Research on Educational Media: Half a Century of Doing Things Right Rather Than the Right Thing

Lau Kam Cheong

ABSTRACT

This paper critically examines research on the influence of educational media on learning. It argues that much of the supposed benefits of media such as greater concreteness, improved learning performance, more efficient learning and increased retention, among others, are not supported by the evidence thus far. Comparative research on different forms of media, and on media attributes have likewise proved inconclusive. The paper goes on to explore reasons for these findings and urges that future studies should focus on studies with media rather than on media.

Introduction

Educational researchers have been preoccupied in attempting to discover the ideal instructional machine since Thorndike in 1912 recommended pictures as a labour-saving device for teaching. The influence of media on learning has been the main concern in research on educational media because of the assumption that the more abstract the subject-matter is, the more difficult it is for students to comprehend. The use of media will add concreteness to the learning situation by allowing students to interpret information with greater ease through more than one of their senses.

Based on this assumption, media advocates have put forth various arguments to support and justify the use of media in instruction. Some of the more common ones are:

- that greater learning results when media are integrated into the traditional instruction process.
- that equal amounts of learning are often accomplished in less time using media.
- that media can facilitate comprehension and increase retention of what is taught and learnt.
- that students are more interested and better motivated when instruction is well supported by media.

Thousands of studies have been conducted over the past fifty years to determine the validity of the above claims. The efforts involved have not been encouraging. There is no strong research evidence to support these claims.

Historical Perspective

The focus of research on a medium is reflected by the period when it is in vogue. Beginning in the 1920s, radio was introduced in the United States as a news and entertainment medium. Its potential as a medium of instruction was extensively investigated in the 1930s. Although radio is still being used today to bring formal instruction to the classrooms of remote schools in countries with vast rural territories like Aus-
tralia, the popularity of research on this medium has declined. Being able to transmit only sound, instructional radio (IR) has many limitations. To enhance its effectiveness, the use of IR has to be supplemented with appropriate printed materials.

During the 1940s, the main focus of research was on instructional film (IF). Educators then were hopeful that this versatile medium, which could combine moving pictures with sound and colour, would bring the world into the classroom by recreating realistically events, actions, experiences or processes occurring anywhere. The limitations of time, size and distance would no longer pose a barrier to learning. However, IF has serious drawbacks. Lessons on films are difficult and costly to produce, and their use requires a screen, a cine projector and a darkened environment. Teachers find the use of IF to be inflexible and inconvenient.

Research emphasis on educational media was extended from IF to instructional television (IT) during the 1950s. The video technology subsequently has introduced an electronic medium that combines the best elements of radio and motion pictures. Instructional television is seen as a convenient and economic means of mass teaching. With the advent of the portable video camera and videocassette recorder, the use of this medium as a feedback tool for role playing and skills training has become very popular. However, its use as a medium for direct instruction in the classroom is still very limited.

When IF and IT were unable to displace traditional teaching in the classroom, educational researchers turned their attention to examine the potential programmed instruction (PI). Programmed instruction is a form of self-instruction involving the use of carefully structured and sequenced educational materials from which students learn. Although the procedures of PI were expounded by Pressey (1932) in the 1930s, when he attempted to device several forms of teaching machine to automate classroom teaching, it was not until about twenty years later that Skinner (1954), a behavioural psychologist, foresaw the application of PI techniques as a means of enhancing the teaching process at all levels of education. In the 1960s, PI emerged as a dominant form of educational media for research. As the development of PI materials involved systematic field testing based on sound pedagogical principles, educators had hoped that they could be adapted to the different learning styles of students to replace the teacher. But research on PI has not been able to make a significant impact in the schools.

It is the firm belief of media advocates that students learn best if they are able to vary the source of information input and their pace of assimilation. From this point of view, learning from PI may be considered restrictive because most of the instructional materials present information in the form of printed texts bound together like a textbook. To expose students to a variety of learning materials covering different aspects of a subject, educational researchers in the United States and the United Kingdom experimented with the use of multi-media instructional situations descriptively labelled as “classroom without walls” or “learning resource laboratories.” Research on the use of multi-media instruction (MMI) was popular in the 1970s. Some of the studies have reported that schools with resources and facilities for MMI provided students with a better environment for independent learning and self-study. The teachers acted mainly as resource managers and facilitators of learning. Their role as a presenter of information has been largely reduced. Although theoretically desirable, MMI has many practical constraints particularly in terms of cost and space.

