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Considerations of Learning and Learning Research: Revisiting the "Media Effects" Debate

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This article revisits the "Media Effects" debate—whether media, in and of itself, affects learning—and presents an analysis of the various arguments from a learning theory perspective. Whether one agrees with a particular position is of lesser importance than the knowledge gained from analyzing each position. One outcome of this analysis is that some of the strongest contestants, namely, Clark (the skeptic) and Kozma (the advocate), may actually be in agreement about instructional support and instructional design. However, there are substantive disagreements when we look at the positions contestants hold on learning and knowing. These differences point to fundamentally different epistemologies, and ultimately suggest different views of the role of instructional media and method, the learner, and the instructor within a learning environment. The stance one takes on learning leads to different responses to the media effects question, and has profound implications for the types of research, instructional design, and assessment questions that one is committed to. As an alternative, a dynamic process of instructional design where assessments are aimed at instructional practices as well as learning outcomes, and instructional media and method are mutually constitutive and modifiable in response to learner and instructional outcomes is proposed.

Long before computers and multimedia technologies were introduced as instructional tools, other forms of technology such as film, radio, and

television, were introduced into classrooms with varying degrees of success (Cuban, 1986). Each new medium seems to attract its own set of advocates who make claims for its ability to improve learning and classroom instruction (Clark, 1983). Behind these claims lies the "Media Effects" debate, the question of whether media, in and of itself, affects learning. Is the current fervor with the design of new instructional media justified?

The issues of the impact of technology on learning and instruction can seem so theoretical and remote, why should the field of instructional design be so preoccupied with this debate? Consider, for example, the current reaction to recent research by Francis Raucher, Gordon L. Shaw, and Katherine Ky (1993) of the University of California at Irvine. They reported a causal relationship between listening to music and performance on abstract reasoning tasks. Specifically, they gave college students standard tests of spatial reasoning after the subjects had experienced one of three conditions for 10 minutes: listening to Mozart (*Sonata for Two Pianos in D Major*, K488), listening to a relaxation tape, or silence. A brief but significant increase in performance of a spatial-temporal IQ task (involving mental manipulations of folded cut paper) was found after listening to Mozart's piano sonata, but not with the other two conditions. This finding has drawn great public interest and led to at least one failed attempt at replication (Stough, Kerkin, Bates, & Mangan, 1994), and one successful replication (Rauscher, Shaw, Levine, Ky, & Wright, 1995).

On the basis of the Irvine study, there now exists a small and growing cottage industry producing musical products for child, adult, and even prenatal cognitive enhancement. Some of the dozens of benefits claimed on the internet, in press releases, and magazine articles include: Improves test scores; cuts learning time dramatically; calms hyperactive children and adults; improves creativity and clarity; heals the body faster; integrates both sides of the brain for more efficient learning; and raises IQ scores 9 points.

The so-called "Mozart Effect" (Campbell, 1997) is centrally a claim about a media effect. In order to examine this and related issues, we return to a debate that began over sixteen years ago. The debate was sparked by Richard Clark in a 1983 *Review of Educational Research* article entitled "Reconsidering research on learning from media." In this article, Clark reviewed summaries and meta-analyses of media comparison studies and concluded that, "[o]ne might reasonably wonder why media are still advocated for their ability to increase learning when research clearly indicates that such benefits are not forthcoming" (Clark, 1983, p. 456). He asserted that media were mere vehicles for learning, and that the truly causal agent in learning is the method of instruction that was used. These assertions obviously were (and still are!) met with strong reluctance from media designers

and researchers who study and invest in media intended to affect learning. In this article, the debate is revisited and an analysis of the underlying epistemologies is provided, as well as the views of learning that have been the foundation for this debate. To do so, a summary of the Media Effects debate is presented, focusing on the arguments put forth by the primary researchers involved: the skeptic, Richard Clark (1983, 1994a, 1994b); and the advocate, Robert Kozma (1991, 1994a, 1994b; though also see (Jonassen, Campbell & Davidson, 1994; Morrison, 1994; Reiser, 1994; Ross, 1994a, 1994b; Shrock, 1994; & Tennyson, 1994). The similarities and differences apparent from the two positions are identified, and the implications for future instructional design, research methodology, epistemology, and learning are explored. Lastly, a methodology for future instructional design, particularly as it relates to the design of multimedia learning environments is prescribed.

