

## Media Will Never Influence Learning

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*The purpose of this discussion is to explain and sharpen different points of view about the impact of media and attributes of media on learning, motivation and efficiency gains from instruction. This paper is an attempt to summarize my arguments about the research and theory in this area and to respond to Robert Kozma's criticism of my earlier discussion of these issues. I will first briefly summarize my arguments about media effects; next I will attempt to characterize the many reactions to the controversial claim that media do not influence learning or motivation. Finally, I will respond to the specific criticisms advanced by Robert Kozma this issue.*

### INTRODUCTION

#### A Brief History of Media Research

□ The claim of "no learning benefits" from media has been made and substantiated many times in the past. Many researchers have argued that media have differential economic benefits but no learning benefits. For example, in the first *Handbook of Research on Teaching*, Lumsdaine (1963) concluded that the benefits of media were primarily economic and that their use was "to develop the technology of instructional method" (p. 669). Mielke (1968) was eloquent on the topic in an article he wrote for the now-defunct *Educational Broadcasting Review* (Mielke, 1968) titled "Questioning the Questions of ETV Research." He predicted that adequately designed research on the learning benefits of various media would yield no significant differences between treatments. Another example of the argument came from this century's most prolific media research reviewer, Wilbur Schramm (1977), who claimed that learning is influenced more by the content and instructional strategy in a medium than by the type of medium. Levie & Dickie (1973) made the same point as Schramm in their chapter on media and technology research in the *Second Handbook of Research on Teaching*. Finally, this was the conclusion I reached with Gavriel Salomon in our review in the third, and most recent, *Handbook of Research on Teaching* (Clark & Salomon, 1986). It is therefore a bit of a mystery why my restatement of the claim of "no differences expected" a decade ago (Clark, 1983) received so much attention. A colleague has suggested that previous discussions of this argument have put the claim in very tentative terms (as befits our training as researchers) and left the door open to media

effects on learning. I made the explicit and clear claim that there were no learning benefits possible and urged that we not continue to waste effort on the question until a "new theory" was developed. I intended to stimulate discussion and I was not disappointed. Before I describe the reactions however, the discussion turns to a brief review of the argument.

#### The Important Aspects of the Learning From Media Argument

My early articles (Clark, 1983, 1985a) claimed, in part, that media are "mere vehicles that deliver instruction but do not influence student achievement any more than the truck that delivers our groceries causes changes in our nutrition" (1983, p. 445). The articles presented evidence in support of the hypothesis that instructional methods had been confounded with media and that it is methods which influence learning. Further, I claimed, that any necessary teaching method could be designed into a variety of media presentations. I also questioned the unique contributions of media attributes. Gavriel Salomon and others (Salomon, 1979) had argued that it was not the medium which influenced learning but instead certain attributes of media that can be modeled by learners and can shape the development of unique "cognitive processes." Examples of media attributes are the capacity of television and movies to "zoom" into detail or to "unwrap" three-dimensional objects into two dimensions. The problem with the media attribute argument is that there is strong evidence that many very different media attributes accomplish the same learning goal (for example, there are a variety of equally effective ways to highlight details other than zooming). In every attempt to replicate the published media attribute studies (see studies cited by Clark, 1985c; Clark & Sugrue, 1988), a number of very different media attributes served the same or similar cognitive functions. This point is critical to my argument. If there is no single media attribute that serves a unique cognitive effect for some learning task, then the attributes must be proxies for some other variables that are instrumental in learning gains.

#### A Replaceability Challenge

It may be useful to apply the following "arm-chair experimental criteria" to any situation where it appears that media or attributes of media have been instrumental in fostering learning gains: *We need to ask whether there are other media or another set of media attributes that would yield similar learning gains.* The question is critical because if different media or attributes yield similar learning gains and facilitate achievement of necessary performance criteria, then in a design science or an instructional technology, we must always choose the *less expensive* way to achieve a learning goal. We must also form our theories around the underlying structural features of the *shared properties* of the interchangeable variables and not base theory on the irrelevant surface features. I challenge Robert Kozma and other colleagues in this area to find evidence, in a well designed study, of any instance of a medium or media attributes that are *not* replaceable by a different set of media and attributes to achieve similar learning results for any given student and learning task. This *replaceability* test is the key to my argument since if a treatment can be replaced by another treatment with similar results, the *cause* of the results is in some shared (and uncontrolled) properties of both treatments. Of course it is important for instructional designers to know that there are a variety of treatments that will produce a desired learning goal. However, the utility of this knowledge is largely economic. The designer can and must choose the less expensive and most cognitively efficient way to represent and deliver instruction. It cannot be argued that any given medium or attribute must be present in order for learning to occur, only that certain media and attributes are more efficient for certain learners, learning goals and tasks. This allows the discussion, and our mental set as theorists, to shift from media attributes as causal in learning to media attributes as causal in the cost-effectiveness of learning. While this may seem a small shift in the representation of the problem, it would have major consequences for instructional research, theory and for design. Cognitive instructional theory can shift to a concern with instruc-