The medium in vogue in the 1980s is computer assisted instruction (CAI). The advent of the microcomputer has been hailed as the key to productivity improvement in every economic sector, and educators see no reason why the potentials of this electronic medium cannot be harnessed for the improvement of teaching and learning. Today, there is considerable concentration of research efforts into the use of computers for teaching. The widespread availability of good cheap software has resulted in the microcomputer becoming to most students a very convenient typewriter, an excellent calculator and a very handy means of storage and retrieval of data. It can be programmed to present learning materials based on the principles and procedures of PI for individualised instruc-

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Educators are optimistic that CAI can provoke the interest of students and sustain their involvement in learning. So far, the research efforts involved have not yet convinced teachers that the microcomputer can be an effective teaching machine. It remains an experimenter’s toy with regard to its application to teaching and learning.

**Research on Media Comparison**

Research to determine the relative effects of different educational media on learning typically takes the form of experimental studies that utilise the systematic and vigorous procedures of the scientific method of inquiry. Such studies involve a comparison of two or more forms of media as teaching tools or as supplements to conventional modes of teaching on the basis of learning achievements. The aim of using a comparative approach is to find out which medium is more effective in terms of influencing learning. A medium may be compared with some traditional teaching methods or some other media. The research question commonly asked may be stated as follows:

Will the use of media (such as IF, IT, PI or CAI, etc.) result in higher learning achievement by students than the use of conventional methods?

To obtain the data needed to answer the question, researchers employ an experimental design that will permit them to compare the relative achievements of equivalent groups of students who have received similar subject-matter from different media. The independent variables being manipulated are the different forms of media for delivering instruction on the subject-matter, and the dependent variables are learning achievements specified in terms of the average test performance of the groups compared. There is an inherent limitation in specifying the dependent variables on the basis of average group performance. All the actual differences between individuals are cancelled out in the overall result. A typical research design for media comparison may be shown as in Table 1.

A recent series of reviews and meta-analyses of research comparing the learning advantage of various media have been carried out by Kulik and his colleagues (1979) and by Clark (1983). Their conclusion is that the results of past media comparison studies seem to be ambiguous. Taken together the findings are inconsistent and inconclusive. Some studies show significant results in favour of media over conventional teaching or vice-versa, and a few others provide strong evidence to support the learning influence of one form of media over another. However, the majority of the studies reviewed show no significant results between the use and non-use of media and between different forms of media.

Media advocates who are optimistic about the role of media in education find the results of studies with no significant difference (NSD) encouraging. They interpret the numerous NSD findings to mean that different forms of media are equally effective and they can promote learning in students just as well as conventional teaching. The NSD results support the link between media and learning achievement. They show that students do learn from media with a variety of subject-matter under different conditions. Thus, an instructional objective can be attained through different media, and a given medium can achieve different objectives so long as students learning is measured in terms of test performance on the specific subject-matter taught. In attempting to explain why media should influence learning, media optimists claim that media can perform the following instructional functions:

<table>
<thead>
<tr>
<th>TABLE 1</th>
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<tbody>
<tr>
<td><strong>Group</strong></td>
</tr>
<tr>
<td>Control</td>
</tr>
<tr>
<td>Experimental (A)</td>
</tr>
<tr>
<td>Experimental (B)</td>
</tr>
</tbody>
</table>
• Gain and control learner attention;
• Inform the learner of expected outcome;
• Stimulate recall of relevant learning;
• Present information;
• Generate student response;
• Provide feedback; and
• Provide for repetition and practice.

A teacher who is effective performs the above functions. An educational medium that can do the same will also be instructionally effective.

Objections to Media Comparison Research

When McLuhan (1967) was spreading the message that "the medium is the message," Lumsdaine (1963) and Mielke (1968) were cautioning educators that research in media comparison might not be valid. They have explained that the lack of significant results in the many studies conducted do not mean equal effectiveness. A finding of NSD in a study simply suggests that the changes in outcome scores (i.e. learning) do not result from any systematic differences in the treatments compared. The changes could be due to other uncontrolled variables. When a study shows a significant advantage in favour of a particular medium, the advantage may be due to the content, or the instructional strategy, or even the novelty effect in the student for the newer medium rather than the medium itself.