CLARK'S POSITION

Clark's (1983) position is quite clear—"media do not influence learning under any conditions" (p. 445). Media, according to Clark, is merely the vehicle used to deliver instruction, and does not influence student learning, "any more than the truck that delivers our groceries causes changes in our nutrition. Basically, the choice of vehicle might influence the cost or extent of distributing instruction, but only the content of the vehicle can influence achievement" (p. 445).

In addition to the skeptical view, Clark draws a clear separation between media and method. It is this separation that forms one of the pillars of his argument against studies of media and learning. In particular, he asserts that researchers do not—and inherently cannot—control for the effects of instructional methods when researching the independent effects of media on learning, thereby confounding media and method. Because of this unavoidable confound Clark is convinced that researchers can never demonstrate that media can affect learning. Based on meta-analyses of past research (e.g., Lumsdaine, 1963; Mielke, 1968), Clark also asserts that there are no clear learning benefits from the use of any particular medium.

It is important to note that although Clark argues that media do not affect learning, he does not call for a moratorium on media research. Rather, he calls into question previous attempts to develop media to achieve the intended learning aims, and he challenges the educational community to adopt a different approach toward instructional design. Following through on this challenge, Clark (1994b) proposes a three step approach to

instructional design. First, one must generate a plausible model of the general cognitive processes required to learn and perform specific tasks. Second, one must develop an operational definition of these cognitive processes based on past and present research studies. Lastly, one must implement:

> a plan for developing an externalized cognitive process support in an instructional program designed to be effective and efficient for specific people in a specific context employing a known delivery medium… The selection of media and symbol systems is critical at this final stage in design because of such factors as learner preferences, available media, and the available time and funds (p. 8).

One example of a good design using these principles, according to Clark's criteria, is the work of John Anderson and Ken Koedinger (Anderson 1983, 1990; Koedinger & Anderson, 1998), which "makes full use of cognitive descriptive theories of learning and expertise in the development of [their] ACT design theory" and the associated instructional approaches (Clark, 1994b, p. 9). For example, the model tracing paradigm used in the ACT-based tutoring environments identifies the skills the students have and those they lack. In so doing, it simultaneously models the student's current knowledge state, and provides explicit instructional prescriptions to foster further knowledge acquisition (Anderson, Conrad, & Corbett, 1989). Examples of media that have been developed using this design include *The LISP Tutor*, *GP Tutor* for high school geometry, and PUMP Algebra Tutor.

KOZMA'S POSITION

In 1991, Robert Kozma challenged Clark's arguments that media and method should be treated as two independent variables, as well as the claim that media do not affect learning. He posed his challenge using examples of computer-supported learning environments developed within constructivist and situated cognition frameworks for learning, and demonstrated how these multimedia environments support the cognitive representations necessary for learning to occur.

Kozma's basic argument is that the capabilities of a medium can make a difference in learning, but learning is contingent upon on how well the capabilities correspond to the particular learning situation—the tasks and learners involved—and the way the capabilities are used in the implementation of the instructional design. Kozma argued that learners will benefit most from the use of a particular medium when its capabilities are employed by the instructional method to provide representations and cognitive

operations that are salient to the task and the situation. Further, these cognitive operations must be ones that the learner cannot or does not perform or provide automatically. Because current computer-supported environments can support the necessary representational and processing capabilities, Kozma believes computers, and media in general, can affect learning.

However, in order to utilize the processing capabilities and realize our students' learning goals, Kozma argued that researchers and designers must reshape the way decisions are made during the design and development of instructional programs. In the past, decisions about the use of a particular medium were made at a macro level, which focused on how the choice of media applies to the entire instructional presentation, and to all learners. In turn, the macro-level decisions affected the media research. The important question for media researchers became: "What is the overall impact of one medium versus another across learners, and is this impact going to be sufficient enough to justify the additional production and delivery costs that might be involved" (Kozma, 1991, p. 204)?