and heavy verbal content. Many writers seemed to suggest that these methods were somehow intrinsic to a given medium. My argument is that the usual uses of a medium do not limit the methods or content it is capable of presenting. Computers can present realistic visual, real-time documentary information, and television can present semantically dense simulations. The method is the simulation or the real-time depiction. A good example of this point was uncovered in one of the earliest and largest (and best designed) studies of computers by Suppes (in Clark, 1983) during the 1960s. In a study of computers versus teachers using drill and practice in mathematics, Suppes found that one of his control school districts had messed up the data collection by delivering more drill and practice in mathematics than was permitted by the study—using teachers and not computers. The result was that in that school district, mathematics achievement increased at exactly the same rate as it did in districts where computers were giving drill and practice. Suppes concluded then that it was not the medium but the drill and practice method that influenced achievement but he noted that the cost of the intervention might have been less with computers.

#### Meta-analytic Evidence

Meta-analytic reviews of media research have produced evidence for the positive learning benefits of research with various media, particularly computers (see reviews in Clark, 1983, 1985a,b). These analyses report an approximate 20 percent increase in final exam scores following computer-based instruction (CBI) when it is compared to traditional forms of instruction (generally live instruction). After a number of discussions, Kulik (1985), one of the primary authors of many of the meta-analytic surveys, agreed that it is not the computer but the teaching method built into CBI that accounts for the learning gains in those studies. More important, Kulik agreed that the methods used in CBI can be and are used by teachers in live instruction (Kulik, 1985). In fact, I reanalyzed a 30 percent sample of the studies he used and found that when the same

instructional design group produces CBT and presents the live instruction with which it is compared in many studies, there is no achievement difference between the CBT and live conditions (Clark, 1985c). To characterize the fact that these powerful methods can be and are used in a variety of media, Kulik employed the catchy phrase "... diffusion of the innovative treatment to the control condition" (Kulik, 1985, p. 386). This statement more or less acknowledges that most of the studies which are grist for the meta-analytic mill, are confounded because the teaching method is not controlled (if it were controlled it could not "diffuse" anywhere).

#### Empiricism Envy

Cunningham (1986) did not dispute my argument that media made no difference to learning or motivation but argued against my empirically-based claims that instructional methods were responsible for achievement gains. Cunningham is well trained as a quantitative researcher but is increasingly attracted to qualitative research and not to empirical method or logical positivism. I think his argument was with the unreconstructed empiricism of my argument rather than with the theoretical claims. I agreed with him that my claim that it is instructional methods which account for learning gains is a hypothesis, not a conclusion (Clark, 1986).

#### Necessary Media Attributes

A number of researchers have argued with my claim about the unique contribution of what Gavriel Salomon calls "media attributes." Remember that the capacity of movies to zoom into detail or to unwrap three dimensional objects has led some to claim that new media have attributes that make unique cognitive representations available (Salomon, 1979). A few go so far as to claim that new "intelligence" might be possible as a result of exposure to these attributes (for example, Salomon, Perkins & Globerson, 1991). I presented evidence (Clark, 1985a,b) that many very different media

attributes could accomplish the same learning goal (i.e. there were a variety of equally effective ways to highlight details other than zooming) and so no one media attribute has a unique cognitive effect. Petkovitch and Tennyson (1984) took me to task with an argument which I still do not completely understand but which seems to be related to the attributes argument. They seemed to agree that media comparison studies are useless but claimed that certain media attributes make necessary contributions to learning. The evidence they offered was a study where a computer simulation was used to teach students some skills required to fly a plane. I responded that people learned to fly planes before computers were developed and therefore the media attributes required to learn were obviously neither exclusive to computers nor necessary for learning to fly. A similar and more extensive argument has been made by Kozma (1991). The next section of this paper addresses Kozma's (1994) points in this debate and in his earlier work.

#### Kozma's Reframed Argument about the Influence of Media on Learning

First, it is important to notice that Kozma (1994) agrees with me that there is *no* compelling evidence in the past 70 years of published and unpublished research that media cause learning increases under any conditions. Like all other researchers who have made a careful study of the arguments and research studies (e.g., Winn, 1990), he reaches a conclusion that is compatible with my claims (Clark, 1983). Kozma then asks that we reframe the argument about the future possibilities of media as causal agents in learning. In his discussion (this issue) Kozma interprets my claim that media attributes are not "necessary" variables in learning studies by quoting scholars from the philosophy of science who suggest that "sufficient conditions" are important to a design science. Kozma states that ". . . scientists concerned with necessary conditions are those interested in eliminating something undesirable, such as disease. . . . On the other hand, scientists interested in the production of something desirable, such as learning, are con-

cerned with establishing conditions that are sufficient to bring it about. . . . Necessary conditions are those in whose absence an event cannot occur, while sufficient conditions are those in whose presence an event must occur" (1994, p. 14). Kozma offers those studies where media attribute treatments are sufficient for learning as evidence for the value of attribute research.