Studies that are unable to establish a significant difference in learning outcome in favour of the media, often report the advantage in terms of the time media can save in classroom instruction. In reviewing the effects of CAI, Kulik and his colleagues (1983) found many studies contended that students learning from CAI demonstrated a time saving of 30% to 50% over their counterparts learning from traditional teaching. The question of whether the time saved is due to the inherent function of the medium, or to the planning and preparation work done outside the classroom is debatable. As the production of a 30-minute CAI or video lesson may take a few weeks or even months to complete, the gain in time saving does not really result from its use but from the design, preparation and development work expended. It is the heavy investment of planning and preparation time outside the period of instruction, and not the use of media, that has brought about the reduction in instructional time.

The optimists have argued that media can cause learning because of their instructional functions, but research has yet to establish a theory that can explain the functions of media in the instructional process. What research has been able to establish is that learning occurs during instruction irrespective of the type of media used. The implication here is clear. It is the instruction (or teaching) that is causing the learning and not the medium used. Media do not have any inherent instructional function. Their only function is to present to the students the subject-matter the teacher (which includes the media designer or producer) has selected for teaching, and deliver the instruction in the manner the teacher has chosen to teach. If the subject-matter conveyed through a medium is poorly organised or inadequately illustrated, it will not facilitate learning. If the content of instruction it delivers is garbage, the student will see and hear garbage. Media therefore cannot influence learning. The learning benefit to be gained in any instructional situation is a function of subject-matter and teaching methods. It is not a function of media. The choice of media for teaching may influence cost and mode of delivery, but only the ‘what and the how’ of teaching will influence learning achievements.

A multitude of factors are interacting in the teaching-learning process. Some of the more obvious factors involved are learner characteristics, learning objectives, the nature of the subject-matter, and instructional strategies. There are many environmental factors such as noise, lighting, classroom comfort and so forth, which have to be considered as well. The employment of media to deliver instruction will not reduce the complexity of the interaction taking place. They may introduce novelty to the instruction situation initially, but they cannot increase the level and quality of interaction. It is the nature of the subject-matter and the instructional strategy of the teacher that control classroom interaction. The media deliver the lessons, but whether the students will find the lessons interesting, does not depend on the media. Students will learn from the teaching programmed in any medium if it is...
used in the right way and for the right reason. A medium cannot be better or worse than another medium. Even the primitive chalkboard or a set of flipcharts can be very effective if skilfully used to present information within the limitations of the medium.

Researchers who are trying to determine the relative efficacy of various media on the basis of learning achievements are therefore asking the wrong question. There is no basis to compare the instructional effectiveness of one medium with another. Different sets of factors are involved in the comparison, e.g., in a study comparing the effectiveness of IF with conventional teaching, a situation using a cine projector, motion pictures with visual effects, amplified sound, background music, and students in a darkened room, is examined together with one using a live teacher, chalkboard, textbook, and students in a lighted room. The comparison is not valid because there are too many variables that cannot be controlled in the two instructional situations. The IF is not a single variable, but a broad group of variables. Similarly, IR, IT, PI, MMI and CAI are broad categories of media which are too coarse to be used as treatment variables for comparison. It is legitimate to compare different versions of the same medium teaching the same topic, but it is not relevant to compare different forms of media teaching the same topic. The reasoning is simple. Many textbooks, for example, have the same title and content page, but they differ in structure, layout, illustration and various other features. It is the same with the other media. Version A of a television lesson teaching a particular topic can be very different in details from Version B teaching the same topic. Version A may be superior to conventional teaching but Version B may be inferior. Thus, it does not make sense to ask as a research question which medium is better or more effective than the other.

Despite their obviously attractive features and advertised superiority, more than fifty years of research efforts have not been able to establish a casual link between media and learning. Clark (1983) has seriously challenged the idea that one particular instructional medium is more effective than another. His reviews and meta-analyses of media comparison studies suggest that media do not influence learning under any conditions. They are mere vehicles that deliver instruction. They do not influence the student's learning achievement "any more than the truck that delivers our groceries causes changes in our nutrition." He concludes that research and media comparison has been fruitless and unproductive. This approach to the study of educational media is unacceptable and should not be pursued further.