With the design of computer-based integrated learning environments, and the flexible and sophisticated control afforded by software, a shift occurred from macro-level to micro-level decisions. With these environments it is (at least theoretically) possible to meet the needs of individual students, reconfiguring the system based on specific learner needs and task demands. The shift from macro- to micro-level design "requires an understanding of the moment-by-moment collaboration between a particular learner and the medium" (Kozma, 1991, p. 204). This understanding requires a different set of research questions than have been considered in past instructional design efforts. These questions focus on the prior knowledge of the learner, how the knowledge is represented and structured, the differences of representations between learners, how learners process symbol systems, and how the medium can process the symbol systems in a way that supports the learner. Consideration of these questions drives research, and provides a new framework from which instructional designers can build future systems.

One example of a computer-based instructional program that facilitates learning through the proper design and use of media is the ThinkerTools environment designed to promote student learning of Newtonian principles (White & Frederikson, 1990; 1998). White and Frederikson developed a progression of computer simulation models that support conceptual change. The progression of models lead the learner from simple to more advanced models—increasing the number of physical rules, constraints, and range of problems accommodated by each simulation. The models allow students to make predictions, solve problems, and receive feedback and explanations. Kozma (1991) argued that the processing capability of the *ThinkerTools*

computer application helped novices build more expert-like models, which in turn led to conceptual change and student learning. In particular, Kozma stated that the computer was able to symbolically represent both physical and idealized objects (such as force vectors) in ways that could inform learners' mental models. He also noted that the computer has the capability of being able to proceduralize the relationships among these symbols. The symbols and processes the computer was able to represent, and portray, affect the types of mental models students develop, and the ways in which students learn.

COMPARING CLARK'S AND KOZMA'S POSITIONS

Although Clark and Kozma disagree about the effects of media on learning, there are substantial overlapping features to their arguments. In this section two of these overlapping features are explored: cognitive representations and processes as mediators of learning; and the design of instructional programs to support learning processes.

Learning Processes

Both Clark and Kozma believe that supporting a learner's cognitive processes in order to generate new knowledge is necessary for learning. However, Clark labels this support as *method*, while Kozma labels it as *media*. Each author uses the same theoretical views, Salomon (1974, 1979), to support their position. For example, when defining method, Clark (1994a) wrote:

> An instructional *method* is any way to shape information that activates, supplants or compensates for the cognitive processes necessary for achievement or motivation (Salomon, 1979). For example, students often need an example to connect new information in a learning task with information in their prior experience. If students cannot (or will not) give themselves an adequate example, an instructional presentation must provide it for them (p. 23, italics in original).

While discussing media, Kozma (1991) wrote:

> Salomon (1974, 1979) suggests that [symbol systems and processing capabilities] should be used to define, distinguish, and analyze media because they are relevant to the way learners represent and process information from a medium. He contends that certain symbol systems

> may be better at representing certain tasks and that information presented in different symbol systems may be represented differently in memory and may require different mental skills to process (p. 181).

To Clark, the presentation of information vital to the learner falls under the realm of method, while to Kozma, this is primarily tied to the choice of media. For example, the foundation of Clark's Replaceability Test is the claim that whenever one finds a medium or media attribute that produces the desired learning outcomes, there must exist an alternative medium and/or media attribute that will produce the same or similar learning outcomes. Clark interprets this as evidence "that *instructional methods* are the underlying common element of all *substitutable* media and attributes of media" (Clark, 1994b, p. 7, italics in original). Using Clark's definition of methods, we translate this quote to mean that learning occurs only when necessary supports of the learner's cognitive processes are provided for. We believe Kozma would agree.

