

ALTERNATIVE INSTRUCTIONAL STRATEGIES
FOR LOW-LITERATE ADULTS:
THE EFFECTS OF STATIC AND DYNAMIC VISUALS ON LEARNING

By

Bruce B. Cohen

Dissertation

Submitted to the Faculty of the
Graduate School of Vanderbilt University

in partial fulfillment of the requirements

for the degree of

DOCTOR OF PHILOSOPHY

in

Teaching and Learning

August, 2007

Nashville, Tennessee

Approved:

Professor Leona Schauble

Professor Victoria Risko

Professor Clifford Hofwolt

Professor Beth Conklin

ACKNOWLEDGEMENTS

This study is dedicated to my many friends in developing nations who inspired this initiative and those at Vanderbilt University and The National Institutes of Health who provided academic, material, and financial support for this study. In particular, I want to thank Professor Leona Schauble and the members of my dissertation committee, Professors Neal Nadler, Robert Innes and Peter Reed at Vanderbilt, Drs. Alexa McCray and Craig Locatis at The National Library of Medicine and colleagues and friends who have had offered words of encouragement for more than a decade.

This study would not have been possible without the generous contributions of countless individuals and organization including Geny Castro for her on-camera talent, Elena Morales for recording the narration in Spanish, Elo TouchSystems for the touch screen monitor, Pella Windows and First Alert for items used in the testing phase of the study, Dazzletech for assisting with Flash programming, Centro Familia, CASA de Maryland, and the owners and staff of Value Village for providing space in which to conduct the study. To each and every one, as well as the 90 participants in the study, I express my heartfelt gratitude. Thank you for your skills, your ideas, and your enthusiasm.

“Never doubt that a small group of thoughtful, committed people can change the world. Indeed, it is the only thing that ever has.”

-- Margaret Mead

TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENTS.....	ii
LIST OF TABLES	v
LIST OF FIGURES	vi
Chapter	
I. INTRODUCTION	1
Antecedents	1
Need for the study	3
Hypotheses	11
II. REVIEW OF RELATED STUDIES	16
III. METHOD	25
Participants	25
Procedure	28
Design of instruction	37
Assessment of learning outcomes	39
IV. RESULTS	45
Summary	60
V. CONCLUSIONS AND RECOMMENDATIONS	62
Scope of the study	62
Findings	63
Discussion	65
Implications	70
Recommendations for further research	72

Appendix

APPENDIX A: STORYBOARD IN ENGLISH	73
APPENDIX B: NARRATIVE IN SPANISH	92
APPENDIX C: TEST QUESTIONS AND DATA RECORD IN ENGLISH	97
APPENDIX D: STUDY DATA	99
APPENDIX E: PREVALENCE AND CORRELATES OF ILLITERACY	102
REFERENCES	103

LIST OF TABLES

Table	Page
1. Post hoc pair-wise comparisons of cumulative scores by modes of instruction	51
2. Post hoc pair-wise comparisons of cumulative scores by levels of education	52
D1. Scores of participants assigned to narrative only	99
D2. Scores of participants assigned to narrative plus stills	100
D3. Scores of participants assigned to narrative plus video	101

LIST OF FIGURES

Figure		Page
1.	Portable display device with capacity for 300 hours of audio, 100,000 still images, or 80 hours of video	10
2.	Examples of stepwise procedures, devoid of temporal conditions	13
3.	Examples of conditional procedures, as distinct from stepwise Procedures	14-15
4.	Cognitive load theory posits discrete auditory and visual channels in working memory	16
5.	Steps six, seven and completed Lego™ as examples of stepwise changes	20
6.	Photos shown to prospective participants to illustrate the topic of the presentation and venue of the study.....	26
7.	A touch screen monitor enabled participants to control the pace of the presentation without a mouse or keyboard	35
8.	Navigational buttons provided participants with a modicum of control over the pace of the presentation	36
9.	Satisfactory performance of the conditional procedure associated with door mat removal	43
10.	Portable, free-standing window used for testing, equipped with two pressure-sensitive switches in the sill	44
11.	Scatterplot of cumulative scores for all four categories of test items by mode of instruction	46
12.	Boxplot of cumulative scores for all four categories of test items by mode of instruction	47
13.	Distribution of cumulative scores for all four categories of learning by years of schooling	48
14.	Boxplot of cumulative scores by education level	49

15. Estimated marginal means of cumulative scores by education level and mode of instruction	53
16. Estimated marginal means for the recall of facts by education level and mode of instruction	55
17. Estimated marginal means for the recall of procedures by education level and mode of instruction	57
18. Estimated marginal means for the demonstration of procedures by education level and mode of instruction	58
19. Estimated marginal means for the demonstration of conditional procedures by education level and mode of instruction	59
20. Examples of illustrations with essential details and minimal distractions	67-68
21. Portable video displays adaptable for use in developing countries to expand the educational options of underserved adults	71

CHAPTER I

INTRODUCTION

Antecedents

After teaching in developing countries for more than a decade, I returned to the United States to determine the feasibility of using computer technology to instruct countless millions of underserved illiterate adults. My interest was piqued by the question of a Kenyan woman in her 30s who asked, "How can I avoid having a seventh child?" Within minutes of talking with her, I realized that she had a very limited understanding of human reproduction or her options for avoiding pregnancy. Furthermore, she had completed only two years of schooling and was unable to read a text-based brochure. "How," I asked myself, "could she access the information she was seeking except on a one-to-one basis or in small groups -- since the personnel and financial resources to support face-to-face teaching are simply not available in most developing nations?"

Subsequently, I asked several other women from Latin America and the Caribbean about the number of children they would like to have had; and their response was another wakeup call. Typically they had five to six children, but their ideal number of children was almost always the same: three. More often than not, one reason they gave for having had more children than they would have liked was the unmet need for information on contraception in the villages of their youth; and this unmet need reinforced my determination to find strategies to

instruct adults in developing countries, especially those who cannot read or are isolated in villages.

Notwithstanding the fact that family size is a function of many other factors (e.g., the need for additional “hands” on farms, religious prescriptions and proscriptions, willingness/reluctance of males to use condoms), all of the women with whom I spoke said that prior knowledge of contraceptive methods might have at least enabled them to delay the birth of their first child and spaced the birth of subsequent children. Studies indicate that delaying the birth of their first child, in turn increases the likelihood that girls remain in school longer; and spacing subsequent children reduces the debilitating effects of continuous child-bearing (Guttmacher, 2004).

Determined to find a way to meet the need for information not only about contraception but also about health generally, I began in 1992 to contact universities in a search for individuals studying the use of interactive multimedia for instructional purposes. Ultimately, a colleague directed me to Vanderbilt where work was underway on the use of videodiscs -- albeit for math education in a formal educational setting. Upon completion of my coursework at Vanderbilt, I accepted a Fellowship at The National Institutes of Health, facilitating public access to health information and initiating research on the use of multimedia for health education among adults who have access to the internet but only a limited ability to read in the language of instruction. Whereas the Fellowship afforded me the opportunity to explore the potential of computer and video technology to meet the needs of these adult learners, it also convinced me that little research is

being devoted to the use of this potential for meeting the instructional needs of adults in developing countries, especially those who cannot read -- hence this study to assess the feasibility of informing and instructing adults by means of multimedia presentations comprised of either static or dynamic images, accompanied by recorded narration in lieu of text.

Need for the study

This study is dramatically different from the preponderance of studies on non-formal education for adults, which rarely focus on instructional strategies and learning outcomes per se (Pratt, 1993; Moulton, 1977). For the most part, studies of non-formal education – especially in developing countries – are ethnographic studies based on anecdotal reports to assess participation rates in literacy programs, for example, and the impact of those programs on women’s empowerment and economic development. Whereas these studies are essential for identifying factors affecting a learner’s interest and public acceptance, they provide little guidance to instructional designers as to strategies best suited to convey distinct types of educational content, especially educational content intended for low-literate adults.

Although this study has its origins abroad, health educators and instructional designers are faced with the same challenges in the United States with low-literate adults who, as patients or care givers, frequently encounter problems of access, comprehension, and shame when seeking health information (Parikh, Parker, Nurss, Baker, & Williams, 1996). Typically, text-

based materials available to the general public require reading skills and levels of comprehension that far exceed those of low-literate adults (Jubelierer, 1991; Miles & Davis, 1995). In response to evidence that the reading level of patient education materials exceeds the reading ability of many patients, the National Cancer Institute of the National Institutes of Health initiated numerous studies to address the problem patients have understanding consent forms, discharge instructions, and similar directives (Mayeaux, Murphy, Arnold, Cavis, Jackson & Sentell, 1996). Findings indicate that part of the solution is to re-write brochures at a 4th or 5th grade reading level which, unfortunately, often results in their being so elementary as to render them only marginally useful (Powell, Tanz, Uyeda, Gaffney, & Sheehan, 2000). Moreover, text-based materials, by their very nature, are inaccessible to those who cannot read at all.

As an alternative to text-based material, radio is a viable medium of communication with low-literate adults insofar as it does not presuppose the ability to read. In developing countries, radio has been used effectively in health campaigns to raise public awareness of the threat HIV/AIDS (Jato, et al., 1999), to promote breastfeeding and pre-natal care (BASICS, 1998), encourage husbands and wives to discuss family and health issues with one another (Storey, Boulay, Karki, Heckert, & Karmacharya, 1999). Although AM/FM and shortwave radios are prevalent in homes of the poor in even the most remote villages (Leh & Kennedy, 2004), radio requires the listener to construct mental images and is therefore limited as an instructional medium since words alone are often ambiguous with respect to space and time.

Film and television as instructional media, on the other hand, enable the spoken word to be combined with drawings, photographs, animations, and full-motion images. To the extent that recorded narrative or dialog is employed instead of text, film and television circumvent constraints imposed by a low-literate learner's difficulty decoding and understanding text. Film and television as dynamic media have the added advantage of being able to illustrate spatial and temporal changes inherent in actions, processes, and physical transformations which learners may otherwise be unable to construct from presentations that rely exclusively on oral or text-based instruction (Greenfield; 1984). Accordingly, film and television enable instructional designers to deliver content with a combination of verbal descriptions and visual depictions as appropriate, supported by research that the choice of instructional medium can indeed affect learning (Mousavi, Low & Sweller, 1995; Cobb, 1997; Clark & Mayer; 2003).

Film and television, however, are costly to produce and deliver – especially to remote villages where large numbers of low-literate adults live. Nevertheless, the allure of film and television is evidenced by the millions of low-literate adults in India, for example, who pay to watch films. Witness also the television antennas above the humble homes in the favelas of Rio de Janeiro and barrios of Mexico City or private clubs that play video tapes and DVDs in areas where television transmission is not available – indications of the extraordinary popularity of film and video across socio-economic classes, ages, and regions.

Beginning in 1967, television producers and educators leveraged the popularity of film and television in developing countries as a means of social marketing for adults generally, including low-literate adults – a strategy referred to as “entertainment-education,” based largely on the social learning theory of Albert Bandura (1964) and the commercial television productions of Miguel Sabido (Singal & Rogers, 1999). Inspired by the success of the first *telenovelas* with pro-social themes, Sabido produced a television series to promote family planning in Mexico, using dramatic scenarios to depict protagonists making wise decisions for themselves and others, with little emphasis on the underlying facts or rationale. While there is research to suggest that the use of film and television has encouraged audiences to emulate positive role models and thereby dispel erroneous beliefs about sex and avoid behaviors that may adversely affect one’s health (Kane, Gueye, Speizer, Pacque-Margolis, & Baron, 1998), there has been little research on the use of film and television for instructing low-literate adults in particular. Low-literate adults are indeed included in the target audiences of the health education campaigns, but the effects of film and television on low-literate adults per se are not the focus of the research. Rather, the focus of the research on health campaigns that employ education-entertainment is on the extent to which the campaigns resulted in attitudinal changes among the audience generally; and sparse attention is devoted to the determination of whether the medium itself as an instructional strategy facilitates or impedes the comprehension of educational content by low-literate adults (Sherry, 1997).

At approximately the same time that health educators were beginning to employ education-entertainment abroad, the Children's Television Workshop was beginning to incorporate the principles of entertainment-education in *Sesame Street* and other innovative productions in the United States. Children's educational television, however, went far beyond the serialized *telenovelas* to impart age-appropriate knowledge and skills, revealing in study after study (Fisch, 2004) the potential of television to promote not only attitudinal and behavioral changes among viewers but also the acquisition of declarative knowledge (i.e., facts including "what", "why", and "when"), spatial knowledge (i.e., "where"), and procedural knowledge (i.e., "how") among the target audience. The benefits of television as a medium of expository instruction were evidenced, for example, in the research of Mielke and Chen (1981), undertaken to assist in the design and production of *3-2-1 CONTACT* for an audience 8-12 years of age. Their research yielded several findings of importance to the re-design of *3-2-1 CONTACT*, including the following:

- information presented visually was recalled better than information presented aurally;
- abstract ideas presented by "talking heads" had little appeal and elicited low levels of recall or comprehension; and
- viewers fixated on static images during extended verbal explanations and typically failed to attend to what was being said.

Other studies of children's educational television also identified exposure to television (Salomon, 1977) and prior knowledge (Clifford, Gunter, & McAleer,

1995) as predictors of learning outcomes; but it is unclear from the literature whether there is a basis for generalizing these findings to adults and even less clear whether television can impart knowledge and skills to adults with little formal education. It is also difficult to ascertain how much of the variation in any given study is attributable to the modality of instruction and production techniques, how much to formal education, and how much to differences with respect to the content of instruction – considerations this study attempts to address, as they are all relevant to the design of instruction for adults with minimal schooling and limited exposure to instructional television.

In recent years, Mayer and colleagues (Mayer, 2001; Mayer, Heiser, & Lonn, 2001) conducted numerous studies to assess the merits of alternative instructional strategies for adult learning via computers and the internet; and it is on the basis of their work that this study builds. In general, their findings suggest that learning is enhanced when instruction is presented simultaneously in two complementary media rather than any one medium alone. Although plausible and potentially relevant to the design of instructional material for low-literate adults, their studies invariably included highly literate participants, as text-based instruction was one of the modes of instruction under investigation, raising questions once again as to whether the findings are applicable to adult learners a limited ability to read.

This study, therefore, purposely precluded text-based instruction as one of the instructional strategies under investigation and attempted instead to reveal the circumstances in which oral narrative alone, oral narrative plus still images,

and oral narrative plus video provide genuine learning advantages for participants, including those with a limited ability to read. Since video is far more costly to produce and deliver than still images, however, this study was designed to determine when stills are as effective as video and when video is superior to stills. Given the added expense, common sense suggests that educators employ video only if there is evidence that it affords significant advantages over stills images in the instance under consideration.

To that end, this study distinguished among four categories of learning outcomes. The first entailed the oral recall of facts; the second entailed the oral recall of procedures, the third entailed a demonstration of stepwise procedures (i.e., actions to be taken as a series of discrete steps), and the fourth entailed a demonstration of conditional procedures (i.e., actions to be taken only when specified conditions are met). Having made these distinctions, it was in turn possible to determine with greater specificity when video was and was not warranted.

This study, however, is only the first phase in an initiative to empower low-literate adults with knowledge and skills they may not otherwise be able to acquire because of their limited ability to read, using a method of delivery similar to the display device illustrated in Figure 1.



Figure 1 Portable display device with capacity for 300 hours of audio, 100,000 still images, or 80 hours of video. Pictured are three of the 90 women from Central and South America who participated in the study.