**Research on Media Attributes**

To eliminate the many conceptual flaws and problems in media comparison studies, educational researchers, encouraged by the work of Levie and Dickie (1973) and Solomon (1974), began to study the characteristics of media and their effects on learning. Media possess characteristic features such as continuous motion, slow motion, zooming into close-up details, manipulation of space and time, and many other qualities which are referred to as media attributes. Each form of media has its unique set of attributes. Solomon (1979) is of the opinion that media attributes may influence the way information is processed in learning. Their effects may vary according to the aptitude of learners, their learning styles, motivational levels, and other personality variables. Consequently, different learners may react differently to the same set of media attributes. It is thought that these attributes can enhance certain cognitive skills like the ability to attend to cues or to recognise forms, patterns and configurations. Researchers concentrate on investigating the effects of media attributes on learning as these attributes may provide the theoretical link between media and learning.

In conducting research on media attributes, investigators attempt to analyse different forms of media in terms of those features which they think can fulfill an instructional function. Their main purpose is to determine what media attributes are relevant for learners with what personality traits and for what kinds of learning tasks. Those attributes that are found to be significant can be used as criteria to guide the selection of media for a particular instructional purpose. The common research question asked
in media attribute studies may be stated as follows:

From which media attributes (e.g. zooming vs flashing, colour vs black-and-white, etc.) and under what conditions will learning be enhanced in what kind of students?

Or alternatively:

For a given medium, what are the essential attributes that should be used for teaching a particular topic to a specific group of students?

To guide the gathering of data required, it is necessary to adopt a research design suitable for matching media attributes to those aptitudes or traits of students that will lead them to learn the most from a particular topic. The aptitude-treatment-interaction (ATI) approach advocated by Cronbach and Snow (1977) for research in teaching offers a research design suitable for this purpose. Researchers who favour the ATI approach view the complex process of teaching and learning in terms of interaction. Thus, the question of whether an instructional medium will produce any effect on learning depends on the interaction among the characteristics of the medium, the subject-matter, the aptitude of the learners, and the conditions of learning. It is postulated that learning will be enhanced with a proper mix of these variables. The ATI approach will enable media researchers to identify patterns for matching media with different ways of presenting the same content to different groups of students in order to maximise their learning. An example of the typical ATI approach for designing media attribute studies may be shown as in Table 2.

The design in the above example will facilitate the researcher to answer such questions as:

- Do students need assistance in cueing when learning from video lessons?
- If so, what kinds of cueing effects should be used?
- Are the types of cueing effects used related to the cue attending ability and sex of students?

In their reviews, Kulik (et al, 1979) and Clark (1983) have found very few media attributes studies with encouraging positive findings. For the majority of the studies, the findings reported are non-generalisable, inconsistent and uninterpretable. Studies with findings like the following examples may be regarded as positive and fruitful:

- A medium with cueing effects (such as zooming, highlighting, etc.) will enhance learning in students with low cue attending ability (Solomon, 1974).
- A medium with attributes that will permit repetition and student participation (such as responding or recalling of information) will facilitate learning (Allen, et al, 1970).

The precise way in which a medium is used will determine its effectiveness. For example, using a video lesson with intermittent

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**Table 2**

<table>
<thead>
<tr>
<th>TREATMENT</th>
<th>CUE ATTENDING ABILITY</th>
<th>Comparison by Treatment</th>
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</thead>
<tbody>
<tr>
<td>Video Lessons with:</td>
<td>Low</td>
<td>Average</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>F</td>
</tr>
<tr>
<td>Zooming Effect</td>
<td>XLM</td>
<td>XLF</td>
</tr>
<tr>
<td>Flashing Effect</td>
<td>XZ</td>
<td></td>
</tr>
<tr>
<td>Highlighting Effect</td>
<td>XH</td>
<td></td>
</tr>
<tr>
<td>No Cueing Effect</td>
<td>XN</td>
<td></td>
</tr>
<tr>
<td>Comparison by Sex</td>
<td>XLM</td>
<td>XLF</td>
</tr>
<tr>
<td>Comparison by Ability</td>
<td>XLO</td>
<td>XAV</td>
</tr>
</tbody>
</table>

M = Male  
F = Female  
X = Mean Score
pauses and brief summaries is more effective than using it with a general summary after viewing (Chu and Schramm, 1967).