If these interpretations of Clark are correct, then the two authors are in agreement with regard to how students learn. Both authors agree with the underlying premise that learners need the cognitive supports of a learning environment, be it from the media or the method, if they are to incorporate newly acquired knowledge or skills into their existing knowledge and skill base. However, the two authors define these supports differently. Kozma argues that the media and the method are mutually supportive and constitutive of one another. Clark, on the other hand, makes a distinction between the two, and privileges method over media by treating media as an external constraint (Frensch & Buchner, 1999) on the instructional method.

Instructional Design

Kozma's and Clark's overlapping ideas are also evident in their discussion about the design of instructional programs. Clark (1994b) argues that instructional designers, developers, and researchers often fail to link their work to basic and applied research with older media on learning from instruction. "We too often act as if we believe that each new delivery technology requires a new theory of learning and performance. Thus we 'reinvent the wheel' constantly but inadequately" (p. 8).

Based on this critique of past media development and media research efforts, Clark asks that future instructional designers: (a) generate a model of general cognitive processes for a task, (b) develop operational definitions of the necessary cognitive processes for a task, and lastly (c) develop a plan

to externalize these cognitive processes through an instructional program. To Clark, this approach distinguishes between scientifically driven and tested technology versus experientially driven, untested craft (Clark & Estes, 1998).

Clark's arguments are parallel to Kozma's call to consider micro-level decisions in the design of instructional programs and understand the moment-to-moment collaboration between the learner and the medium of the learning context. In essence, both Clark and Kozma are asking educational researchers and instructional designers to consider the processes by which learners acquire new information. The only difference between the two views lies in Kozma's additional consideration of the interactions between the learning processes and the media. Thus, it appears that the two researchers are asking us to design future instructional programs in very similar ways.

In light of their common ground, it is puzzling that Clark and Kozma generate such different responses to the question of whether media can affect learning. One might be tempted to attribute Clark's and Kozma's differences to semantics– blurring the boundaries of media and method. However, we believe that there is a more fundamental difference between the two researchers. Clark and Kozma differ in their views on learning. In the following section, how differences in their views of learning lead to different epistemological, pedagogical, and methodological implications for instructional design are demonstrated. Also discussed is how these implications impact the ways that one responds in the Media Effects debate.

IMPLICATIONS OF CLARK'S AND KOZMA'S VIEWS OF LEARNING

Clark on Learning

Clark's view of learning is difficult to pin down because Clark never explicitly defines learning in his writing. However, based on other positions he holds, it can be inferred that learning is the acquisition of the knowledge and skills necessary to perform a given task, and the learner acquires information through the transmission or delivery of information (Cuban, 1993). Given this position, the task of an instructional program is to provide the representations and other cognitive supports (methods) through a delivery device (media) that allows the learner to acquire the knowledge and skills necessary for enhanced achievement.

As mentioned earlier, Clark (1994a) defines methods as the ways to shape information that activate, supplant, or compensate for the cognitive processes or strategies necessary for achievement or motivation that students can not or will not provide for themselves (Salomon, 1979). Media,

on the other hand, are the packages that contain and deliver the instructional method and content. This very distinct separation between media and method indicates Clark's epistemological stance that locates knowledge solely within the individual. The processes (methods) necessary for learning to occur are a property of the individual. In this view, the means (media) used to move information (knowledge) from one individual (e.g., instructor) to the next (e.g., student) are generic, replaceable delivery containers. For example, as you read this article, a transfer of knowledge is (hopefully) occurring, allowing you to transform and adopt (or reject) this information into your own thoughts. In the instructionalist view, this transfer process is possible only because of the underlying reading processes necessary for understanding; the text merely acts as a means to convey the ideas.

Just as Clark's view of learning has epistemological implications, his view of learning has pedagogical implications as well. First, Clark's view of knowledge creates a separation between the instructional agent and the learner agent. Although learning is dependent upon certain necessary cognitive processes of the learner, the learning process itself is relatively passive and reactive; while the instructional process is relatively active and causal. Because learning is seen as the transmission of information from the instructor, learning agency[1] must rest solely with the instructor, and it is this agent who is responsible for the success or failure of a given learning environment.