This phase of the study was to identify the relative advantages of dynamic images accompanied by an audio narrative over static images accompanied by the same narrative and reveal the circumstances in which dynamic images provide a genuine learning advantage, applicable to the design of instructional materials for low-literate adults both in the United States and abroad (Miles & Davis, 1995; Weiss & Coyne, 1997). Given the convergence of audio-video and computer technologies, accompanied by a decline in the costs of production and delivery of instructional media, it is reasonable to imagine the findings of this investigation being applied to the design of multimedia presentations for underserved populations.

Hypotheses

From a review of the literature, three plausible hypotheses emerged.

1. Instruction using two modalities can enhance learning outcomes when auditory and visual information are complementary.

Advocates of the cognitive load theory contend that modes of instruction can be combined to enhance learning. The basis for this premise is presented in the following chapter, but their contention in essence is that learning occurs more readily when the cognitive demands on learners are distributed rather than singular. Their studies suggest that two modes of instruction, employed correctly, can increase cognitive efficiency. They caution that two modes of instruction are not inevitably better than one if they both place demands on the same cognitive resources. The two should be mutually reinforcing, each using a separate channel in working memory. Otherwise, they contend, the cognitive load will increase and learning will be impaired. Given that oral narrative was combined with still images in one case and with video in another, the cognitive load theory suggests that narrative plus stills or narrative plus video are potentially superior to narrative alone.

2. Depending on the level of schooling, participants will learn differentially from each of the three modes of instruction.

Again, studies by advocates of the cognitive load theory suggest that learning outcomes differ not only with respect to the instructional media employed but also the characteristics of the learner. Whereas their studies

assess learning outcomes as a function of a learner's prior knowledge, and this study assesses learning outcomes as a function of a learner's level of education, the presumption is that some learners will benefit more and some will benefit less from a given combination of modes of instruction, depending on important characteristics of the learner.

3. Depending on the category of learning, participants will learn differentially from narrative only, narrative plus static images, and narrative plus video -- with evidence for the superiority of dynamic images over static images on measures of conditional procedures.

Facts, by their very nature, are static so it was reasonable to assume that video would not afford an advantage over stills for recalling facts. Procedures of any kind, on the other hand, are dynamic to some degree and thus may be portrayed and recalled more effectively when presented as a video rather than a series of stills. With respect to the recall of procedures, however, as opposed to the demonstration of those same procedures, the task participants were asked to perform was essentially naming. Thus, it seemed reasonable to assume that video would not afford an advantage over stills for either the oral recall of facts or the oral recall of procedures.

The third and fourth categories of learning outcomes were different from the first and second in that they required participants to demonstrate rather than recall what they had learned. Testing in this case entailed the manipulation of equipment and objects similar to those in the presentation to ascertain a participant's ability to perform tasks in a real-world context as distinct from only having to describe them orally.

Moreover, the third and fourth categories were distinct from each other in that the third category required participants to demonstrate stepwise procedures and the fourth required them to demonstrate conditional procedures. Insofar as stepwise procedures are comprised of a sequence of discrete actions, it was assumed that video would not afford an advantage over stills. Stepwise procedures, such as the examples in Figure 2, include no temporal conditions and minimal spatial conditions which, it is assumed, can be adequately illustrated in a static image or series of static images without the need for the learners to view changes as a function of time.

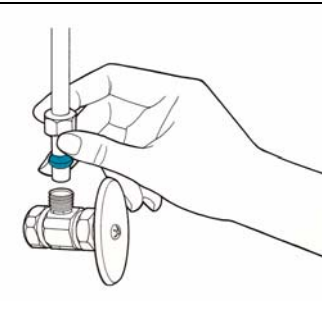
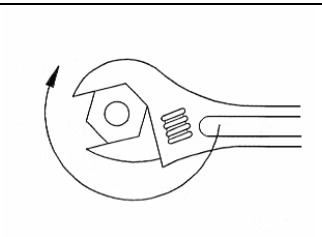
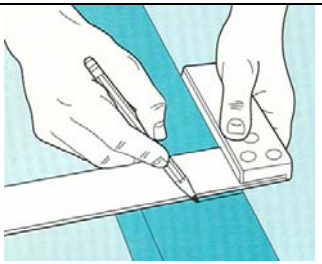

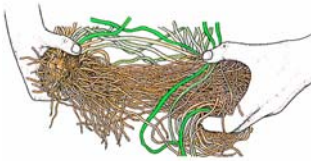


Procedure	Narrative	Visual
Assembling objects with multiple steps	Slip the flange nut onto the tube, followed by the compression ring. Insert the tube into the fitting, and screw the nut down until it is hand-tight.	
Performing a procedure with structural and functional conditions	Orient the wrench so pressure is applied on the fixed jaw and tighten the jaw against the nut or bolt.	
Performing a procedure with two spatial conditions	To mark a line at 90 degrees to an edge, press the handle flush against the edge with the blade flat on the surface.	

Figure 2 Examples of stepwise procedures, devoid of temporal conditions.

Conditional procedures, on the other hand, are procedures to be completed under specific conditions, for example, for a specified duration, with a certain force, or with continuity of motion – examples of which are illustrated in Figure 3. In the case of conditional procedures, unlike the other three categories, video was assumed to offer a compelling advantage over stills because of the ability of video to convey temporal and spatial information dynamically among elements in the video.

Procedure	Narrative	Visual
Performing a procedure with one spatial condition and one temporal condition	To check the pulse of an infant, gently press with two fingers on the artery in the infant's arm and count the number of heartbeats in 15 seconds.	
Performing a procedure with two spatial conditions and a temporal condition	Divide tuberous plants by gradually pulling and twisting simultaneously.	
Performing a procedure repeatedly with temporal and kinetic conditions	Give quick, repeated thrusts, compressing the chest 3-5 cm.	
Performing a procedure with continuity of motion	Start with the knife in a vertical position, bringing it down in a smooth arc while holding the blade at a constant 20 degree angle to the steel.	

(figure continues)


Procedure	Narrative	Visual
<p>Performing a procedure with spatial and kinetic conditions</p>	<p>With your three middle fingers, start in your armpit making circular motions 1 cm in diameter. Use light pressure to feel for changes in your skin; medium pressure to feel changes below the surface; deep pressure to feel changes closer to your ribs.</p>	

Figure 3 Examples of conditional procedures, as distinct from stepwise procedures.

CHAPTER II

REVIEW OF RELATED STUDIES

This study of the relative advantages of static and dynamic images stems from work on cognitive load theory posited by Sweller (1988) and subsequently by other investigators engaged in the design and evaluation of multimedia instruction (Sweller, Van Merriënboer, & Paas, 1998; Mayer, 1989; Mayer & Gallini, 1990; Mayer 2001). Cognitive load is a construct that refers to the mental resources in working memory required moment by moment as we are engaged in various mental tasks. Proponents of the cognitive load theory refer to a model of working memory derived from the work of Paivio (1971, 1986) and Baddeley (1992) which presupposes, based on an information-processing paradigm illustrated in Figure 4, that we have two systems for processing auditory and visual information.

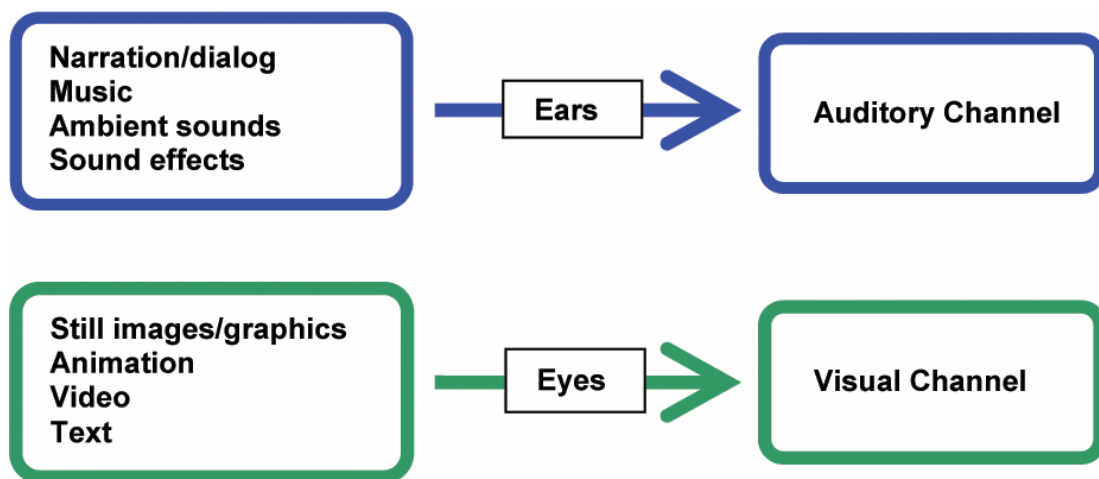


Figure 4 Cognitive load theory posits discrete auditory and visual channels in working memory.

One premise of this model of working memory is that the two systems are dichotomous in the sense that demands on one do not normally impinge on the other (i.e., discrete parallel processors). A second premise is that the capacity of each channel is limited. Although the capacity or temporary cache of each system is limited, proponents of the cognitive load theory suggest that increasing the flow of information through a learner's auditory channel does not, in turn, reduce the learner's capacity for simultaneously acquiring visual information. Under normal circumstances, there is not an adverse spillover effect from one system to the other. A third premise is that verbal and visual representations are qualitatively different and not direct substitutions for one another (Mayer, 2001).

Thus, one implication of the theory is that instruction using both modalities does not necessarily diminish learning (Pezdek & Stevens, 1984) and can, in fact, enhance learning when auditory and visual information are complementary (Steinberg, 1991; Lang, 1995). To be complementary, instruction in the second channel should be similar to the content in the primary channel and concurrent or otherwise very close in time. The challenge to instructional designers is to assure that the content in the auditory system reinforces the content in the visual system, and vice versa.

A second implication of the theory is that the judicious selection and integration of instructional strategies can enhance learning outcomes by reducing load on a learner's cognitive resources. Placing too much load on either system can adversely affect learning outcomes, analogous perhaps to an electrical load too great for the wires in a circuit, resulting in wasted energy and diminished

performance. A study by Watt and Welch (1983) is a case in point. Based on an investigation of children's educational television, they found that visual complexity generally impaired performance on tests of recall. Other studies suggest that there are instances when images of any kind impede learning (Chu & Schramm, 1967; Clark & Mayer, 2003) or simpler images are more effective than complex images when the task entails learning facts (Dwyer, 1978). The lesson for educators is to avoid distracting graphics (Dwyer, 1978) or extraneous words (Mayer, Heiser, & Lonn, 2001), first and foremost to reduce the load on the learner's working memory.

Intuitively, it is reasonable to avoid distractions because they divert our attention from the task at hand; but it is also useful to regard distractions as demands on our mental resources, per the cognitive load theory. This is a subtle but important distinction because it raises the question whether elements such as extraneous sounds, sprightly voices, bright colors, or superfluous motion add to a learner's cognitive load while viewing a multimedia presentation. If not, why not? Do we have a means of filtering out these distractions before they enter the visual or auditory systems in our working memory?

Indeed, there is some evidence in the literature that we have a means of attending to content as distinct from the formal features of production (Anderson & Lorch, 1983; Campbell, Wright, & Huston, 1987). For younger children, a common strategy is to turn away from the television between one and two hundred times per hour (Anderson & Field, 1983). Older children appear to filter out distractions perhaps using schemas (Anderson, 1980) or mental models (Jih

& Reeves, 1992) to make sense of instructional content as distinct from extraneous auditory and visual details and formal features of production, such as special effects and cameral angles. Were it not so, children would be unlikely to get past the “noise” introduced into programs expressly for the purpose of attracting and maintaining the viewer’s attention, and their visual and auditory channels would be constantly overloaded before any learning could occur. How this filtering process works is unclear, but the implication of the cognitive load theory is that filtering occurs by some means, be it by the viewer or, as may be necessary in the case of low-literate adults, by the instructional designer during the development of the presentation itself to reduce the cognitive load on the learner’s working memory.

In practice, this suggests that instructional designers could opt to incorporate static images in presentations when temporal information is not relevant to comprehension. An instance when this might be particularly valuable is when learning objectives are exclusively declarative, entailing memorization of an explicit fact. Another possible case is when the learning objective is exclusively spatial, as in Figure 5, or when it is unnecessary -- perhaps even distracting -- to note all the small changes in appearance and orientation that occur as these Lego vehicles are being assembled. What is important is not precisely how the pieces are held or turned but how they are finally placed. The toy developers expect that people can decide for themselves how to achieve these benchmark steps -- the goal being far more important than precisely how the goal is achieved.

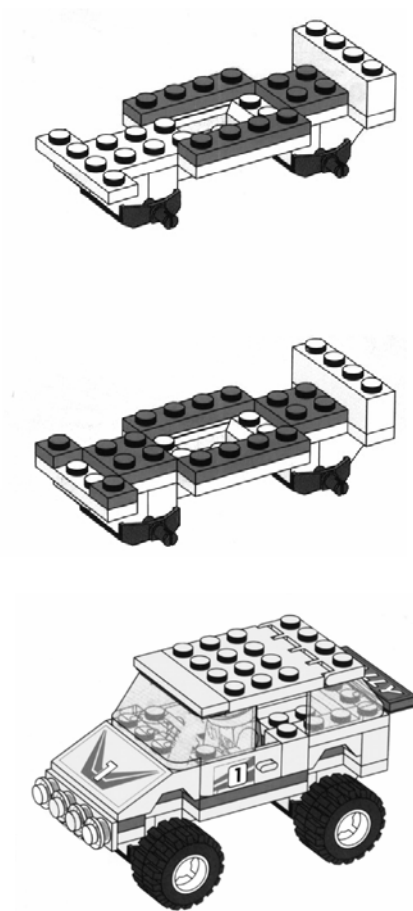


Figure 5 Steps six, seven and completed Lego™ as examples of stepwise changes.

On the other hand, in some situations dynamic images can facilitate comprehension in ways that static images cannot, as noted by Hochberg and Brooks (1966):

- They provide depth cues about three-dimensional space;
- They enable objects too large to be represented on the screen to be displayed through successive views; and
- They depict spatial and temporal changes.

Moreover, static images tend to isolate one characteristic of an object or procedure and let that one characteristic stand for the whole, which is not conducive to comprehensive understanding (Arnheim, 1969).

Empirical evidence of the educational benefits of dynamic images is also manifest in studies on the instructional applications of animation. On the basis of a study of children ages five and seven, for example, Rydin (1979) found that Swedish children of both ages learned more about seed germination when they watched an animated film, compared to a series of still photos, even though both versions were accompanied by an explicit narration. Whereas comprehension and retention were consistently lower among the younger children regardless of version, the older children clearly benefited from the temporal information included in the animation to make sense of the process of germination. In a similar study in England, children who watched a full-motion film versus a series of stills had greater success assembling a multi-level, pyramidal puzzle that required them to move, rotate, and fit 21 blocks of various sizes (Murphy & Wood, 1982).

Other examples abound in the literature (Mayer & Anderson, 1991), although there are also many studies comparing static and dynamic images in which no significant effect or mixed effects were found. Wetzel, Radtke, & Stern (1994), for example, cite several studies which found no effect or mixed effects when comparing the effectiveness of static graphics and animation for teaching about the physiology of the human heart, geometric shapes, and the Newtonian

laws of motion. Motion, in these instances, apparently did not enhance comprehension or otherwise add value to instruction.

