery process—they do not shape or limit what is to be tested. The issue for researchers is, if existing tools are inadequate, then new tools need to be developed. One does not argue that a given phenomenon cannot be confirmed because of the limitations of the concept of the scientific method.

CONCLUSION

In this article I have addressed the debate of media influences in learning on the basis of a general problem in science; that is, where proponents of a given solution try to generalize their paradigm to a complex world. I characterized this approach as the big wrench. In contrast to the big-wrench approach, I proposed that integrated approaches, that allow for creation of solutions employing all available resources, offer the best solutions to learning problems. Thus, my argument in this debate on media influences is that at this time (and, in the future), media will always be embedded in a complex association with instructional methods, learner variables, content, context, and risk.

In the second section of this article, I summarized my argument of an integrated approach with an example of an integrated model that links media attributes with instruc-


Tennyson, R.D. (1987, February). Computer-based enhancements for the improvement of learning. In M. Simonson (Chair), "... Mere vehicles ...": Discussion of what the research says by those who are doing the saying. Invited symposium presented at the meeting of the Association for Educational Communication and Technology, Atlanta.