Second, from an instructionalist's view, instructional activities are organized to optimize the transmission and acquisition of necessary information for the learners. Thus, the pedagogical practices of the teacher or other media (computers in particular) are focused on optimizing the delivery of information. When considering the ways that media are to be used within the classroom from the instructionalist's view, it is only with regards to how to convey necessary information to the learners (Koschmann, 1996).

Lastly, Clark's epistemological stance provides the footing to challenge the research community—by way of the Replaceability Test—to develop and adopt research methodology that separates media from method. Clark's argument is as follows: Media are generic containers, and methods are active processes for instruction, therefore when conducting media-effects research these variables should be treated independently of each other. If researchers are to prove that media affect learning, then they must demonstrate adequate control of method. This separation, made possible through his view of knowledge, is fundamental to Clark's interpretation of past media research studies.

Kozma on Learning

In contrast to Clark, Kozma defines learning as an active, constructive process whereby the learner strategically manages available cognitive resources to create new knowledge by extracting information from the environment and integrating it with information already stored in memory. Cognitive resources are distributed between a learner's internal knowledge base and the external environment (media, other persons, etc.). Within this framework, the learner typically builds his or her own knowledge and skill set by participating within a learning environment.

Kozma's constructivist stance on learning commits him to a different view of knowledge than that held by Clark. Within Kozma's framework for learning, knowledge is neither the property of an individual nor of the environment, rather it can be seen as the continuous, reciprocal interaction between the learner and her or his environment (Greeno, 1989, 1998; Pea, 1993). This view of knowledge is consistent with Kozma's definitions of media and method. Kozma does not make the distinction between media and method that Clark makes. Media, in Kozma's view, are constrained by their technology—the mechanical and electronic aspects that determine their functions (Salomon, 1979). The primary effect of the technology of a medium is to enable and constrain the symbol systems it can employ, and the processes that can be performed with it. For example, both videodiscs and broadcast media use image and sound symbol systems. However, information can be searched or its pace of progression changed with videodisc in a way that is not possible with broadcast video (CTGV, 1997a). Just as a technology enables and constrains its symbol system and processes, the medium enables and constrains the methods for its use. As Kozma states, "the method draws on and instantiates the capabilities of the medium" (1991, p.205). In fact, Kozma (1994b) later goes so far as to say, "[i]f media are going to influence learning, method *must* be confounded with the medium. Media must be designed to give us powerful new methods, and our methods must take appropriate advantage of a medium's capabilities" (p. 16, italics in original).

As one considers the pedagogical implications from a constructivist's view of learning as compared to that advanced by Clark (1983, 1994a, 1994b), a shift occurs from the delivery of information to the creation of enabling supports for learners. Although Kozma contends that knowledge is constructed through the reciprocal interaction of the learner and the environment, it is ultimately the learner who must actively and effectively modulate the resources provided within the environment. Put another way, the environment (teacher, media, self, etc.) can create the conditions and provide the

supports that enable the learning of the student, but the student, rather than the instructor, fills the executive role and utilizes these enabling conditions. Thus, this view locates learning agency with the learner. Just as Clark's view of knowledge leads him to ask about experimental controls for separate effects of media and method, Kozma's view of knowledge allows him to challenge the traditional distinction made between media and method and ask alternative research questions.

Tennyson (1994) argues that Kozma advocates a "big wrench" approach to media and learning—the view that media, technology in particular, serve as a panacea for instruction—and as such, will forego the "hard" evidence presented in past studies (a la Clark) that claim there are little, if any, learning effects from media. "Big wrench" advocates will also use research techniques such as field studies and small N research to argue for media use in instruction that often do not meet the rigor of experimental designs, or support the same generalizability.

The authors do not believe Kozma is ignoring experimental evidence presented by researchers like Clark, or giving up quantitative research techniques to pursue a belief that technology will provide an instructional remedy for our schools. Rather, Kozma is operating under a different paradigm of learning that requires different methodologies such as: teaching experiments, clinical interviews, analyses of videotapes, action research studies, ethnographic observations, software development studies, and computer modeling (Lesh, Lovitts, & Kelly, 2000). Kozma was quite explicit when he stated:

> [T]he source of this failure [for establishing a relationship between media and learning] is due to the fact that our theories, research, and designs have been constrained by vestiges of the behavioral roots from which our discipline sprang… Missing in these studies are any mentalist notions or descriptions of the cognitive, affective, or social processes by which learning occurs… Consequently, we will understand the potential for a relationship between media and learning when we consider it as an interaction between cognitive processes and characteristics of the environment, so mediated (Kozma, 1994a, p. 8).