Of special interest, however, is another study conducted by Blake (as cited in Wetzel, et al) who used animation as a cuing device for learning the movements of chess pieces. In Blake's study, participants viewed static images, static images enhanced with animated arrows, or a full-motion presentation. Participants with high spatial aptitude performed equally well in all three conditions. Those with low spatial aptitude, however, performed better with both animated and full-motion presentations than with the static materials. Might this distinction also apply to adults with little formal education, such as the participants who took part in the present study?

Perhaps the improved performance of those with low spatial aptitude is merely an "artifact" of motion in the sense that the animated arrows functioned merely as cues, directing the viewer's attention, but nothing more. Perhaps viewers with low spatial aptitude were not skilled at inferring and mentally visualizing the motion that the arrows were meant to imply. In any case, research on spatial aptitude or visual literacy in general suggests that comprehending graphic information requires mastering a multitude of conventions, including "the ability to comprehend and create visuals in a variety of moving and non-moving media to communicate effectively" (Adams & Hamm, 1989, p. 36). Buttolph & Branch (1992) deal with visual literacy as a function of the characteristics of the learner and type of information to be conveyed, the premise being that some visuals are more effective for some learners than others

and images are appropriate for some types of content and not others – as evidenced in a study by Mackworth and Bruner (1970) who concluded that children tend to have difficulty scanning images for salient features, making far more eye movements than mature adult viewers. Zimmerman (1996) concludes from work with low-literate adults that visual literacy does not develop automatically as we mature. Adults with no prior exposure to illustrations, for example, may have difficulty distinguishing between foreground and background, or understanding depth cues, motion, or the passage of time (Holmes, 1963; McBean, 1989), but with a modicum of effort and patience, visual literacy can be learned in three stages (Haaland & Fussell, 1976). First, novices learn to interpret the separate elements in a picture, then to interpret the situation depicted in the picture (i.e., how the elements fit into a coherent schema); and finally, to interpret a sequence of pictures. The lesson that emerges is that visual literacy can be learned, but instructional designers should not take it for granted, especially among adults with little formal schooling who may react to images in unexpected ways.

So, too, should instructional designers be cognizant of the limits of dynamic visual representations, employing animation or video only when they are congruent with the learning task (Reiber, 2000), as the literature provides evidence that dynamic images can facilitate learning in some instances but not in all instances. On the one hand, dynamic images can provide more support than still images for constructing mental models (Brandsford, et al., 1996), and watching video with a purpose can be conducive to active learning (Cognition

and Technology Group at Vanderbilt, 1997). On the other hand, fast-paced image changes can lead to a low state of alertness (Healy, 1990) or hypnotic, trance-like state (Wagschal, 1987) – consistent with the cognitive load theory, which predicts that learning will be diminished if the learner’s capacity to process the visual information is exceeded.

CHAPTER III

METHOD

Participants

Participants included 90 adult women from low-income communities of Washington DC and Maryland, cities with a preponderance of houses and apartments built before 1978, when lead was routinely used as a paint additive. Participants were recruited in these urban and suburban communities from among Spanish-speaking adults, regardless of years of schooling. Recruitment was undertaken in cooperation with Centro Familia and CASA de Maryland, grassroots organizations working closely with immigrants primarily from Mexico, Central, and South America. To be included in the study, participants were required to be 18 years of age or older and a native speaker of Spanish. Proportionally, the distribution of countries of origin was Peru 31 percent, El Salvador and Nicaragua 14 percent each, Honduras 11 percent, Mexico and Guatemala 9 percent each, Bolivia, Columbia, The Dominican Republic, and Panama 3 percent each. Each of the 90 women who participated in this study did so individually.

Participants were recruited in four locations: a day-care program as mothers arrived with their children, an employment center as day laborers waited work assignments, a senior center, and a thrift shop as shoppers perused merchandise. Overall, approximately 40 percent of those invited to participate

eventually opted to participate. There was almost 100 percent participation among women at the day-care center, employment center, and senior center. Those at the thrift store, however, participated at a far lower rate, contending that they had to return to work or otherwise had only enough time to shop.

Prospective participants were approached personally by the researcher. Each was asked initially if she spoke Spanish and, if so, whether she would like to participate in a study of strategies for teaching and learning. Those who wanted to know more were then shown the two photos in Figure 6 and told that they were being invited to learn about lead in older homes, that the presentation was entirely in Spanish on a monitor similar to a television and did not involve reading. If they expressed interest in participating, they were informed that the study would last 30 minutes for which they would receive \$10.



Figure 6 Photos shown to prospective participants to illustrate the topic of the presentation and venue of the study.

All who indicated interest in participating were directed to the study venue, seated in front of the monitor, and asked to listen to the following recorded segment in Spanish to inform them again of the purpose of the study, invite any questions, and await their consent:

You are invited to participate in this study, conducted by Mr. Bruce Cohen. It is a study of strategies for teaching and learning. If you decide to participate, you will receive \$10 for your participation. It will be entirely in Spanish and take 30 minutes. Each will participate individually, and you can decide to leave the study at any time.

The presentation Mr. Cohen has prepared pertains to the hazards of lead and steps you can take to protect your family from lead in an older house. The presentation includes an oral narration in Spanish, so it does not matter if you can or cannot read. If you decide to participate, Mr. Cohen will ask several questions at the conclusion of the presentation to determine what you learned.

If you would like to participate, please indicate your intentions to Mr. Cohen. Thank you.”

The presentation paused at the conclusion of the invitational segment and proceeded to the instructional segments only after each participant explicitly consented to participate in the study. Whereas 93 consented, two dropped out after receiving calls on their cell phones and one was asked to leave when it became apparent that she was under the influence of alcohol.

As noted previously, this study was designed to investigate instructional strategies effective for use with low-literate adults in developing countries, but participants were not selected on the basis of their ability to read. Instead, at the conclusion of each session, participants were asked to self-report how many years of formal schooling they had completed as the basis for subsequent analysis. Admittedly, years of formal schooling is not necessarily a measure of one's ability to read, only a rough estimate or proxy for literacy for the purposes of the study.

Procedure

As participants were recruited, each was assigned to one of three variations of a presentation employing alternative modes of instruction as experimental conditions:

- Narrative only (n = 29)
- Narrative plus still images (n = 33)
- Narrative plus video (n = 28)

Assignment of participants to each treatment condition was based on the output of a random-number generator included with Triola statistic textbooks from Addison-Wesley. On a typical day, three to five participants took part in the study, one at a time, requiring approximately 30 minutes from start to finish.

The audible component of the presentation was identical for all participants, regardless of the treatment condition to which they were assigned, presented as an oral narrative in Spanish, divided into 11 segments, in this order:

1. INTRODUCTION:

This presentation is about the danger of lead in older houses and steps to reduce the risk to infants and young children.

Today, the main sources of lead in older houses are lead-based paint and lead used in plumbing.

Lead-based paint was used in houses built before 1978. If the paint is not in good condition, chips fall to the ground and produce dust. If an infant or young child inhales or ingests this dust, it can cause problems with hearing, learning, and behavior (such as hyperactivity).

In the past, lead was also used to join sections of water pipes. If this lead were to contaminate water for cooking and drinking, it could also cause problems with hearing, learning, and behavior.

Remember: Lead is poisonous to infants and young children, even in small quantities.

2. PLACING MATS:

One thing you can do to reduce lead dust in your house is to place rugs at every door to the outside. It is important to place rugs not only at the main entrance but also at any door to the outside and the door to the garage.

The purpose of the mats is to collect lead dust from paint on the outside of the house.

Whenever possible, place a mat on both sides of every entrance, . . . inside . . . and outside.

3. WIPING SHOES:

Ask family members and visitors to wipe their shoes on the mats every time they enter from outside.

Insist that they wipe each shoe at least twice, once on each mat. More times is better to reduce the dust on their shoes.

4. PREPARING A SPRAY BOTTLE

To reduce lead dust when cleaning your house, it is useful to prepare a spray bottle.

Add one spoon of dishwashing detergent to an empty one-liter bottle.

Add hot water. In the United States, the hot water tap is on the left.

Let the water run until you feel hot water.

Secure the cap . . . and shake until the detergent is dissolved.

5. REMOVING DOORMATS:

Use doormats for no more than two months before replacing them.

To minimize the spreading of dust, lightly mist the door mats.

Fold each mat inward to trap the dust, and then roll the mats as tightly as possible.

Place each mat in a thick plastic trash bag for disposal.

6. VACUUMING CARPETS:

In a house with carpets, use special techniques for vacuuming to reduce lead dust.

Lead dust is heavy and settles deep in carpets.

Therefore, you should vacuum very slowly . . . three times more slowly than normal.

And do it in at least three directions.

Remember: The more you vacuum, the more lead dust you will pick up.

7. WASHING HANDS:

Another measure is to wash any lead dust from your hands before preparing food for infants and young children.

Wash with warm water and soap for at least 20 seconds . . . the time it takes to sing “Happy Birthday”.

8. DRAWING WATER FOR COOKING AND DRINKING:

In case lead was used to join the pipes in your house, use water for cooking and drinking only from the cold water tap. The reason is that cold water dissolves lead less than hot water. In the United States, the cold water tap is on the right.

Another precaution is to let the water run if the cold water tap has not been used for several hours. In this case, let the cold water run for 20 seconds or until you feel the water get cold.

9. CLEANING WINDOW WELLS:

If your windows are painted, paint chips and lead dust often accumulate in the window well, within easy reach of children.

In this case, it is essential to clean the window well thoroughly.

First, vacuum the window to remove the paint chips.

Then spray the window well with the mixture of water and detergent.

Tear off a piece of paper towel . . . and use the paper towel to wipe up as much dirt as possible without turning the paper towel.

Since lead dust can be difficult to dislodge, you must apply pressure when you wipe, to remove as much lead dust as possible.

When you've cleaned up a small area with one paper towel, put it into a plastic trash bag and start with a new towel.

Continue using new pieces of paper towel until the window wells are thoroughly clean.

10. TESTING BLOOD:

Even if children appear healthy, they may have toxic levels of lead in their blood. The only way to know for sure is take them to a clinic to have a simple blood test.

Most communities in the United States have a clinic that will test your child free of charge.

11. TESTING FOR LEAD-BASED PAINT:

To test for lead on a painted surface, obtain a test kit from a hardware store. The kit contains liquid in a small vial and a cotton swab.

Remove the cap from the glass vial and dip the cotton swab into the liquid.

Gently rub the surface to be tested with the tip of the cotton swab for 20 seconds.

If the painted surface or tip of the cotton swab turns yellow, or brown, or black, lead is present. If there is no change of color, no lead is present.

Participants controlled the pace of instruction, which was delivered by a touch-screen monitor donated by Elo TouchSystems, illustrated in Figure 7. Use of a touch screen interface precluded the need for a mouse or keyboard to navigate from segment to segment, which might have been intimidating for anyone unfamiliar with computers. All 90 participants, including those assigned to the narrative-only version, used the touch screen monitor with built-in speakers.



Figure 7 A touch screen monitor enabled participants to control the pace of the presentation without a mouse or keyboard.

For participants assigned the narrative-only version, the screen was blank for the entire presentation except for navigational arrows at the bottom of the screen. Components of the three versions of the presentation were assembled and delivered as an Adobe Flash application, providing participants a level of interactivity using the touch-screen interface that otherwise would not have been possible.

Each of the three versions of the presentation included a REPLAY and CONTINUE button to provide learners the option of replaying a given segment or continuing to the next segment, as illustrated in Figure 8. The REPLAY button, represented by a red arrow pointing to the left, enabled participants to repeat the consent statement or any of the segments of instruction. Similarly, the CONTINUE button, represented by a green arrow pointing to the right, enabled participants to continue directly to the next segment or pause between segments to process what they have heard and seen. An audible tag sounded at the conclusion of each segment to alert participants to the fact that the program awaited their input.

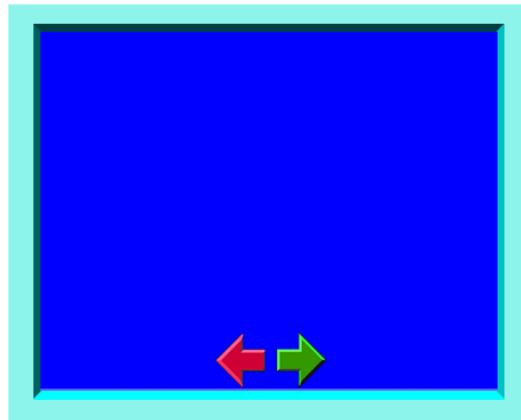


Figure 8 Navigational buttons provided participants with a modicum of control over the pace of the presentation.

None of the 90 participants had prior experience with computers and most appeared apprehensive initially when asked to navigate from instructional segment to segment by touching the monitor screen. Within one or two

segments however, most were at ease with the process. In only two cases did it take slightly longer for participants to become adept at navigating via touch.

Total duration of the 11 segments was 14 minutes, a function of the oral narrative which did not vary in duration among versions. Immediately after the presentation, participants were tested as described below, a process which required an additional 12 – 14 minutes. Participants were then asked to self-report how many years of school each had completed and country of origin. Finally, each was paid a stipend of \$10.

Design of instruction

To provide instruction relevant to those who would be participating in the study, a topic was selected for the presentation that addresses a real-world problem, namely, the hazards of lead and measures parents can employ to reduce the risk of lead poisoning in houses and apartments built before 1978. Eliminating lead from gasoline and paint greatly reduced exposure of the public in general to the toxic effects of lead, but exposure to lead persists in the paint and pipes in many older homes in the United States occupied by immigrants from Latin America, the adults included as participants in this study.

Guided by the study's hypotheses, the presentation instructed participants with respect to both facts and procedures for mitigating the hazards of lead-based paint. Accordingly, instructional objectives included being able to recall the effects of lead poisoning and to demonstrate procedures for mitigating exposure to lead in the home (e.g., washing hands for 20 seconds, vacuuming

area rugs in several directions and for longer than usual, testing painted surfaces for lead). Whereas the facts are not esoteric and the procedures are not difficult to perform, the facts and procedures are specific to the task under consideration and were considered not to be common knowledge to prospective participants.

Instructional development was undertaken in close coordination with content experts from the Montgomery County, Maryland's Department of Health and Human Services Childhood Lead Poison Prevention Program. Other partners included The Center for Community Action for Primary Prevention (Baltimore, MD) and the Lead Safe Washington Program associated with the Department of Housing and Community Development (Washington, DC). Topics addressed included sources of lead exposure in the home and steps parents can take to reduce a child's risk for lead poisoning.

Three versions of the presentation were developed, one with narrative only, another with narrative plus stills, and a third with narrative plus video. Since the narrative would eventually comprise the foundation of all three versions of the presentation, it was imperative that the narrative be carefully planned. Accordingly, over several months, the narrative was reviewed by content experts to assure accuracy and developed in colloquial English, with a conscious effort to employ simple sentences with concrete words and verbs that imply observable actions. The narrative in turn served as the framework for shooting and editing the 11 distinct instructional segments in full-motion video.

Video production employed a stationary camera with a minimum of panning and zooming. Editing was limited to cuts and dissolves between scenes

and fades at the beginning and end of each sequence. Children and adults appearing in the video are all of Hispanic origin in attempt to lend cultural authenticity to the images. Initially, the audio track included ambient sounds recorded with the video, for example, the sound of running water and whine of the vacuum cleaner. Subsequently, however, these ambient sounds were eliminated when pilot testing revealed that they distracted or confused participants in the version without images.