Findings from studies which indicate that a medium with attributes for displaying special effects will motivate students to learn better than one without such effects are non-generalisable. This is because other studies have found that special visual effects distract rather than motivate learning. Similarly, findings which suggest that students learn better from media that can show colours or motion are also not generalisable because learning can occur in many other situations where the attribute of colours or motion is not involved. Many researchers have obtained inconsistent and uninterpretable findings in their studies. When complicated ATI research designs are employed, many unexpected patterns of results are possible because various treatment variables are interacting with several intervening variables on a two-way, three-way or even on a four-way basis. For example, in a hypothetical study comparing the effectiveness of video lessons using cartoon and animation with similar video lessons showing actual objects and motion to teach multiplication at the third grade level, the possible pattern of results, if it occurs as shown in Table 3, would difficult to interpret:

<table>
<thead>
<tr>
<th>Video Lesson Using</th>
<th>Low Numerical Ability</th>
<th>Average Numerical Ability</th>
<th>High Numerical Ability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cartoons and Animation</td>
<td>Boys &gt; Girls</td>
<td>Boys &lt; Girls</td>
<td>Boys = Girls</td>
</tr>
<tr>
<td>Actual Objects and Motion</td>
<td>Boys &lt; Girls</td>
<td>Boys = Girls</td>
<td>Boys = Girls</td>
</tr>
</tbody>
</table>

In the above example, it is not possible to explain the contributions of the treatment variables (i.e. cartoon and animation vs actual objects and motion) involved. Neither can the relationship between the treatment variables and the intervening variables of sex and numerical ability be established. Although the ATI approach allows for the investigation of interaction between media attributes and student characteristics, it cannot ensure that the significant results obtained must necessarily be meaningful. The extent to which the findings in a study can be meaningfully interpreted depends on the kinds of media attributes and student characteristics identified for investigation.

There is some evidence, particularly from those studies with positive findings that media attributes can facilitate learning by influencing the way information is perceived and processed by the learner. Zooming and close-up shorts, for example, force the learner to attend to details. Visual effects that unfold or unwrap a three-dimensional image into its two-dimensional form help the learner to mentally transform the shape of solid objects onto flat surfaces, and the animation of shapes and forms facilitates his recognition of patterns and configurations. Such findings support the argument that media attributes exert a positive effect on certain cognitive skills. They have important implications for teachers who are faced with a wide range of media used today.

Teachers have to select the "best" or "most appropriate" medium to serve their specific instructional purpose. They need criteria and guidelines to decide which media to use for achieving different instructional objectives. Like a good orator who shapes his message to fit the audience and the topic of his speech, the effective teacher has to match the medium to his instructional tasks. However, practical criteria for media selection have yet to be established. It is hoped that research on media attributes can help teachers tackle this problem. But whether the kinds of studies undertaken can make an important contribution in this direction is doubtful.
Objections to Media Attributes Research

Many media attributes are not specific to any particular medium. The showing of colours, close-ups, texts, and graphic illustrations, for example, is not unique to the film or video medium only. Even the 35mm photographic colour slides have these attributes. More sophisticated attributes of motion and special visual effects can be incorporated in IF, IT and CAI lessons. Media attributes are not characteristics, and qualities that exist in one medium may be found in another. It is of no importance to compare media attributes as there is no correspondence between media and attributes. Since many media can present a given attribute, variables such as motion, colour, close-up, etc. are not media attributes any more than the texts and diagrams are attributes specific only to the textbook medium. Thus, it is misleading to refer to visual cueing effects created by zooming, flashing and highlighting as film attributes just because they appear in the film medium. A film lesson need not contain zooming if there is no need for zooming. Just like the texts and diagrams in a textbook, visual effect elements in a film or a television lesson allow us to create sufficient conditions to teach certain concepts and cognitive skills. They are not the essential variables that are particular to the learning of those concepts and cognitive skills.