This paradigm requires different questions when exploring the relationship between media and learning, questions that revolve around the individual characteristics of a medium and the learner in addition to questions that explore the interactions between media and learners (Cobb & Bowers, 1999; Greeno & MMAP, 1998; Kelly & Lesh, 2000). The studies cited by Clark as support for the claim that media do not affect learning used different research questions and methodologies than Kozma is using. Thus, Kozma is not ignoring this body of research cited by Clark. Rather, this research

does not answer Kozma's questions regarding distributed cognition, or provide Kozma with the same evidence it provides for Clark and Tennyson.

At the beginning of this section, it was argued that although there are overlapping features between Clark's and Kozma's views on the Media Effects debate (with Clark's stance on method matching Kozma's stance on media), their substantive differences are a result of their different views of learning. How their views of learning affect the types of distinctions made between media and method, the pedagogical implications, and, most importantly, the types of questions that drive their respective research programs has been demonstrated. Clark's view of knowledge commits him to a separation between media and method. However, knowledge is viewed by Kozma as an interaction between the learner and his or her environment, where learning is the development of knowledge within the learner. Thus, Kozma is interested in the interaction, rather than the separation, between media (the learner's environment) and method (supports for active learning within the learning environment). This view on the distributed nature of knowledge forces Kozma to ask different research questions than would a static, individual view of knowledge. By understanding the types of questions each researcher is asking, and exploring why they are asking such questions, we are better able to understand why Kozma and Clark disagree on the effects of media.

RECIPROCITY OF MEDIA AND METHOD

Before continuing with a general discussion of the issues, a claim about media and method is introduced. Clark is willing to take the media research community to task by claiming media and methods are entities unto themselves, separate from the instructional contexts within which media and methods exist and operate. Kozma describes methods as dependent upon media, whereby methods draw on and instantiate the capabilities of the medium. Just as Kozma talks about method primarily in terms of its match to a chosen medium, Clark talks about media primarily in terms of how it serves the method (cost and efficiency). The writings of both researchers indicate an underlying reciprocity: In order to talk about either media or methods, we must talk about the other.

In a sense, Clark and Kozma have, in their writings, deconstructed the question of media and learning to a theoretical level, and in so doing have created a dualism between these two terms that does not and we believe cannot exist at the practical level (i.e., in the classroom; Cobb & Bowers, 1999). To make the distinction between media and method both on a theoretical level and in practice, we introduce the terms instructional media and

instructional method as constructs that exist in context, and are necessarily mutually constitutive of the other. Ironically, Clark alludes to this when he states that "The selection of media and symbol systems is critical at this final stage in [instructional] design because of such factors as learner preferences, available media, and the available time and funds" (Clark, 1994b, p. 8). However, Clark does not seem to acknowledge a general reciprocal relationship between media and method that is found inherent in this area.

One example of the reciprocity is the interaction between textbooks and reading comprehension. If one looks only at instructional media, one would expect that highly coherent texts would be preferred over texts with low coherence for learning. But, when one considers the interaction of media (texts) and methods (reading and supporting activities), we see that prior knowledge affects readers' comprehension processes (i.e., their self-directed methods) for a given text and subsequent learning. For example, McNamara and her colleagues (McNamara, Kintsch, Songer & Kintsch, 1996) found that high-coherence biology texts helped low-knowledge students to learn, but hindered the comprehension processes of high-knowledge readers. The high-knowledge readers benefited most from low-coherence texts that engaged them, and elicited a more active reading process. Thus, we see the powerful interaction between media (text organization) and method (comprehension processes).