Upon completion of the video, individual frames were captured from the video and incorporated as the visual elements for the version with still images. (See Appendix A for the narrative in English with corresponding still images.) The instructional narrative was subsequently translated into Spanish, recorded, and incorporated into all three versions of the presentation, with a total run time of approximately 14 minutes. Pilot testing with women from Mexico, El Salvador, Peru, and the Dominican Republic revealed the need to revise the narrative several times to assure that it would be intelligible to prospective participants from throughout Latin America. (See Appendix B for the final translation of the narrative in Spanish.)

Assessment of learning outcomes

All participants were administered the same non-adaptive, criterion-referenced post-test. The challenge of developing valid and reliable measures of learning outcomes was compounded in this case by the fact that test questions and procedures had to be understood and answered by low-literate learners.

This precluded use of written test questions which, by the very fact that they are written, would be incomprehensible to subjects unable to read. Accordingly, testing was administered orally in Spanish in a one-on-one session immediately following the presentation to which the participant was assigned. See Appendix C for an English version of the instrument employed to record a participant's responses.

One point was assigned for each correct response, for a possible total score of 35, distributed as follows:

- Recall of facts (0-6 points)
- Recall of procedures (0-14)
- Mastery of stepwise procedures (0-6)
- Mastery of conditional procedures (0-9)

The following questions prompted participants to recall facts:

- According to the presentation, what materials used in the construction of an older house contains lead ?
[Answers: lead in paint (or paint dust) and solder (or water pipes or plumbing)]
- How does lead poisoning affect children ?
[Answers: affects intelligence (or academic performance), hearing, behavior (hyperactivity)]
- Why is it important to use cold water when preparing food or drink ?
[Answer: less lead]

The following questions prompted participants to recall procedures:

- According to the presentation, what are the steps you can take to protect children from lead in an older house ?

[Answers: place two mats at each entrance, wipe shoes when entering, remove mats when soiled, mix spray, wash hands before preparing food, wash hands with warm water, wash hands for 20 seconds, clean window sills, vacuum rugs in three directions, vacuum rugs slowly, use cold water for cooking, test paint]

- When preparing a spray bottle to clean lead dust, how much detergent is added per liter of water ?

[Answer: one spoon]

- How do you know with certainty if a child is lead poisoned ?

[Answer: have their blood tested]

Participants were then directed to cleaning supplies, sink, door mats, vacuum cleaner, area rug, and free-standing window to demonstrate stepwise and conditional procedures:

- According to the presentation, demonstrate the correct procedure for preparing a spray bottle.
- According to the presentation, demonstrate the correct procedure for washing hands before preparing food for infants.
- Now demonstrate the correct procedure for obtaining water from the faucet for cooking or drinking.

- Demonstrate the correct procedure for removing door mats filled with lead dust.
- Demonstrate the correct procedure for vacuuming an area rug.
- Demonstrate the correct procedure for cleaning a window sill.
- Finally, demonstrate the correct manner for analyzing paint to identify the presence of lead.

One point was assigned when participants demonstrated each of the following stepwise procedures:

- Used the cold water tap to obtain water for drinking or cooking
- Sprayed door mats before removal
- Folded door mats before removal
- Vacuumed window sill
- Wiped window sill with paper towel
- Inserted cotton swab into vial containing reagent

Likewise, one point was assigned when participant demonstrated each of the following conditional procedures:

- Assessed temperature of tap water before proceeding
- Observed spray bottle to assess dissolution of the detergent
- Washed hands for 20 seconds
- Rolled door mats tightly
- Vacuumed area rug in three directions
- Vacuumed area rug for one minute
- Vacuumed area rug for two minutes

- Applied heavy pressure when wiping window sill with paper towel
- Wiped cotton swab on painted surface for 20 seconds

Assuring the reliability of test items was a matter of making them as objective as possible, eliminating experimenter expectancy as an extraneous variable. Direct observation was sufficient to assess performance of stepwise procedures and several of the conditional procedures. A point was awarded, for example, if a participant placed her hand in the water flowing from the tap to assess the temperature; a point was awarded if a participant inspected the spray bottle to ascertain if the detergent had dissolved; and a point was awarded if a participant vacuumed the area rug from end to end and side to side in at least three directions. A stopwatch was used to assess performance of procedures with temporal conditionality, including the time a participant washed her hands, vacuumed the area rug, and tested a painted surface for the presence of lead. Determination of whether a door mat was rolled tightly was a matter of observing whether participants produced two or more coils, as illustrated in Figure 9.



Figure 9 Satisfactory performance of the conditional procedure associated with door mat removal.

Because it was not possible to observe directly whether heavy pressure was being applied when participants wiped the window sill with paper towel, two momentary switches were installed in the window sill, unobservable to participants. See Figure 10. If a participant activated one or both of the switches, a small light illuminated to indicate that sufficient pressure had been applied to comply with instructions included in the narrative.



Figure 10 Portable, free-standing window used for testing, equipped with two pressure-sensitive switches in the sill to indicate if participants applied sufficient pressure, as instructed in the presentation.

Testing for the presence of lead was undertaken with samples of wood that were, in fact, painted with lead-based paint, using test kits readily available for home use which produce a distinct change of color to indicate the presence of lead.

CHAPTER IV

RESULTS

Data collected in the course of this study were analyzed for evidence that the use of multiple modes of instruction does or does not enhance learning, depending on the learning objectives under consideration and the learner's level of education. Recall that participants were randomly assigned to one of three experimental groups to assess the effect of three modes of instruction: narrative only, narrative plus still images, and narrative plus video. The outcome measure was participants' responses to test questions in four categories: the recall of facts, recall of procedures, demonstration of stepwise procedures, and demonstration of conditional procedures. Data from the study are included as Appendix D.

The first hypothesis to be tested posits that instruction using two modalities can enhance learning outcomes when auditory and visual information are complementary.

Inspection of the cumulative scores for each participant reveals an unmistakable upward trend from Mode 1 (narrative only) to Mode 2 (narrative plus still images) to Mode 3 (narrative plus video). This trend is observable in Figure 11, which displays only one high score (i.e., 75 percent or higher) among participants assigned to Mode 1, one high score among participants assigned to Mode 2, and four high scores among participants assigned to Mode 3.

Conversely, there were four low scores (i.e., 25 percent or lower) among participants assigned to Mode 1; two low scores among participants assigned to Mode 2; and no scores 25 percent or below among participant assigned to Mode 3.

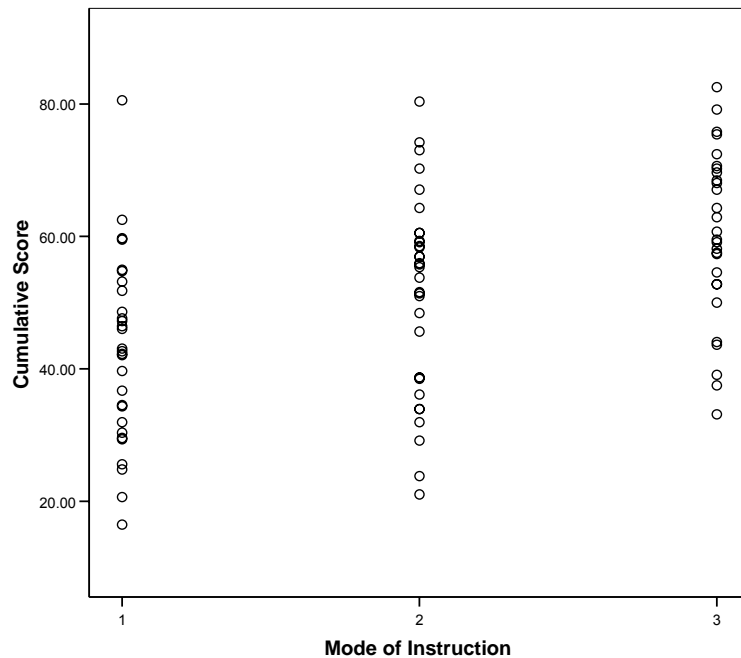


Figure 11 Scatterplot of cumulative scores for all four categories of test items by mode of instruction. Whereas scores trended upward from Mode 1 to Mode 2 to Mode 3, they are highly variable within each condition.

Figure 12 affirms the general trend with respect to median scores for each mode of instruction, and a one-way analysis of variance confirms the significance of this trend, in support of the proposition that two forms of media may in fact be more effective than one, $F(2, 87) = 11.208, p < .000$. There is, however, an unmistakable overlap of scores across modes of instruction in the first and fourth quartiles, represented as whiskers. This suggests that, with respect to the cumulative scores, individual participants are quite variable in their response to

all three modes of instruction and further analysis is needed to identify the factors affecting the efficacy of each mode of instruction.

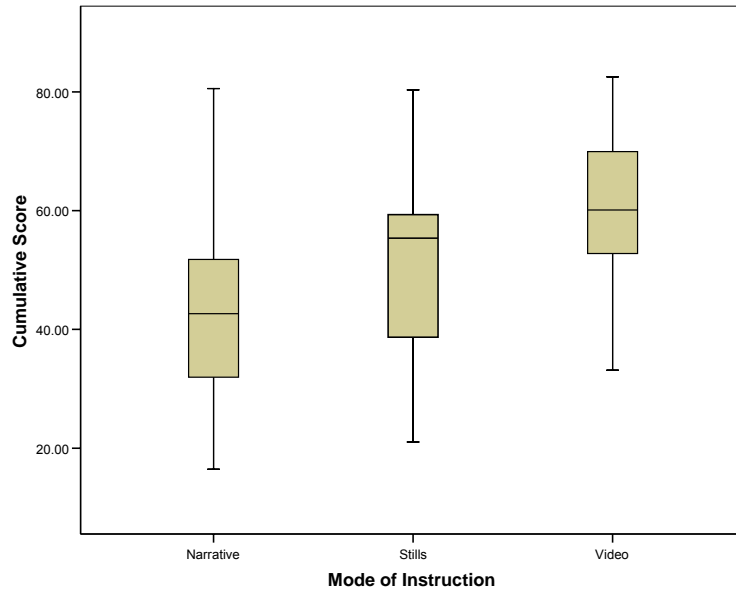


Figure 12 Boxplot of cumulative scores for all four categories of test items by mode of instruction. Although median scores within each box trend upward, it is apparent that many scores overlap at the highest and lowest quartiles.

The second hypothesis to be tested posits that participants will learn differentially from each of the three modes of instruction, depending on their level of schooling.

To explore the potential interaction of education, each score was plotted against years of schooling as self-reported by the 90 participants. Figure 13 reveals that scores trend upward such that participants with the highest scores tended to have more education, while those with the lowest scores tended to have less education. Unexpectedly, however, those with more than 12 years of schooling were not consistently among participants with the highest scores. In fact, participants with a secondary education tended to score higher than those

with 13 or more years of schooling. Among participants with the six highest total scores, five had 10-12 years of schooling, while only one participant with some university education was among those with the highest scores. It is also noteworthy that two of the participants with no schooling had scores that surpassed the scores of many participants with six or more years of schooling. As common sense would lead one to expect, cumulative scores do vary at least in part with years of schooling; but as a predictor of the dependent variable, with $R^2 = .166$, years of schooling was found to be a weak predictor at best, ruling out the probability at this point that observed results are accounted for by years of schooling rather than experimental treatments.

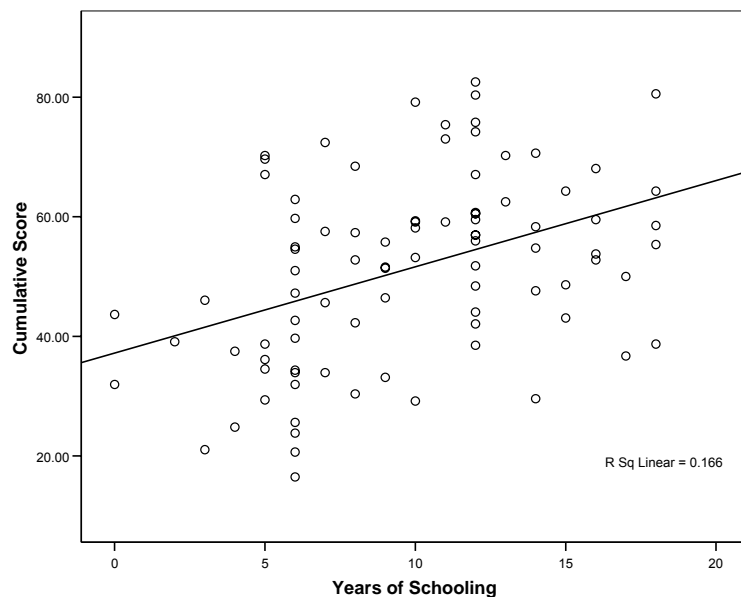


Figure 13 Distribution of cumulative scores for all four categories of learning by years of schooling, for each of the 90 participants in the study. Given the wide dispersion of scores, the regression line is a poor fit which means that years of schooling is a weak predictor of the dependent variable, cumulative score.

As already noted, participants with 12 years of schooling tended to have the highest scores, beyond which the scores begin to fall off. This is more evident in the boxplot in Figure 14. In this case and hereafter for the purpose of analysis, the total number of years of schooling completed by each participant was coded as being in one of three education levels:

- Level 1. Primary (0-6 years of schooling) (n = 29)
- Level 2. Secondary (7- 12 years of schooling) (n = 40)
- Level 3. Tertiary (13 + years of schooling) (n = 21)

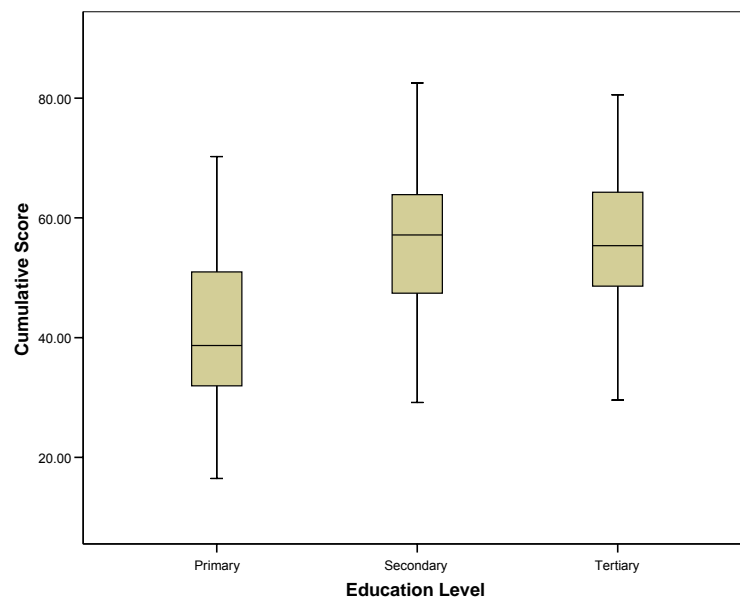


Figure 14 Boxplot of cumulative scores by education level. The median score, represented by the horizontal line in each box, rises for participants with a secondary versus primary level education but declines for participants with a tertiary versus secondary level education.

Although it offers no explanation for the rise and subsequent decline in scores across the three education levels, a one-way analysis of variance reveals

that education level accounts for some of the variability, $F(2, 87) = 11.688$, $p < .000$. One plausible explanation of the fall-off in scores for participants with a tertiary education may be that those with more than 12 years of schooling are from privileged families and remained in school not on their own merits but because of their wealth or social status. Another possibility is that a disproportionate number of senior citizens were among those with tertiary education and that the seniors who participated in the study may have had auditory or vision or impairments, impaired short-term memory, or a combination of potentially confounding factors. For lack of data with respect to the age of individual participants, however, the reason for the fall off in scores beyond 12 years of schooling remains a matter of curiosity and conjecture.