This argument contains some of the most important elements of our disagreement. My reply is relatively simple. When a study demonstrates that media attributes are sufficient to cause learning, the study has failed to control for instructional method and is therefore confounded. It is true that in some cases instructional treatments containing media attributes are sufficient to cause learning. When this happens, the necessary condition to cause learning is embedded in the sufficient treatment. We know that the active ingredient in successful media treatments is not the media attributes because in all known attempts to replicate these studies, different attributes produce similar learning results—provided that the required instructional method is present in the compared versions of the media attributes. That necessary condition or "active ingredient" of the treatment which was sufficient to cause learning from instruction is best characterized as an instructional method which activates, compensates or supplants the cognitive processes necessary for learning to occur (Salomon, 1979). In other words, any treatment that is sufficient for learning must embody whatever is necessary to cause learning.

#### Structural and Surface Features of Research Constructs

The concepts of *necessary* and *sufficient* are similar to the concepts of *structural* and *surface* features in research on the role of analogies in transfer during problem solving (for example, Gick & Holyoak, 1987). Surface features of analogies are those whose characteristics are of only limited and domain-specific importance. For example, in science and mathematics instruction, irrelevant features of analogies often cause misconceptions in learning. When

told that an atom is like the solar system, students often believe that electrons must attract each other and be attracted to the nucleus of the atom because planets are attracted to each other and to the sun by gravity. Gravity is a surface feature that is important to understanding the solar system but not the atom. The structural (necessary) features that underlie both systems are central bodies (nucleus, sun) that are encircled by rotating spheres (electrons, planets). The point that I had hoped to make in my earlier reviews is that media attributes are surface features of learning systems. Those surface features may affect the economics but not the learning effectiveness of instruction. Instructional methods are structural (necessary) features of media attribute studies. On the other hand, instructional methods may be surface features of treatments concerned with the economics of learning.

I accept the point that whenever learning occurs, some medium or mix of media must be present to deliver instruction. However, if learning occurs as a result of exposure to any media, the learning is caused by the instructional method embedded in the media presentation. Method is the inclusion of one of a number of possible representations of a cognitive process or strategy that is necessary for learning but which students cannot or will not provide for themselves. Kozma (1994) accuses me of creating an "unnecessary and undesirable schism" (p. 16) between method and medium. My claim is that Kozma has confounded the two constructs. He is asking you to consider media as an integral aspect of method. I am suggesting that if we take his advice, we will continue to misinterpret the research on instructional media and learning and continue to fail in our efforts to construct powerful learning environments for all students.

All methods required for learning can be delivered by a variety of media and media attributes. It is method which is the "active ingredient" or active independent variable that may or may not be delivered by the medium to influence learning. The derivation and delivery of a method to support learning is always necessary. A great variety of media "translations" of any given method are sufficient to cause learn-

ing. Therefore, aside from the identification of necessary methods for learners and tasks, it is important to derive media that are capable of delivering the method at the least expensive rate and in the speediest fashion. Media influence cost or speed (efficiency) of learning but methods are causal in learning.

Let me try to illustrate my point one more time with a medical analogy. People often have preferences for one or another way to use a chemical medicine prescribed by a physician to improve health. Some people will argue for tablets and others for liquid or injected forms of treatment. Is it sufficient that one take a tablet medicine? Only if the tablet contains the active ingredient required to help us. Different forms of a medicine might help us provided that they all contain the same method or active ingredient. The different forms of medicine are similar to different media. The media include a variety of tablets, liquid suspensions, suppositories or injections. All of these different media are often capable of delivering a necessary active chemical ingredient with different levels of efficiency, but with more or less equal effects on our physical symptoms. The active chemical ingredient of these medical media is analogous to the necessary method in instruction. We could not construct an adequate medical design science using different (sufficient) forms of delivery media alone and it would be irrelevant to measure whether these delivery forms reduce our symptoms (unless we were concerned with the effects of belief on health). Scientific arguments about the necessary or sufficient nature of oral ingestion of tablets versus an injection of the liquid form of a medicine would be largely irrelevant. Yet the discussion of delivery forms for medicine is very important. Each of these delivery forms has different *efficiency* characteristics. Some forms of delivery get the active ingredient to the patient much faster (or slower) in quantities which are more "pure" or more "diluted" at greater or less cost to the patient. For this reason I disagree with Kozma's suggestion that we not separate medium and method in instructional research. Instead I claim that our failure to separate medium from method has caused enormous confounding and waste in a very important and expensive research area.