As another example of the ways in which instructional methods and instructional media interact, we turn to *The Adventures of Jasper Woodbury* videodisc technology. *Jasper* is designed to facilitate learning using authentic problems that act as anchors for instruction (CTGV, 1997a, 1997b). The designers intended the *Jasper* episodes to be used to supply information to teams of cooperative solvers over extended problem-solving sessions—as much as a week or more—and that the information be frequently revisited using the random access capability of the videodisc. However, this design does not ensure that the teacher will use the medium in this way. Consider a teacher who shows her students the Jasper story, proceeds to show the class the solution, and then immediately gives the class a test on how to solve the problem—all in one 45 minute class period. Here, the instructional design of *Jasper* calls for a particular instructional method (i.e., cooperative problem solving) for this medium. However, the instructional medium, in practice, supports a variety of methods that may deviate widely from the designers' intentions.

In the previous section, how views of learning have epistemological implications that, in turn, can shape pedagogical approaches and drive research methodologies in particular ways to answer the question of whether media can and does affect learning was demonstrated. Consideration of

instructional methods and instructional media in context as mutually constitutive, as opposed to the exclusive theoretical concepts of media and method, provide another way to address the Media Effects debate. In particular, Clark and Kozma attribute learning to different factors, but run into tension as they discuss their arguments in practice. This tension exists because the dualism that exists on the theoretical plane disappears when these aspects of instruction and curriculum are considered in practice.

DISCUSSION

The stance one takes on learning has profound implications for the types of research, design, and assessment questions that one is committed to during instructional design. Although this commitment seems to be important for the ways that one interprets and builds on past research and designs, we think researchers are often too loose when they describe the process of learning, and its associated implications. For example, although Clark claims that media do not affect learning, he never actually defines what he means by learning. Clark also appears to be inconsistent about the associated implications for the assessment of media and method for learning. Clark draws a distinction between media and method typical of the logical positivistic stance, and details how the two are confounded in past media studies. This confound forms a large part of his argument of why method, not media affects learning. However, if ones truly takes a logical positivistic, experimental stance, then one cannot say that either media or method affect learning. If the two are confounded with each other, their effects cannot be experimentally distinguished from one another!

Based on this observation, we propose that a first step in instructional design is to explicitly define not only the learning goals (outcomes), but also the ways in which one thinks students will learn (learning process), and why one thinks learners will learn in the manner predicted. By explicating a stance on learning, it is possible to make better decisions about one's claims, about the ways in which past research is used, and about current and future iterations of an instructional design. Assuming that one is careful to define one's views of learning, and one provides the various implications associated with these views, we may ask, is this sufficient? Or put another way, once learning is defined and its process described, can we use either Clark's or Kozma's methodology for studying the impacts of various instructional designs?

The authors believe that defining learning, and working within the common ground in Clark's and Kozma's frameworks for design (specifying

cognitive processes from research on learning from instruction, etc.) is necessary for instructional design, but is not sufficient. As Nathan (1998, 1999) points out, you cannot derive the design of an instructional technology simply from a theory of learning. There are too many degrees of freedom left unconstrained, and too many instructional design questions left unspecified to fully prescribe the final implementation. Winn (1992) voices these considerations: As the autonomy of learners within constructivism-inspired learning environments is considered, instructional designers must come to realize that the learning trajectories, and therefore the outcomes will, in general, be unspecified prior to instruction. If, in addition, the complexities of authentic learning activities within these environments are taken into account (e.g., students planning a mission to Mars, Petrosino, 1997), it may well be that instructional design, as it has been traditionally regarded, is completely out-moded. As both the role of the learner grows, and the bounds of what is learned expands, it may be that instruction lags rather than leads learning.

To address these concerns two components must be added to the design framework that allows us to iteratively rethink the current design: assessment and redesign. By building assessment and re-design into the instructional design process, in the end, we come closer to fully constraining the implementation. The assessment component must be diagnostic for the instructional process, as well as for the learning process (Barron, Schwartz, Vye, Moore, Petrosino, Zech, & Bransford, 1998). Changes detected by the assessment instruments must be accounted for in the models of learning and development that guide the design of both the assessment and instruction. Unfounded changes must be looked at with great care, since they lie outside of the learning model, and therefore cannot be easily interpreted. For example, when a significant change is found in a pretest-posttest design that is not accounted for in the cognitive analysis of learning, and not predicted by the instructional design, the researcher needs to re-examine the models on which the assessment and the instruction are built.