To further explore the effects of the three modes of instruction and the education levels on cumulative scores, a two-way analysis of variance was conducted including a post hoc test using the Bonferroni procedure to compare all pairs of means. In this case, the dependent variable is the cumulative score which includes all four categories of learning outcomes, with categories of learning aggregated. Level of education is included to be certain of the generalizability of findings regardless of education levels. The model states that the dependent variable is a function of the Mode of Instruction, the education level, and the interaction of mode of instruction and education level. Mode of instruction and education level both contributed to outcome score. $F(8, 81) = 6.852$, $p < .000$. To explore these effects further, comparisons were based on a Bonferroni post hoc test of the data, the results of which are displayed in Table 1.

Table 1 Post hoc pair-wise comparisons of cumulative scores by modes of instruction.

(I) Mode of Instruction	(J) Mode of Instruction	Mean Difference (I-J)	Sig.	95% Confidence Interval	
				Lower Bound	Upper Bound
2 Stills	1 Narrative	9(*)	.025	1	17
3 Video	1 Narrative	18(*)	.000	9	26
3 Video	2 Stills	9(*)	.022	1	17

As with other post hoc tests, Bonferroni pair-wise comparisons yielded differences between the means of the participants assigned each of the three instructional conditions under consideration, in this case the three modes of instruction. The results of these tests, displayed in Table 1 as the mean difference between specific modes of instruction, revealed that all three of the possible pair-wise comparisons were significant at the .05 level. Each of these mean differences is the incremental increase we would expect in the total score for all categories A-D on a scale of 100 if the mode of instruction were to change from Mode 1 to Mode 2 in the first case, Mode 2 to Mode 3 in the second case, and Mode 1 to Mode 3 in the third case.

This suggests that, in general, a participant who was assigned Mode 1 could expect a nine-point gain if she were to have been assigned Mode 2 and an additional nine-point gain if she had been assigned Mode 3. Restated, the mode of instruction employing stills would be expected to yield a nine-point improvement over narrative alone; and video would be expected to yield a nine-point improvement over stills. Of course, if the study were to be repeated again

and again, we would expect these mean differences to vary within the upper and lower bounds of the confidence interval in Table 1; but these results provide further confirmation that supplementing one medium, in this case narrative, with another can enhance learning outcomes – presumably by reducing load on a learner’s short-term memory.

As experience and reason would suggest, Table 2 confirms that participants with more education tended to achieve higher overall scores than participants with less education, but the gains from the three modes of instruction were extremely variable among the three levels of education. Pair-wise comparisons of overall scores, regardless of medium of instruction, revealed that participants with a primary education scored 15-16 points lower than participants with a secondary tertiary education but unexpectedly revealed no significant difference between those with a secondary and tertiary education.

Table 2 Post hoc pair-wise comparisons of cumulative scores by levels of education.

(I) Education Level	(J) Education Level	Mean Difference (I-J)	Sig.	95% Confidence Interval	
				Lower Bound	Upper Bound
2 Secondary	1 Primary	16(*)	.000	8	23
3 Tertiary	1 Primary	15(*)	.000	6	23
3 Tertiary	2 Secondary	-1	1.000	-9	7

This convergence of scores between participants with a secondary and tertiary education is also evidenced in Figure 15. In the narrative-only mode of

instruction, there is a seven-point difference between the two groups but a negligible difference in the narrative-plus-stills or narrative-plus-video mode of instruction – as though participants with a tertiary education encountered a ceiling effect for learning outcomes. Whereas data gathered for this study do not provide insights into the reason scores rose less for participants with a tertiary education than they rose for participants with a secondary education, Figure 15 clearly indicates that cumulative scores for both groups did in fact rise with the addition of stills and rose even further with the addition of video. The addition of stills, however, did not facilitate learning for participants in the group with the least education and may have impaired learning outcomes for those with 0-6 years of schooling.

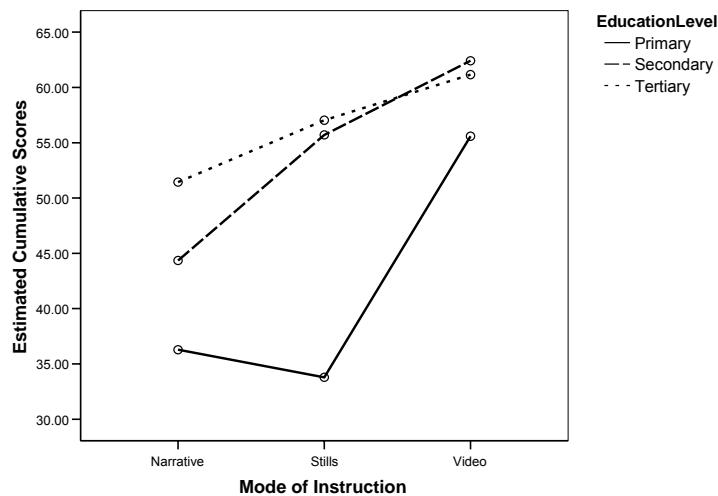


Figure 15 Estimated marginal means of cumulative scores by education level and mode of instruction. Video appears to yield the highest total scores for all three education levels, whereas stills appear to yield higher total scores than narrative for participants with secondary and tertiary educations but not for participants with only a primary education.

Although the addition of stills did not improve learning for the group with the least education, the addition of stills did improve learning for the other two groups and all three groups benefited from the addition of video -- confirming in principle that still images or video can in fact enhance learning when added to instructional narrative, notwithstanding the surprising revelation that still images appeared to impair learning for the least educated.

At this point, results indicate that the mode of instruction and level of education are both factors affecting learning outcomes, consistent with the theory of cognitive load, which in turn suggests that learning can be enhanced by adding either stills or video to narrative, thereby reducing demand on the learner's working memory. To understand how these findings might be applied to the design of instructional materials -- specifically, when and to what extent the addition of still images or video enhances learning over narrative alone -- it is necessary to disaggregate the results by category of learning outcome.

The third hypothesis to be tested posits that still images and video will enhance learning differentially, depending on the learning outcome, with greater mastery of conditional procedures achieved among participants assigned the video mode of instruction.

As noted, results in the foregoing section are based on analysis of learning outcomes in the aggregate. The following results, by comparison, are derived from similar analyses conducted on each of the four kinds of outcome items, including the recall of facts, recall of procedures, demonstration of stepwise procedures, and demonstration of conditional procedures.

With respect to the recall of facts, a two-way analysis of variance revealed a significant main effect for education level $F(2, 81) = 9.684, p < .000$ but not for mode of instruction $F(2, 81) = 1.847, p = .164$. Post hoc analysis estimated a five-point advantage in the mean score for participants at the secondary level versus the primary level and a six-point advantage for participants at the tertiary level versus the primary level. This disparity is reflected in Figure 16, which plots the marginal means of A on a scale of 0-25 by mode of instruction and education level. With respect to the recall of facts, the advantages were a function of education level and not mode of instruction. Therefore, varying the mode of instruction would not be expected to have a direct effect on an individual's ability to recall facts.

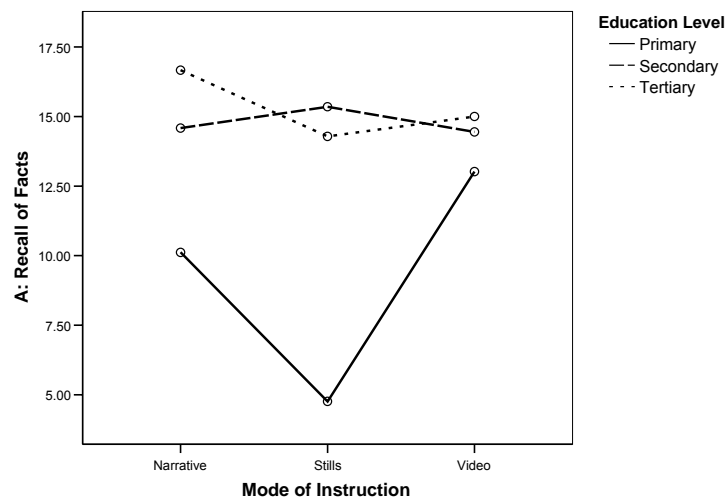


Figure 16 Estimated marginal means for the recall of facts by education level and mode of instruction. Though not determined to be statistically significant, the precipitous decline in scores from narrative to stills for participants with a primary education suggests that still images may impede learning facts for some adults.

In Figure 16, it appears that the mode of instruction had little or no impact on participants with a secondary or tertiary education. For participants with a primary education, however, there is once again evidence of a precipitous decline in the marginal mean of those who received narrative plus stills versus narrative only. The decline, however, does not appear across all categories of learning for participants with a primary education -- as evidenced by the positive slopes of the lines between Mode 1 and Mode 2 in Figure 17 and more notably Figure 19.

When we focus exclusively on the recall of procedures, there is a significant main effect for mode of instruction $F(2, 81) = 3.823, p = .026$ but not for education level $F(2, 81) = 2.811, p = .066$. Whereas post hoc analysis identified the significant difference to be the pair-wise comparison of means between narrative and video in general, the improvement between narrative and stills was greater than the improvement between stills and video for participants with more education. The graph indicates the opposite for those with a primary education, namely little improvement between narrative and stills but great improvement between stills and video.

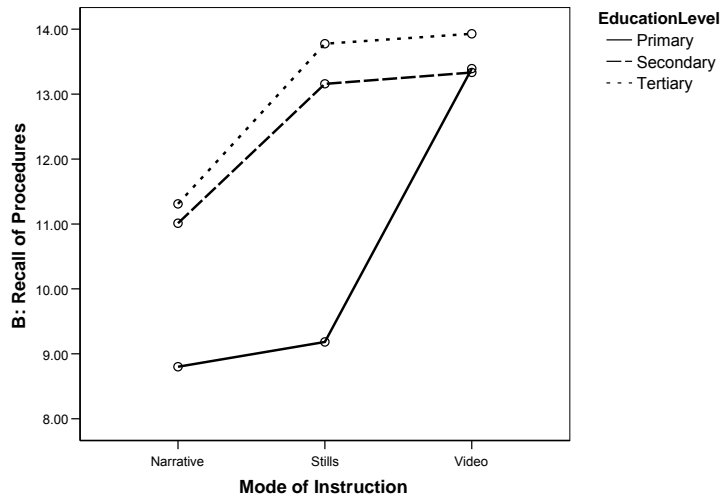


Figure 17 Estimated marginal means for the recall of procedures by education level and mode of instruction. The benefits of stills and video are variable, depending on education level.

Analysis of variance again revealed a significant main effect for mode of instruction when participants were asked to demonstrate procedures $F(2,81) = 5.309, p = .007$; and post hoc test results called attention to the improvement between narrative and video. Figure 18 illustrates the improvements associated with video but, in this case, participants with a secondary education as well as those with a primary education seem to benefit from video far more than do participants with a tertiary education.

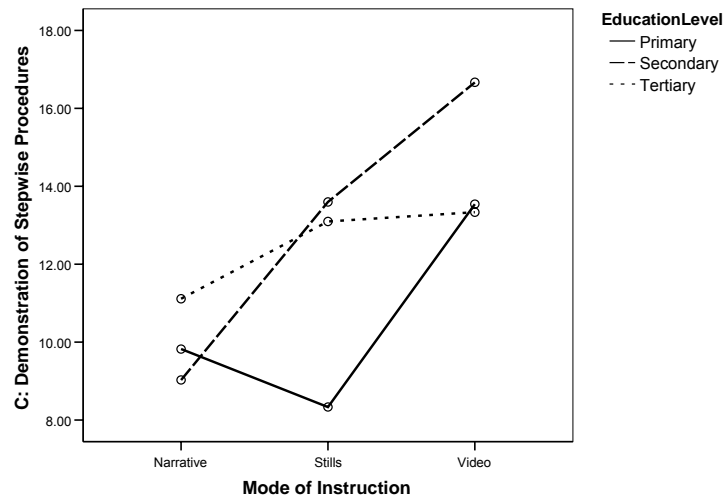


Figure 18 Estimated marginal means for the demonstration of procedures by education level and mode of instruction. Again, the benefits of stills and video are variable, depending on education level.

Based on data from participants asked to demonstrate conditional procedures, analysis of variance revealed a significant main effect for both mode of instruction $F(2,81) = 15.514, p < .000$ and education level $F(2,81) = 4.356, p = .016$. For the first time, as seen in Figure 19, narrative plus stills was superior to narrative alone and narrative plus video was superior to narrative plus stills for all three education levels.

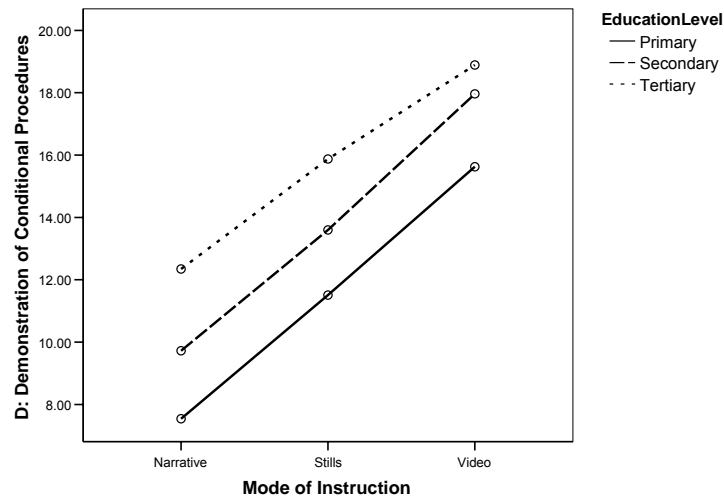


Figure 19 Estimated marginal means for the demonstration of conditional procedures by education level and mode of instruction. Uniquely in this case, scores rise for all three levels of education with the addition of stills, and rise as much again with the addition of video.

Further analysis of data exclusively from participants with a primary education revealed significant between-group means for narrative only versus narrative plus video for categories B and D. A one-way analysis of variance with post hoc pair-wise comparison of means yielded a five-point increase from narrative only to narrative plus video for category B and yielded an eight-point increase for category D. Proportionally, this represents a 90-95 percent improvement in test scores with the addition of video for learning objectives that entailed either the recall of procedures or mastery of conditional procedures. With respect to the categories A and C, however, pair-wise comparisons between mean scores for narrative plus stills did not rise to statistical significance at the .05 level.

Summary

The null hypothesis regarding the cognitive load theory postulated no mean difference between modes of instruction, whereas the experimental assumption postulated that media can be combined to enhance learning outcomes. As a corollary to the experimental assumption, it was also assumed that some combinations of media would be more effective for certain learning objectives than for others. More specifically, it was assumed that narrative plus video would be more effective than narrative alone or more effective than narrative plus still images for learning that entails procedural learning, most notably procedures with more than one concurrent condition.

Although results varied by the educational level of participants, these results provided grounds for accepting the assumption that media can be combined to enhance learning outcomes. The addition of still images to narrative appeared to significantly improve the scores of participants with a secondary or tertiary education. When participants were asked to demonstrate conditional procedures, adding still photos improved the scores of participants with a primary education, as well. The addition of video to narrative, however, raised scores for three of the education levels, raising the score for participants with a primary education most dramatically, so that total scores in the video mode of instruction for all three education levels were remarkably similar.