We continue to invest heavily in expensive media in the hope that they will produce gains in learning. When learning gains are found, we attribute them to the delivery medium, not to the active ingredient in instruction. When learning gains are absent, we assume we have chosen the wrong mix of media. In any event, many educators and business trainers are convinced that they must invest scarce resources in newer media in order to insure learning, performance or motivational gains.

#### Evidence for Kozma's View

Finally, Kozma's evidence for his view is to describe the latest round of studies that utilize the currently fashionable media—*ThinkerTools* to teach force and motion problem solutions and the *Jasper Woodbury Series* intended to help students solve mathematics problems (see Kozma, this issue). These studies were not designed so that their results would provide evidence about the claims being made in this dispute. The research conducted to validate these very creative instructional programs did not control for the sources of confounding that lie at the root of the argument. The computer-based *ThinkerTools* program was compared with a standard curriculum for teaching force and motion. It is not clear whether the standard curriculum used similar instructional methods but it is very doubtful. The videodisk-based *Jasper* program group was compared with a control group that did not receive instruction in "decomposition and solution strategies." One must question whether this missing instruction could have been delivered with a very different medium or set of media attributes. One must assume that these comparisons confound method and content in the same way that many previous studies in this area fail to control for important alternative hypotheses. One way to begin to answer questions about the structural necessity of media attributes is to ask whether other learners have achieved similar learning results with different instructional treatments. Have learners acquired problem-solving techniques similar to those presented in *ThinkerTools* or *Jasper* in the past? If so, the media attributes available from

expensive computers and video disks are not structurally important in learning problem-solving skills. Yet in making this point, I do not want to appear to be critical of the developers of these two excellent programs. The substantive point of both design activities was to explore the utility of different combinations of instructional method.

#### CONCLUSION

Kozma agrees with me that evidence does not yet support the claim that media or media attributes influence learning. This has been the conclusion of all media researchers who have entered into a dialogue about this issue (e.g., Winn, 1990). However, Kozma hopes that future media research will be more positive. He accepts the claim that in thousands of media research studies conducted over a period of 70 years, we have failed to find compelling causal evidence that media or media attributes influence learning in any essential and structural way. However, Kozma remains optimistic that with careful consideration of cognitive processes, we will find a critical connection between media attributes and learning. He suggests that my insistence that educational researchers separate these two classes of variables will retard a very promising area of research.

In brief, my claim is that media research is a triumph of enthusiasm over substantive examination of structural processes in learning and instruction. Media and their attributes have important influences on the cost or speed of learning but only the use of adequate instructional methods will influence learning. I define methods as the provision of cognitive processes or strategies that are necessary for learning but which students can not or will not provide for themselves. I claim that absolutely any necessary teaching method can be delivered to students by many media or a variety of mixtures of media attributes—with similar learning results.

The media research question is only one of a number of similarly confounded questions in educational research. It is difficult for alternative questions to gain acceptance, even though

adequate research exists to refute invalid but intuitively appealing beliefs. The development of an instructional design science is necessary but very complex. Part of the difficulty, in my view, is that we tend to encourage students (and faculty) to begin with educational and instructional *solutions* and search for problems that can be solved by those solutions. Thus we begin with an enthusiasm for some medium, or individualized instruction, or deschooling—and search for a sufficient and visible context in which to establish evidence for our solution. Negative evidence is suspect and we are predisposed to believe that it is flawed. In the case of media research, 70 years of largely negative evidence has been and continues to be ignored by many researchers. Positive evidence is accepted easily because it confirms our expectations and helps to attract research support. We need a greater appreciation for negative evidence and to begin with a focus on the problem (for example, the need to increase achievement, or access to instruction, or to address the labor intensiveness of instruction) and then search relevant research literatures for robust, research-based theories that can support the development of a variety of solutions to those problems. If we begin by implicitly and explicitly attempting to validate a belief about the solutions to largely unexamined problems, we are less open to evidence that our intuitions might be very far off the mark.

If the arguments advanced here have failed to convince you, I ask you to consider one or two questions as you reason about media research. Whenever you have found a medium or set of media attributes which you believe will cause learning for some learners on a given task, ask yourself if another (similar) set of attributes would lead to the same learning result. If you suspect that there may be an alternative set or mix of media that would give similar results, ask yourself what is causing these similar results. It is likely that when different media treatments of the same informational content to the same students yield similar learning results, the cause of the results can be found in a method which the two treatments share in common. Design science (and a world with limited resources and many com-

peting problems) requires that you choose the least expensive solution and give up your enthusiasm for the belief that media attributes cause learning. □

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