To account for redesign in our framework, one of us (Nathan, 1999) is developing a model for instructional design where assessment and instruction are components in a feedback system, and the instructional practice is continually modified based on participant interactions, learning outcomes and assessment findings relative to the current learning goals. In this framework, both the instructional media and the instructional methods are considered to be modifiable, and are determined by the current state of the learner, the learning environment (including instructional media and instructional methods), and the assessment information. This model embodies the dynamic, interactive processes of instructional design suggested by Winn (1992) and Glaser (1976) to deal with the complexities of learning as it really happens.

CONCLUSIONS

Let us now return to the earlier discussion of the "Mozart Effect." If the effect is true (and currently this is still controversial), this research stands as a counter-example to Clark's claims that media in and of itself cannot affect learning outcomes. The "Mozart Effect" is simply a media manipulation, with no instructional methods, and no training, practice or reflection on the part of the learner. However, we raise a broader question for educational technology research: Even if the "Mozart Effect" is found to be true, should designers of instructional media rest easy, now that the debate is settled with an existence proof? We do not think so. Our understanding of learning and performance based on the last century of research on transfer, and the last few decades of research on knowledge representation and learning, makes us suspicious about the claims that a passive learner, with no additional practice and no new conceptual structures will experience significant changes in cognitive development. As our instructional assessment plan outlines, we cannot simply be satisfied with finding changes, even when they are positive ones. The assessment approach must be tightly coupled to a model of how cognitive and social changes arise, and we need to be able to account for the observed changes in terms of the psychological processes specified in this model.

In returning to the original question, sparked by Clark, we now provide our response: Can media affect learning? We believe that the answer to the question depends upon one's view of learning and learning agency. For example, Clark's stance on learning locates the necessary conditions for learning (cognitive processes and agency) within the instruction. However, for Clark, instruction consists of method and media—two separate entities. With this separation, Clark could reply (and does!) that media by itself cannot be said to affect learning. If, on the other hand, one adopts our view that media and method, while separable in theory, cannot be separated in practice, then he could answer that media does affect learning by considering media to be an integral and necessary component of some effective instruction.

A constructivist stance on learning locates the necessary conditions for learning within the learning environment (including the instruction and the learner), but locates learning agency solely within the learner. This implies that although the media employed in the instruction can provide the supports for learning, it is ultimately the learner who must engage in these supports. Thus, the constructivist could respond that media can affect learning, but only insofar as the media enable the learner to preside over his or her own knowledge.

A situative (Greeno & MMAP, 1998) stance on learning, one that acknowledges the distributed, contextual nature of knowledge, locates the necessary conditions for learning and learner agency within the specific activity. It is through the interactions of the actors of an activity (teacher, learner, media, peers, etc.) that new modes of participation develop over time (on both an individual and cultural level). It is the development of these different modes of participation that represent learning in this view (Lave & Wenger, 1991; Wenger, 1998). Thus, a person who adopts a situative stance on learning would answer that media, as with all components of the activity, do affect learning.

We are confident this debate will continue to raise issues about methodology, epistemology, and pedagogy. However, we feel this exchange is a fruitful one and causes us to look closely at the philosophical issues around learning and instruction, particularly with regard to new media and educational technology. For this we are grateful to Clark for sparking this debate, and to Kozma and the other participants who have contributed to the various exchanges that have taken place over the years.

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Note

1. Agency is the instrument by which one structures one's environment and situation to meet one's goals. The importance of agency with regards to pedagogy is that locating agency within the instructional agent or within the learner affects the ways in which we think about a learning environment. The ways in which one thinks about a learning environment has dramatic influence over the practices (pedagogy) one designs to create the best possible environment for its learners.