Furthermore, participants with the least education achieved the most dramatic increases in all four categories of learning with narrative plus video compared to narrative alone, most notably with respect to the recall of

procedures and mastery of procedures predicated on conditionalites. Analysis of data from participants assigned to the stills plus narrative condition, by comparison, raised questions about the utility of still images for adults with no more than a primary education. Surprisingly, stills plus narrative yielded higher scores over narrative alone in only one of the four categories of learning and appeared to impair learning with respect to the recall of facts and mastery of stepwise procedures. For learners with no more than a primary education, video was nominally better than narrative for learning facts and demonstrably superior for learning procedures, both stepwise and conditional.

CHAPTER V

CONCLUSIONS AND IMPLICATIONS

Scope of the study

The central premise of this study is that working memory is comprised of independent auditory and visual channels, and that by distributing instruction across channels rather than relying exclusively on one channel, learners potentially are able to encode instruction more efficiently, thereby reducing cognitive load on short-term memory. It is important to note that the theory does not predict that two media of instruction are inherently more efficient than one, as they must also be concurrent and mutually reinforcing.

To test the study's central premise, 90 participants were randomly assigned to three variations of a presentation on an authentic health issue to determine the relative effectiveness of the instructional strategies employed:

- Narrative only (n = 29)
- Narrative plus stills (n = 33)
- Narrative plus video (n = 28)

All 90 participants were Spanish-speaking adult women residing in the United States. The narrative was identical in all three versions, comprised of 11 segments, one to two minutes each in duration. Each version of the presentation was delivered to participants individually via touch screen monitor with integrated speakers and on-screen buttons to navigate from segment to segment.

Immediately upon conclusion of the presentation, each participant was asked 35 questions to assess her recall of facts, recall of procedures, ability to perform stepwise procedures, or ability to perform conditional procedures based on the version of the presentation to which she had been assigned. Data collected, including the mode of instruction and number of years each participant attended school, were subsequently analyzed to determine if the mode of instruction or years of schooling were factors affecting any of the four categories of learning outcomes mentioned above.

Findings

Initial analysis of data from the study provided support for the cognitive load theory insofar as participants, regardless of level of education, tended to achieve higher overall scores with narrative plus video compared to narrative alone. Two of the three groups of participants also achieved higher overall scores with the addition of stills to narrative. The fact that stills did not afford an advantage to one group of participants was an important finding as discussed below but did not in itself refute the cognitive load theory, given that video yielded greater learning outcomes for all three groups.

Further analysis of scores disaggregated by category of learning revealed differential effects for stills and video as a function of both category of learning and level of education. With respect to the recall of facts, neither stills nor video afforded an advantage to any of the three groups relative to scores with narrative alone. Given that facts are semantic propositions, this finding was expected

since neither static images nor video provided supplementary information beyond the content conveyed in the narrative.

With respect to the recall of procedures, which required participants to list procedures included in the presentation, stills enhanced learning compared to narrative alone among participants with secondary and tertiary educations but not among participants with the least education. For those with secondary and tertiary educations, video provided no additional benefit over stills; but video did, in this case, enhance the recall of procedures for those with the least education.

With respect to the demonstration of stepwise procedures, it was expected that stills would provide a significant benefit to all learners by illustrating essential spatial information without regard to other conditions, but analysis of the data revealed that stills did not afford a benefit compared to narrative only. Video, on the other hand, did enhance learning stepwise procedures compared to narrative alone.

With respect to the demonstration of conditional procedures, data analysis revealed that still images afforded significant benefits compared to narrative and video afforded significant benefits compared to stills for all three levels of education. This was the only instance when all three groups benefited uniformly by stills compared to narrative only and by video compared to stills.

Discussion

In general, the study demonstrated the relevance of cognitive load theory to instructional design and provided evidence of enhanced efficiency for working memory under multi-modal conditions. As predicted, there were several instances when one form of multi-modal instruction or the other was superior to uni-modal instruction for participants, and one instance when both stills and video were superior to narrative alone for all participants regardless of level of education.

The study also revealed, however, that multi-modal instruction afforded no benefits with respect to the recall of facts and afforded benefits unevenly with respect to the other two categories of learning when the learner's level of education is taken into consideration. For the purpose of imparting facts as oral propositions, the study's findings suggest that narration alone was as effective as narration plus stills or narration plus video. Given the considerable cost of producing and delivering stills and video and the negligible benefits for teaching and learning facts, radio or audio CDs merit consideration as cost-effective media for imparting facts to adult learners generally.



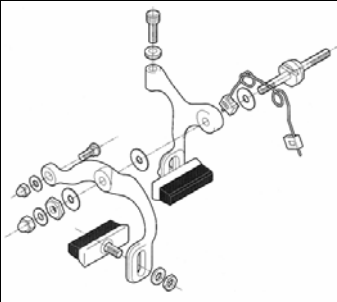
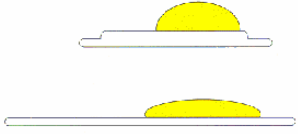
For adults with seven or more years of education, the addition of stills to narrative seemed to be warranted when instructional objectives entailed recalling or demonstrating procedures, either stepwise or conditional. For those with the least education, on the other hand, the addition of stills to narrative did not seem to be warranted for learning stepwise procedures. This was a surprising result as

reason suggests that stills would enhance learning stepwise procedures compared to narrative alone.

This failure of stills to enhance learning for factual stepwise procedures among the least educated participants prompts questions as to why stills might afford advantages in one case and not in the other. Given that the still images employed in the study were essentially still photographs (i.e., frames captured from video), it is possible that they provided too much detail, especially for learners with 0-6 years of schooling. Conceivably, when the task was stepwise, learners felt they had time to scan the image for interesting but inessential details, diverting their attention from the core message. When the task was more complex, as with conditional procedures, performance improved with the addition of stills perhaps because they had to attend more carefully to the core message, thereby making more efficient use of the stills.

In retrospect, stills may have afforded greater benefit to learners with minimal schooling if the still images had been more parsimonious, as in the examples in Figure 20. Alternatively, given their limited experience with two-dimensional representations, it may be that any still image is inherently distracting unless essential for clarifying ambiguities in the narrative, requiring additional mental effort to “decode” the still image. By comparison, learners with seven years or more of schooling presumably have had far more experience with two-dimensional representations and therefore able to more efficiently filter extraneous detail and extract relevant information from the still image –

explaining in part but not entirely the disparity between the utility of stills for participants with minimal schooling and participants with seven years or more.

Design objective	Narrative	Visual
Illustrating a static physical condition	A stroke may result in weakness on one side of face or body.	
Identifying an object by shape, color, texture	Peach trees are self-fertile, so only one tree is needed to obtain fruit.	
Illustrating the relation among objects	All of the moving parts of a side-pull brake caliper fit onto the central pivot bolt.	
Comparing shapes	The yolk of a fresh egg will have a round and compact appearance.	

(figure continues)



Design objective	Narrative	Visual
Comparing lengths	Set up your extension ladder with the base one meter away from the wall for every meter the ladder reaches up.	
Comparing volumes	To prevent dehydration, mix one teaspoon of sugar with a little salt at the end of the spoon.	

Figure 20 Examples of illustrations with essential details and minimal distractions.

As predicted, video yielded higher scores than still images on mastery of conditional procedures for all participants regardless of level of education – attributable presumably to video’s ability to portray multiple actions concurrently

or sequentially based on temporal or conditions depicted in the video. In two other instances, video was also superior to stills for participants with less education, enabling them to achieve scores for recalling procedures in general and demonstrating stepwise procedures equal to participants with considerably more education.

For participants with tertiary education, however, video was not superior to stills for recalling procedures in general or demonstrating stepwise procedures. In those two categories of learning outcomes, stills were adequate and video added little or nothing of value, also as predicted.

Analysis of the data across all four categories of learning investigated indicated that participants in all three education levels benefited from multi-modal versions of the presentations. When analyzed further, results revealed that the benefits of stills were greater in more instances for participants with secondary and tertiary levels of education and the benefits of video were greater in more instances for participants with less education – suggesting that video is more accessible than stills for participants with less education, perhaps because of the greater realism of video or the propensity of movement to direct and maintain a learner's attention.

Implications

The results of this study have implications for health education, agricultural extension, disaster relief, and support for micro-enterprises – to name four endeavors requiring the teaching and learning of facts and procedures to adults with minimal education. In essence, the study supports the use of video for reaching millions of functionally illiterate adults in their communities, urban or rural, not only in developing countries but also in the United States.

Apart from the added cost of producing and delivering video which must be weighed carefully, the study provided evidence of the superiority of video over stills or narrative alone in three of the four categories of learning investigated. With the advent of less expensive and more reliable devices for delivering video to remote villages in developing nations, the study is expected to encourage educators to incorporate video for imparting knowledge of procedures among adult learners with little or no education.

Although not ideal because of their small screen, the ubiquity of cell phones provides a potential delivery device for instructional video. Other options include modified electronic gaming units with a touch screen monitor or displays such as those in Figure 21, the power requirements for which can be met with solar panels if electric power is not otherwise available.



Figure 21 Portable video displays adaptable for use in developing countries to expand the educational options of underserved adults.

Recommendations for further research

Given that this study investigated the effects of stills and video on a limited range of categories of learning, additional research is needed to explore the effects of stills and video on higher order learning such as problem solving and behavioral change, especially among participants with minimal education. A follow-on study might investigate the benefits of interactive multimedia not only for acquiring declarative and procedural knowledge but also applying the training to the circumstances prevalent in the lives of the learners.

Whereas the presentation tested in this study was entirely devoid of text, a similar study might be undertaken to investigate the effects of including a limited number of words displayed on-screen as text for semi-literate learners. Conceivably, the occasional display of one or two words could facilitate navigation and recall among semi-literate learners while serving as an incentive for those who have not yet learned to read.

More research is also needed to determine if the benefits observed in this study are lasting over time, how the formal features in videos (e.g., pans, zooms, cuts, and wipes) affect learners with minimal education, how much visual detail is enough and how much is too much, how learners in predominately oral cultures interpret and encode two-dimensional dynamic images, the importance of intergenerational transmission of knowledge in traditional cultures, interface design and user control over the pacing and sequencing of video, and whether individuals are visual or auditory learners as a function of education.

APPENDIX A

STORYBOARD IN ENGLISH

AUDIO

[INVITATION]

You are invited to participate in this study, conducted by Mr. Bruce Cohen. It is a study of strategies for teaching and learning.

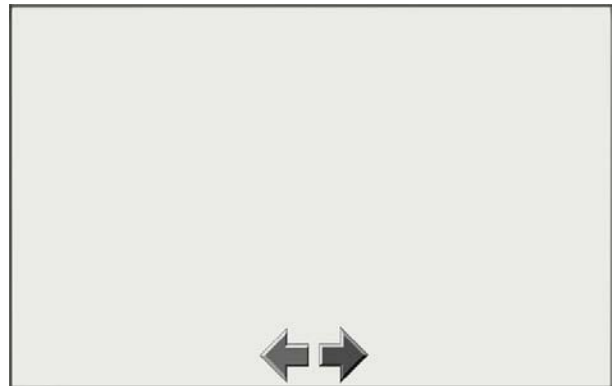
If you decide to participate, you will receive \$10 for your participation. It will be entirely in Spanish and take less than one hour. Each will participate individually, and you can decide to leave the study at any time.

The presentation Mr. Cohen has prepared pertains to the hazards of lead and steps you can take to protect your family from lead in an older house. The presentation includes an oral narration in Spanish, so it does not matter if you can or cannot read.

If you decide to participate, Mr. Cohen will ask several questions at the conclusion of the presentation to determine what you learned.

If you would like to participate, please indicate your intentions to Mr. Cohen. Thank you.

SCREEN



ORIENTATION

This presentation lasts approximately 10 minutes. Remember as much as possible from the presentation so you can answer questions and demonstrate the procedures in the presentation.

The presentation is comprised of segments. At the conclusion of each segment, the presentation pauses. You will also hear a chime to indicate that the segment ended.

When you are ready to begin the presentation, press the arrow below.

[chime]



INTRODUCTION

This presentation is about the danger of lead in older houses and steps to reduce the risk to infants and young children.



Today, the main sources of lead in older houses are lead-based paint and lead used in plumbing.



Lead-based paint was used in houses built before 1978. If the paint is not in good condition, chips fall to the ground and produce dust.



If an infant or young child inhales or ingests this dust,

. . . it can cause problems with hearing, learning, and behavior (such as hyperactivity).



In the past, lead was also used to join sections of water pipes. If this lead were to contaminate water for cooking and drinking, it could also cause problems with hearing, learning, and behavior.



Remember: Lead is poisonous to infants and young children, even in small quantities.



[chime]

PLACING MATS

One thing you can do to reduce lead dust in your house is to place mats at every door to the outside.



It is important to place mats not only at the main entrance but also at any door to the outside and the door to the garage.



The purpose of the mats is to collect lead dust from paint on the outside of the house.



Whenever possible, place a mat on both sides of every entrance,

. . . inside



. . . and outside.



[chime]

WIPING SHOES

Ask family members and visitors to wipe their shoes on the mats every time they enter from outside.



Insist that they wipe each shoe at least twice, once on each mat.



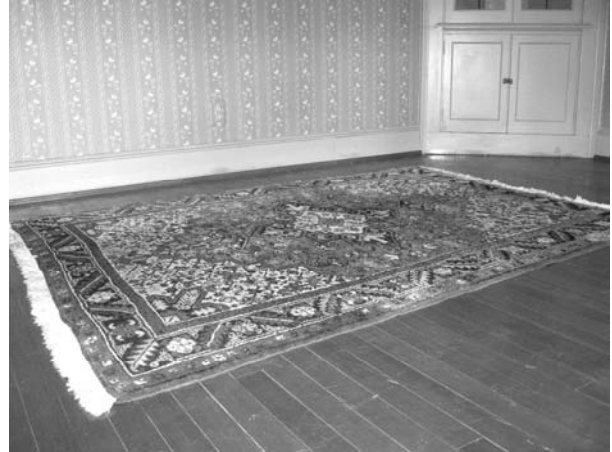
More times is better to reduce the dust on their shoes.



[chime]

VACUUMING CARPETS

In a house with carpets, use special techniques for vacuuming to reduce lead dust.



Lead dust is heavy and settles deep in carpets.



Therefore, you should vacuum very slowly

. . . three times more slowly than normal.



And vacuum in at least three directions.



Remember: The more you vacuum, the more lead dust you will pick up.

[chime]



PREPARING A SPRAY BOTTLE

To reduce lead dust when cleaning your house, it is useful to prepare a spray bottle.



Add one spoon of dishwashing detergent to an empty one-liter bottle.



Add hot water. In the United States, the hot water tap is on the left.



Let the water run

. . . until you feel hot water.



Secure the cap . . .



and shake until the detergent is dissolved.



[chime]



CLEANING WINDOW WELLS

If your windows are painted, paint chips and lead dust often accumulate in the window well, within easy reach of children.

In this case, it is essential to clean the window well thoroughly.



First, vacuum the window to remove the paint chips.



Then spray the window well with the mixture of water and detergent.



Tear off a piece of paper towel . . .
and use the paper towel to wipe up
as much dirt at possible without
turning the paper towel.



Since lead dust can be difficult to
dislodge, you must apply pressure
when you wipe, to remove as much
lead dust as possible.



When you've cleaned up a small
area with one paper towel, put it
into a plastic trash bag and start
with a new towel.

Continue using new pieces of paper
towel until the window wells are
thoroughly clean.

[chime]



REMOVING DOORMATS

Use doormats for no more than two months before replacing them.

To minimize the spreading of dust, lightly mist the door mats.



Fold each mat inward to trap the dust,



and then roll the mats as tightly as possible.



Place each mat in a thick plastic trash bag for disposal.