So far, research on media attributes is unable to identify a visual effect element that bears an inherent general advantage in most learning situations. Neither motion (as against still visuals) nor colour (as against black-and-white) nor any other visual effect element has produced a significant overall positive effect on learning. The relative value of a visual effect element depends on the specific learning task involved. Thus, the use of motion appears to be effective only when the content or activity to be learnt entails motion (e.g., dancing, drama, sports and games, etc.). Many media with a similar variety of visual effect elements can be used to achieve the same learning objective. The visual effect element chosen for experimental treatment in a study does not have the most direct influence on learning. It is what the teacher or the media designer does (i.e. the teaching) that is important. Hence, it is unlikely that researchers will find learning differences that can be unambiguously attributed to any visual effect element of a medium.

Research on media attributes also has many problems that plague media comparison studies. The researchers have not asked the right questions when they focus attention on the so-called media attributes and mistakenly regard the learning acquired by students from the teaching conveyed through the media as learning benefits from the media. Furthermore, in using the ATI research design, it is extremely difficult to control the various non-media variables involved. In an experiment examining the effects of media attributes, only the attributes compared should be different. All the other aspects of the treatment including the non-media variables (subject-matter, instructional strategy, learning activities, etc.) must be identical.

Because so many media and non-media variables are involved, it is near to impossible to find interaction with the ATI approach in which a set of media attributes will consistently work for a well-defined group of learners. It is therefore not surprising that there is a proliferation of studies with inconsistent and uninterpretable findings. According to Clark (1983), studies on media attributes have not been able to demonstrate the validity and utility of media-content-student match. He has found no research evidence from his meta-analysis review to support the view that media attributes are a causal factor in student learning. As such, it may not be fruitful for researchers to go on exploring the effects of media attributes on learning.

Concluding Remarks

After more than half a century of effort, research directed at finding a link between media and learning has not paid off. Studies on media comparison and media attributes involving the use of IR, IF, IT, PI, MMI and CAI have not produced any conclusive evidence that media can teach. In using the tools of experimental psychology to conduct their research, media advocates have put all their energies to ensure that their procedures and rules are
correct. Their approach is "right", but the research questions they have hoped to answer are incorrect because they forget the real function of media.

Media are mere mechanical or electronic delivery devices and as such neither the devices nor their visual or sound effect elements can teach. Learning is the result of how students respond to the subject-matter and the instructional methods of the teacher conveyed through the media. In education, media have many useful functions as vehicles for delivering instructions. They can amplify sound, enlarge or reduce visual illustrations, repeat the information presented by a teacher in exactly the same manner, show the movement of an extremely fast action in slow motion or hasten the speed of an extremely slow process, and produce many special visual effects. But they cannot cause learning to happen.

As past and current efforts in research on educational media have not yielded beneficial results, there is a need for change. Future research should focus on studies with media rather than on media. Since the improvement of learning in student is the main concern, researchers should focus attention on the kinds of instructional contents and activities that could be efficiently conveyed through the media; for instance, a study comparing the effects of step-size of text organisation via PI, IT or CAI is research with media and not on media. It is the step-size of text organisation which is the focus of research and not PI or IT or CAI. There are many aspects of teaching and learning which can be researched on with media. In conducting research in areas such as information sequencing, explaining, questioning, note-taking responses of students, and so forth, media have to be used as a delivery device to control the many factors that are likely to vary in a teaching-learning situation.

What has been discussed in this paper summarises a somewhat uncomfortable position concerning research on educational media. This does not mean that media are useless for instructional purposes. The traditional chalkboard, textbook and overhead projector have, despite their obvious limitations, successfully augmented the instructional efforts of teachers. Likewise, the newer electronic media, especially video and the computer, will, if properly utilised, continue to help teachers improve their instructional efforts. The Open University in the United Kingdom and many other universities elsewhere are utilising the various media efficiently to deliver instruction to off-campus students. The key to instructional improvement by media is through their augmentation of the teacher’s efforts. It is what the teacher feeds into a medium and the manner he presents it through the medium that teaches. The medium only delivers the instruction as intended — no more and no less.

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