[chime]

WASHING HANDS

Another measure is to wash any lead dust from your hands before preparing food for infants and young children.



Wash with warm water and soap for at least 20 seconds,



. . . the time it takes to sing “Happy Birthday”.

[chime]



DRAWING WATER FOR COOKING AND DRINKING

In case lead was used to join the pipes in your house, use water for cooking and drinking only from the cold water tap. The reason is that cold water dissolves lead less than hot water. In the United States, the cold water tap is on the right.



Another precaution is to let the water run if the cold water tap has not been used for several hours.

In this case, let the cold water run for 20 seconds or until you feel the water get cold.



[chime]

TESTING BLOOD

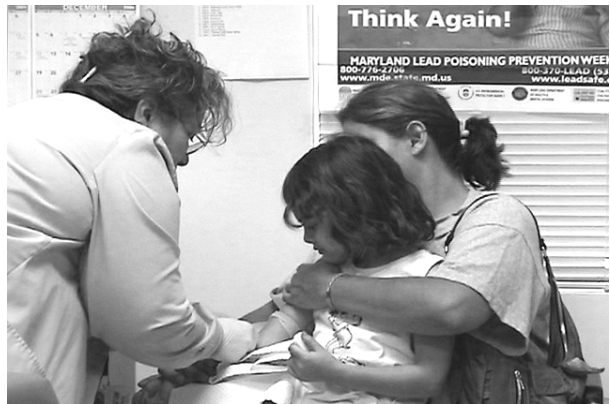
Even if children appear healthy, they may have toxic levels of lead in their blood.

The only way to know for sure is take them to a clinic to have a simple blood test.



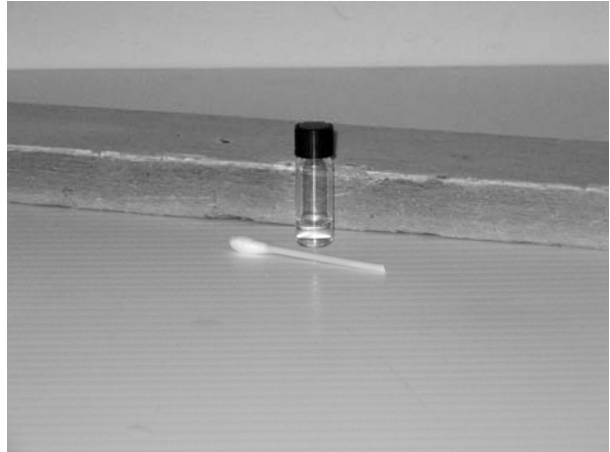
Most communities in the United States have a clinic that will test your child free of charge.

[chime]

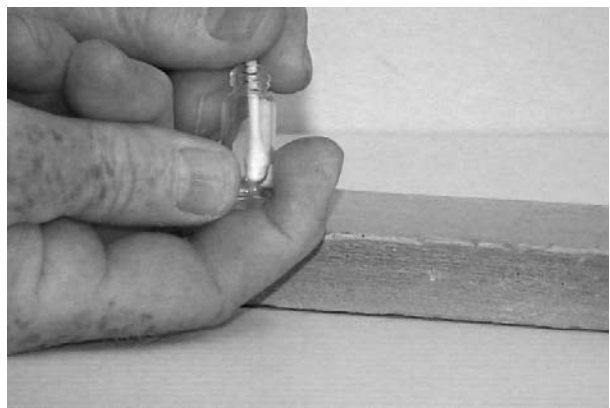


TESTING FOR LEAD-BASED PAINT

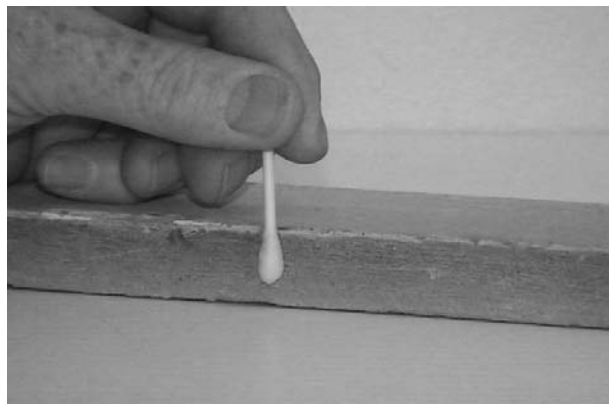
To test for lead on a painted surface, obtain a test kit from a hardware store. The kit contains liquid in a small vial and a cotton swab.



Remove the cap from the glass vial and dip the cotton swab into the liquid.



Gently rub the surface to be tested with the tip of the cotton swab for 20 seconds.



If the painted surface or tip of the cotton swab turns yellow, or brown, or black, lead is present. If there is no change of color, no lead is present.

[chime]



APPENDIX B

NARRATIVE IN SPANISH

Invitación a participar:

Le invita a usted a participar en esta encuesta, conducida por el Sr. Bruce Cohen. Esta es una encuesta de estrategias de instrucción y aprendizaje.

Si usted decide participar, recibirá \$10 por su participación. Estará enteramente en español y tomará menos de una hora. Cada uno participará individualmente, y usted puede decidir en cualquier momento dejar la encuesta.

La presentación que el Sr. Cohen preparó pertenece a los peligros del plomo y a las medidas para proteger a su familia del plomo en una casa vieja.

Esta presentación incluye una narración oral en español, así que no importa si puede ó no leer.

El Sr. Cohen hará varias preguntas al final de la presentación para determinar lo que usted aprendió.

Si desea participar, por favor, informe al Sr. Cohen. Gracias.

Instrucción:

Esta presentación dura aproximadamente 10 minutos. Favor recordar el contenido de la presentación para que pueda contestar a preguntas y demostrar los procedimientos en la presentación.

Esta presentación se trata de segmentos cortos. En la conclusión de cada segmento, la presentación se detiene. Usted escuchará un tono como éste [*tono*] para indicar que el segmento terminó.

Si usted quiere repetir un segmento, presione la flecha roja abajo. Puede repasar un segmento tantas veces como usted lo desee.

Cuando usted esté listo para comenzar la presentación, presione la flecha verde abajo. [*tono*]

1. Introducción:

Esta presentación se trata del peligro del plomo en casas viejas . . . y las medidas de reducir el riesgo a los infantes y a los jóvenes.

Actualmente, las fuentes principales del plomo en casas viejas son pintura con plomo . . . y plomo usado en la plomería.

En el pasado, el plomo fue utilizado para ensamblar secciones de las tuberías de agua. Si este plomo contamina el agua para cocinar y beber, podría también causar problemas con la audición, aprendizaje, y comportamiento.

La pintura con plomo fue utilizada en las casas construidas antes de 1978. Si la pintura no está en buenas condiciones, las virutas caen a la tierra y vuelven al polvo. Si un infante o joven inhala o traga este polvo, puede causar problemas con la audición, aprendizaje, y comportamiento (tal como la hiperactividad).

Recordar que el plomo es venenoso en los infantes y en los jóvenes, incluso en cantidades pequeñas. *[tono]*

2. Colocar las alfombras:

Una cosa que usted puede hacer para reducir el polvo de plomo en su hogar es colocar en cada puerta al exterior dos alfombras.

Es importante colocar las alfombras no sólo en la entrada principal sino también en cualquier puerta al exterior y la puerta al garage.

El propósito de las alfombras es recoger el polvo del plomo en el exterior de la casa.

Siempre que sea posible, colocar una alfombra en ambos lados de cada entrada . . . adentro . . . y afuera. *[tono]*

3. Limpiar los zapatos:

Pedir que cada uno de los miembros de su familia y los visitantes limpien sus zapatos en las alfombras cada vez que entran a la casa.

Insistir que limpien cada zapato por lo menos dos veces, una vez en cada alfombra. Más tiempo sacuda sus zapatos, mejor será el resultado. *[tono]*

4. Preparar una botella con atomizador:

Para reducir el polvo de plomo cuando limpia su casa, es útil preparar una botella con atomizador.

Agregar una cucharadita de detergente de lavaplatos a una botella de un litro.

Agregar el agua caliente. En los Estados Unidos, el grifo de agua caliente está a la izquierda.

Dejar correr el agua hasta que esté bien caliente.

Cerrar bien la botella . . . y agitarla hasta que el detergente se disuelva. *[tono]*

5. Quitar las alfombras:

Utilizar las alfombras por no más de dos meses antes de sustituirlas.

Para reducir la dispersión del polvo, rociar ligeramente las alfombras.

Doblar cada alfombra hacia adentro para atrapar el polvo, y después enrollar la alfombra tan firmemente como sea posible.

Colocar cada alfombra en un bolso plástico grueso de la basura para desechar. *[tono]*

6. Limpiar con la aspiradora:

En una casa con alfombras de área, utilizar técnicas especiales con la aspiradora para reducir el polvo de plomo.

El polvo de plomo es pesado y penetra profundamente en las alfombras de área.

Por lo tanto, debe pasar la aspiradora muy lentamente . . . tres veces más lento que usualmente . . . y hágalo por lo menos en tres direcciones.

Recordar que cuanto más se pase la aspiradora, más se recogerá el polvo. *[tono]*

7. Lavar las manos:

Otra medida es lavar cualquier polvo de plomo de sus manos antes de preparar el alimento para los infantes y los jóvenes.

Lavarse las manos con agua tibia y jabón por lo menos 20 segundos . . . el tiempo que toma cantar “Cumpleaños Feliz”. *[tono]*

8. Obtener agua para cocinar y beber:

Si las tuberías en su casa tienen soldadura con plomo, tomar el agua para cocinar y beber solamente del grifo de agua fría. La razón es que el agua fría disuelve menos plomo que el agua caliente. En los Estados Unidos, el grifo de agua fría está a la derecha.

Otra precaución es dejar correr el agua en las tuberías si no se ha utilizado el grifo frío durante algunas horas. En este caso, dejar correr el agua fría por 20 segundos o hasta que se sienta una reducción en la temperatura del agua .
[tono]

9. Limpiar los canales de las ventanas:

Si sus ventanas son pintadas, las virutas de pintura se acumulan a menudo en el canal de la ventana, al alcance de las manos de los niños.

En este caso, es esencial limpiar los canales de la ventana a fondo.

Primero: Limpiar la ventana con la aspiradora para quitar las virutas de la pintura.

Luego rociar el canal de la ventana con la mezcla del agua y del detergente.

Con un pedazo de la toalla de papel . . . limpiar tanta suciedad como sea posible sin voltear la toalla de papel.

Puesto que el plomo es difícil de quitar, usted debe aplicar presión para quitar tanto plomo como sea posible.

Cuando ha limpiado encima de un área pequeña con una toalla de papel, desecharla en la bolsa de la basura y comenzar con una toalla nueva.

Continuar el uso de nuevos pedazos de toalla de papel hasta que los canales de la ventana queden bien limpios. *[tono]*

10. Evaluar la sangre:

Aún los niños que parecen en buen estado de salud, pueden ser envenenados por plomo en su sangre. La única manera de saber con seguridad es hacerles un análisis de sangre.

La mayoría de las comunidades en los Estados Unidos tienen una clínica que prueba a su niño gratuitamente. *[tono]*

11. Analizar la pintura:

Para identificar la presencia del plomo en una superficie pintada, obtener un detector de plomo en una ferretería. El detector contiene un cotonete y un frasco pequeño con líquido.

Destapar el frasco . . . luego introducir el cotonete en el líquido del frasco.

Frotar suavemente la superficie que se probará con la punta del cotonete por 20 segundos.

Si la superficie pintada o la punta del cotonete se vuelve marrón o negro, el plomo está presente. Si no hay cambio de color, no hay plomo presente. *[tono]*

APPENDIX C

TEST QUESTIONS AND DATA RECORD IN ENGLISH

According to the presentation, what materials used in the construction of an older house contain lead ?

- A₁ PAINT (PAINT DUST)
- A₂ SOLDER (WATER PIPES or PLUMBING)

According to the presentation, how does lead poisoning affect children ?

- A₃ INTELLIGENCE (ACADEMIC PERFORMANCE)
- A₄ HEARING
- A₅ BEHAVIOR (HYPERACTIVITY)

According to the presentation, what are the steps you can take to protect children from lead in an older house ?

- B₁ PLACE TWO MATS AT EACH ENTRANCE
- B₂ WIPE SHOES
- B₃ REMOVE MATS WHEN SOILED
- B₄ MIX SPRAY
- B₅ WASH HANDS BEFORE PREPARING FOOD
- B₆ WASH HANDS WITH WARM WATER
- B₇ WASH HANDS FOR 20 SECONDS
- B₈ CLEAN WINDOW SILLS
- B₉ VACUUM RUGS IN THREE DIRECTIONS
- B₁₀ VACUUM RUGS SLOWLY
- B₁₁ USE COLD WATER FOR COOKING
- B₁₂ TEST PAINT

When preparing a spray bottle to clean lead dust, how much detergent is added per liter of water ?

- B₁₃ ONE SPOON

How do you know with certainty if a child is lead poisoned ?

- B₁₄ HAVE THEIR BLOOD TESTED

According to the presentation, demonstrate the correct procedure for preparing a spray bottle.

- C₁ AGITATED BOTTLE
- D₁ CHECKED DISSOLUTION OF DETERGENT

According to the presentation, demonstrate the correct procedure for washing hands before preparing food for infants.

- D₂ WASHED HANDS FOR 20 SECONDS

Now, demonstrate the correct procedure for obtaining water from the faucet for cooking or drinking.

- C₂ USED COLD WATER TAP
- D₃ WAITED OR ASSESSED WATER TEMPERATURE

Why is it important to use cold water when preparing food or drink ?

- A₆ LESS LEAD

According to the presentation, demonstrate the correct procedure for removing door mats filled with lead dust.

- C₃ SPRAYED MATS
- C₄ FOLDED MATS
- D₄ ROLLED MATS TIGHTLY

According to the presentation, demonstrate the correct procedure for vacuuming an area rug.

- D₅ VACUUMED RUG IN THREE DIRECTIONS
- D₆ VACUUMED RUG LONGER THAN 1 MINUTE
- D₇ VACUUMED RUG LONGER THAN 2 MINUTES

According to the presentation, demonstrate the correct procedure for cleaning a window sill.

- C₅ VACUUMED WINDOW SILL
- C₆ SPRAYED WINDOW SILL
- D₈ APPLIED HEAVY PRESSURE

And finally, demonstrate the correct procedure for analyzing paint to determine if it contains lead.

- D₉ WIPED MOISTENED SWAB ON PAINTED SURFACE FOR 20 SECONDS OR UNTIL COLOR CHANGED

APPENDIX D

STUDY DATA

Table D1 Scores of participants (n = 29) randomly assigned to narrative only (Mode of Instruction 1).

Years of Schooling	Education Level	A	B	C	D	Total
0	Primary	8	13	8	3	32
3	Primary	21	7	13	6	46
4	Primary	8	5	8	3	25
5	Primary	13	5	8	8	35
5	Primary	13	7	4	6	29
6	Primary	4	5	8	3	21
6	Primary	4	5	4	3	16
6	Primary	17	13	17	14	60
6	Primary	8	13	13	14	47
6	Primary	8	4	17	11	40
6	Primary	17	11	4	11	43
6	Primary	8	11	4	11	34
6	Primary	13	16	21	6	55
6	Primary	0	9	8	8	26
8	Secondary	17	5	0	8	30
8	Secondary	13	9	13	8	42
9	Secondary	13	9	17	8	46
10	Secondary	17	14	8	14	53
12	Secondary	8	14	8	11	42
12	Secondary	21	14	8	8	52
13	Tertiary	21	13	13	17	63
14	Tertiary	21	9	8	17	55
14	Tertiary	8	14	8	17	48
14	Tertiary	13	2	4	11	30
15	Tertiary	13	13	13	11	49
15	Tertiary	17	13	8	6	43
16	Tertiary	25	18	8	8	60
17	Tertiary	8	9	17	3	37
18	Tertiary	25	13	21	22	81

A = recall of facts, B = recall of procedures, C = demonstration of stepwise procedures, D = demonstration of conditional procedures

Table D2 Scores of participants (n = 40) randomly assigned to narrative plus stills (Mode of Instruction 2).

Years of Schooling	Education Level	A Total	B Total	C Total	D Total	Grand Total
3	Primary	0	7	8	6	21
5	Primary	0	13	4	19	36
5	Primary	8	5	17	8	39
6	Primary	0	13	8	11	32
6	Primary	8	11	13	19	51
6	Primary	8	7	0	8	24
6	Primary	8	9	8	8	34
7	Secondary	17	5	13	11	46
7	Secondary	13	9	13	0	34
9	Secondary	13	7	17	19	56
9	Secondary	13	7	21	11	52
9	Secondary	13	13	13	14	51
10	Secondary	17	11	13	19	59
10	Secondary	4	13	4	8	29
11	Secondary	25	16	13	19	73
11	Secondary	21	16	8	14	59
12	Secondary	17	21	17	19	74
12	Secondary	13	18	13	6	48
12	Secondary	17	16	17	11	61
12	Secondary	25	18	21	17	80
12	Secondary	13	16	21	11	61
12	Secondary	21	14	13	19	67
12	Secondary	17	13	8	19	57
12	Secondary	8	11	8	11	38
12	Secondary	17	13	17	11	57
12	Secondary	13	14	13	17	56
13	Tertiary	21	16	17	17	70
14	Tertiary	13	13	17	17	58
15	Tertiary	17	14	17	17	64
16	Tertiary	17	11	13	14	54
18	Tertiary	0	18	13	8	39
18	Tertiary	17	7	13	22	59
18	Tertiary	17	18	4	17	55

A = recall of facts, B = recall of procedures, C = demonstration of stepwise procedures, D = demonstration of conditional procedures

Table D3 Scores of participants (n = 21) randomly assigned to narrative plus video (Mode of Instruction 3).

Years of Schooling	Education Level	A Total	B Total	C Total	D Total	Grand Total
0	Primary	13	9	8	14	44
2	Primary	8	7	13	11	39
4	Primary	4	13	13	8	38
5	Primary	13	14	21	19	67
5	Primary	17	16	13	25	70
5	Primary	21	20	13	17	70
6	Primary	17	14	13	19	63
6	Primary	13	14	17	11	55
7	Secondary	17	20	17	19	72
7	Secondary	21	9	8	19	58
8	Secondary	17	14	13	14	57
8	Secondary	13	13	17	11	53
8	Secondary	17	14	21	17	68
9	Secondary	4	5	13	11	33
10	Secondary	13	5	21	19	58
10	Secondary	21	13	21	25	79
10	Secondary	13	16	8	22	59
11	Secondary	21	14	21	19	75
12	Secondary	13	11	21	17	61
12	Secondary	4	11	13	17	44
12	Secondary	17	16	21	22	76
12	Secondary	13	18	13	17	60
12	Secondary	17	21	25	19	83
14	Tertiary	17	18	17	19	71
16	Tertiary	21	13	13	22	68
16	Tertiary	8	13	13	19	53
17	Tertiary	13	13	8	17	50
18	Tertiary	17	14	17	17	64

A = recall of facts, B = recall of procedures, C = demonstration of stepwise procedures, D = demonstration of conditional procedures

APPENDIX E

PREVALENCE AND CORRELATES OF ILLITERACY

In 2005, there were an estimated 781 million illiterate adults in the world, approximately two-thirds of whom were women (UNESCO; 2006). These estimates are based on definitions that differ from country to country, but they generally reflect the share of the population fifteen years and older who cannot read and write a short, simple sentence about everyday life.

Although the rate of illiteracy is declining, the total number of illiterate individuals worldwide is increasing. The prevalence of illiterate women is especially acute in rural areas where it is common for girls to abandon their studies after the third or fourth grade, when they are considered old enough to help their mothers raise their siblings (Harbison & Hanushek; 1992). Even in the United States, 14 percent of all adults fall into the lowest of four English-language literacy levels, 55 percent of whom did not graduate from high school and 26 percent of whom are 65 and older (NCES 2002).

Undoubtedly there are a multitude of adverse effects from being illiterate but the health consequences of the inability to read have been well documented in recent years. Studies have found, for example, that patients in the lowest of the four literacy groups are five times more likely to misinterpret prescriptions than patients with adequate skills, and they averaged two more visits to physicians per year than their more literate peers (NAS, 2003).

REFERENCES

- Adams, D. M., & Hamm, M. E. (1989). *Media and literacy: Learning in an electronic age*. Springfield, IL: Charles Thomas.
- Anderson, D. & Field, D. (1983). Children's attention to television: Implications for production. In M. Meyer (Ed.), *Children and the formal features of television* (pp. 56-96). Munich: Saur.
- Anderson, J. R. (1980). *Cognitive psychology and its implications*. San Francisco: Freeman.
- Arnheim, R. (1969). *Visual thinking*. Berkeley: University of California Press.
- Baker, D.W., Parker, R.M., Williams, M.V. Pitkin, K. Parikh, N.S., Coates, W., & Imara, M. (1996). The health care experience of patients with low literacy. *Archives of Family Medicine*, 5, (6), 329-334.
- Baddeley, A. (1992). Working memory. *Science*, 255, 556-559.
- Bandura, A. (1964). Social learning through imitation. In E. B. Page (Ed.), *Readings for educational psychology*. New York: Harcourt, Brace & World.
- BASICS. (1998). *Guia de diseno de la radionovela El Zambo Angolita*. Arlington: BASICS.
- Bransford, J., Sharp, D., Vye, N., Goldman, S., Hasselbring, T., Goin, L., O'Banion, K., Livernois, J., Saul, E., (1996). MOST environments for accelerating literacy development. In S. Vosniadou, E. de Corte, R. Glaser & H. Mandl (Eds.), *International perspectives on the design of technology-supported learning environments* (pp. 223-255). Mahwah, NJ: Lawrence Erlbaum Associates.
- Buttolph, D., & Branch, R. (1992). Learner characteristics, information types, instructional strategies, and diagrams. In J. Baca, D. Beauchamp, & R. Braden (Eds.), *Visual communications: bridging across cultures* (pp. 327-335). Blacksburg, VA: International Visual Literacy Association.
- Campbell, T., Wright, J., & Huston, A. (1987). Form cues and content difficulty as determinants of children's cognitive processing of televised educational messages. *Journal of Experimental Child Psychology*, 43, 311-327.

- Chu, C., & Schramm, W. (1967). *Learning from Television: What the research says*. ERIC Document ED 914 900.
- Clark, R.C. & Mayer, R.E. (2003). *E-learning and the science of instruction: Proven guidelines for consumers and designers of multimedia learning*. San Francisco, CA: Jossey-Bass/Pfeiffer.
- Clifford, B. R., Gunter, B., & McAleer, J. (1995). *Television and children: Program evaluation, comprehension, and impact*. Hillsdale, NJ: Lawrence Erlbaum Associates.
- Cobb, T. (1997). Cognitive efficiency: Toward a revised theory of media. *Educational Technology Research and Development*, 45 (4), 21-35.
- Cognition and Technology Group at Vanderbilt (1996). Looking at technology in context: A framework for understanding technology and education research. In D.C. Berliner & R.C. Calfee (Eds.), *The handbook of educational psychology* (pp. 807-840). New York: Macmillan.
- Dwyer, F. (1978). *Strategies for improving visual learning*. State College, PA: Learning Services.
- Fisch, S. M. (2004). *Children's Learning from educational television: Sesame Street and beyond*. Mahwah, NJ: Lawrence Erlbaum Associates.
- Greenfield, P. M. (1984). *Mind and media: The effects of television, video games, and computers*. Cambridge, MA: Harvard University Press.
- Guttmacher Institute, Alan (2004). The broad benefits of investing in sexual and reproductive health Guttmacher Report on Public Policy, 7 (1): 5 March 2004 New York: The Alan Guttmacher Institute.
- Haaland, A. & Fussell, D. (1976). *Communicating with pictures*. Kathmandu, Nepal: UNICEF.
- Hochberg, J. & Brooks, V. (1996). Perception of motion pictures. In M. Friedman & E. Carterette (Eds.), *Cognitive ecology*. (pp. 151-203). San Diego, CA: Academic Press.
- Holmes, A, (1963). *A study of visual symbols in Kenya*. London: Overseas Visual Aids Centre.
- Jato, M.N., Simbakalia, C., Tarasevich, J.M., Awasum, D.N., Kihinga, C., & Ngirwamungu, E. (1999). The impact of multimedia family planning promotion on the contraceptive behavior of women in Tanzania. *International Family Planning Perspectives*, 25 (2), 60-67.

- Jih, H. J., & Reeves, T. C. (1992). Mental models: A research focus for interactive learning systems. *Educational Technology Research & Development, 40* (3), 39-53.
- Kane, T., Gueye, M., Speizer, I., Pacque-Margolis, S., & Baron, D. (1998). The impact of a family planning multimedia campaign in Bamako, Mali. *Studies in Family Planning, 29* (3).
- Lang, A. (1995). Defining audio/video redundancy from a limited-capacity information processing perspective. *Communication Research, 22* (1), 86-115.
- Leh, S. C., & Kennedy, R. (2004). Instructional and information technology in Papua New Guinea. *Educational Technology Research & Development, 52* (1). 96-101.
- Mackworth, N. & Bruner, J. (1970). How adults and children search and recognize pictures. *Human Development, 13* 149-177.
- Mayeaux, E. J. Jr., Murphy, P.W., Arnold, C., Davis, T. C., Jackson, R. H., & Sentell, T., (1996). Improving patient education for patients with low literacy skills. *America Family Physician, 53* (1), 205-211.
- Mayer, R. E. (1989). Models for understanding. *Review of Educational Research, 59*, 43-64.
- Mayer, R. E. (2001). *Multimedia learning*. New York: Cambridge University Press.
- Mayer, R. E., & Anderson, R. B. (1991). Animations need narrations: An experimental test of a dual-coding hypothesis. *Journal of Educational Psychology, 83* (4), 484-490.
- Mayer, R. E. & Gallini, J. K. (1990). When is an illustration worth ten thousand words? *Journal of Educational Psychology, 82*, 715-726.
- Mayer, R.E., Heiser, J., & Lonn, S. (2001). Cognitive constraints on multimedia learning: When presenting more material results in less understanding. *Journal of Educational Psychology, 93*, 187-198.
- McBean, G. (1989). *Rethinking visual literacy: Helping pre-literates learn*. Katmandu, Nepal: UNICEF.
- Mielke, K. (1983). Formative research on appeal and comprehension in 3-2-1 CONTACT. In J. Bryant & D. Anderson (Eds.), *Children's understanding of television*. (pp. 241-263). San Diego, CA: Academic Press.

- Mielke, K. & Chen, M. (1981). *Children, television, and science: An overview of the formative research for 3-2-1 CONTACT*. New York: Children's Television Workshop.
- Miles, S., & Davis, T. (1995). Patients who can't read: Implications for the health system. *Journal of the American Medical Association*, 274, 1719-1720.
- Moulton, J. (1997). *Formal and non-formal education and empowered behavior: a review of the research literature*, SARA Project, Washington, DC; USAID/AFR/SD, Washington, DC. 48 pp. PN-ACB-230.
- Mousavi, S., Low, R., & Sweller, J. (1995). Reducing cognitive load by mixing auditory and visual presentation modes. *Journal of Educational Psychology*, 87, 319-334.
- Murphy, C. M., & Wood, D. J. (1982). Learning through media: A comparison of 4-8 year old children's responses to filmed and pictorial instruction. *International Journal of Behavioural Development*, 5, 195-216.
- NAS (2003). Priority areas for national action: Transforming health care quality. Washington DC: Institute of Medicine of the National Academy of Science.
- NCES (2003). *The 2003 National Assessment of Adult Literacy*. National Center for Education Statistics. Number: 2003495rev. Washington DC: U.S. Department of Education.
- Paivio, A. (1971). *Imagery and verbal processes*. New York: Holt, Rinehart and Winston.
- Paivio, A. (1986). *Mental representations: A dual coding approach*. New York: Oxford University Press.
- Parikh, N.S., Parker, R.M., Nurss, J.R, Baker, D.W., & Williams, M.V. (1996). Shame and health literacy: The unspoken connection. *Patient Education and Counseling*, 27 (1), 33-39.
- Pezdek, K. & Stevens, E. (1984). Children's memory for auditory and visual information on television. *Developmental Psychology*, 20, 212-218.
- Powell, E. C., Tanz, R. R., Uyeda, A., Gaffney, M. B., & Sheehan, K. M. (2000). Injury prevention using pictorial information. *Pediatrics*, 105 (1), e16.
- Pratt, D. D. (1993). Andragogy after twenty-five years. In S. B. Merriam (Ed.), *An update on adult learning theory* (pp. 15-23). San Francisco, CA: Jossey-Bass.

- Rieber, L. P. (2000). *Computers, graphics, & learning*. Madison, WI: Brown & Benchmark.
- Rydin, I. (1976). *The tale of the seed: Facts and irrelevant details in a TV program for children*. Stockholm: Sveriges Radio.
- Salomon, G. (1977). Effects of encouraging Israeli mothers to co-observe *Sesame Street* with their five-year-olds. *Child Development*, 48, 1146-1151.
- Sherry, J. L., (1997). Pro-social soap operas for development: A review of research and theory. *Journal of International Communication*, 4 (2), 75-101.
- Singhal, A., Rogers, E. M. (1999). *Entertainment-education: A communication strategy for social change*. Mahwah, NJ: Lawrence Erlbaum Associates.
- Steinberg, E. R. (1991). *Computer-assisted instruction: A synthesis of theory, practice and technology*. Hillsdale, NJ: Lawrence Erlbaum Associates.
- Storey, D., Boulay, M., Karki, Y., Heckert, K., & Karmacharya, D. M. (1999). Impact of the integrated radio communication project in Nepal, 1994-1997. *Journal of Health Communication*, 4, 271-294.
- Sweller, J., Van Merriënboer, J.J.G., & Paas, F. (1998). Cognitive architecture and instructional design. *Educational Psychology Review*, 10, 251-296.
- UNESCO (2006). *Adult (15+) Literacy Rates and Illiterate Populations by Region and Gender*. Montreal, Canada: UNESCO Institute for Statistics.
- Watt, J. H., & Welch, A. J. (1983). Effects of static and dynamic complexity on attention and recall. In J. Bryant and D. Anderson (Eds.), *Children's understanding of television: Research on attention and comprehension*. (pp. 69-102). San Diego, CA: Academic Press.
- Weiss, B.D., & Coyne, C. (1997). Communicating with patients who cannot read. *New England Journal of Medicine*, 337, (4), 272-274.
- Wetzel, C. D. Radtke, P. H., & Stern, H. W. (1994). *Instructional effectiveness of video media*. Hillsdale, NJ: Lawrence Erlbaum Associates.
- Zimmerman, M., Newton, N., Frumin, L., & Wittett, S. (1996). *Developing health and family planning materials for low-literate audiences*. Seattle, WA: Program for Appropriate Technology in Health.