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ABSTRACT

A study investigated the results of previous studies on the effectiveness of pictorial instruction, specifically examining whether the use of black-and-white pictorial instruction as a supplement to verbal instruction is more effective than the use of verbal instruction alone. Thirty-four studies on pictorial instruction that varied widely but that met certain criteria were used as samples for a meta-analysis. Results of the examination indicated that, across all studies analyzed, pictorial instruction was found to be significantly more effective than verbal instruction alone. Findings showed that specific level of pictorial instruction effectiveness was related to socioeconomic background, course content area, course difficulty level, time of exposure, mode of presentation, stimulus detail, time of testing, and course objective. Findings also showed that studies in which different instructors were used in the experimental and control groups yielded higher levels of effectiveness than studies in which the same instructor was used. It is expected that if instructor characteristics had been controlled, the level of effectiveness would somewhat diminish but remain statistically significant. (A table of data is included, and a figure and references are attached.) (NKA)

An Analytic Study of the Efficacy of Black-and-White Pictorial Instruction on Achievement

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Abstract

In this paper, the results of a meta-analysis of the relationship between pictorial instruction, in which black-and-white pictures are used, and achievement are reported. Contrary to previous findings by others, pictorial instruction was found to be significantly more effective than verbal instruction alone. Specific level of pictorial instruction effectiveness was found to be related to socioeconomic background, course content area, course difficulty level, time of exposure, mode of presentation, stimulus detail, time of testing, and course objective. Additionally, it was found that studies in which different instructors were used in the experimental and control groups yielded higher levels of effectiveness than studies in which the same instructor was used. Had instructor characteristics been controlled, it is expected that the level of effectiveness is somewhat diminished but remains statistically significant.

An Analytic Study of the Efficacy of Black-and-White Pictorial Instruction on Achievement

Pictorial Instruction, a common instructional technique, involves a process in which two-dimensional physical resemblances of objects or concepts (e.g., pictures, photographs, schematic drawings, maps, carttons) are used as supplements to verbal instruction. The practice of using pictures as supplements to verbal instruction in many learning situations is based on the belief that visual memory is potent (Yuile and Marschark, 1983) and that providing examples when teaching concepts is crucial to the learning process (Tennyson and Park, 1980).

Many studies have found no significant difference between the achievement of subjects who were exposed to pictorial instruction and that of the corresponding control group (Duchastel, 1980). However, when certain attribute were taken into consideration, use of pictures as supplement to verbal materials could be facilitative. For example, when learners were required to draw or otherwise identify location and interrelation among parts, specific patterns or functions, or content relationships, use of pictures was found to be effective (Dwyer, 1978). Pictorial instruction was found to be effective among learners with low verbal abilities (Holliday, Brunner, and Donais, 1977). However, with young adults, the difference between the effectiveness of pictorial and verbal instruction was not significant (Winn, 1981).

In a review of literature, Knowlton (1966) concluded that the use of "...the analogical and logical picture may have an

unsuspected importance for instruction." In another review of literature, LesGold, DeGood, and Levin (1977) found that pictures were useful extenal memory aids for young children's discourse processing. Haring and Fry (1979) found that pictures facilitate reading comprehension and immediate and delayed recall. Dwyer (1978), in another review of literature, concluded that the use of differnt types of visual illustration and black-and-white versus color pictures led to different levels of achievement.

Overall, the answers to two basic questions remain unclear. First, there is some disparity in the answer to the fundamental question of whether pictorial instruction makes a difference. Theoretical consideration of the potency of visual memory as well as the importance of examples seem to indicate that pictorial instruction should make a difference. On the other hand, most studies have failed to find evidence to support such theoretical belief. However, when pictorial instruction is used under specific sets of conditions or for specific learners, various studies have found it to be effective. A more definitive answer is needed to first address the fundamental question as to whether pictorial instruction in general, is more effective than verbal instruction. Next, an overall summary of conditions under which pictorial instruction is more effective than other conditions is needed.

A second area of disparity in the literature is in the nature and quality of various pictorial instruction studies and reviews. The study vary widely in design, variables measured, methods of analysis, and quality. Reviews of literature in this area have been piece-meal and fragmented. For instance, in

LesGood, DeGood, and Levin's (1977) review of the effects of pictorial instruction on discourse processing, only five studies were considered. This lack of comprehensiveness renders the conclusions from such reviews, at best, tentative with potential bias. Other problems have stemmed from the different methodological approaches used in these reviews. Studies have been integrated chronologically, by objectives, or through other systematic schemes. With the lack of a standard approach to the integration of the original primary studies among thse review of literature, it is difficult to further integrate or syrthesize thse reviews at the next level to derive a general summary of the effectiveness of pictorial instruction.

This paper reports the results of a meta-analysis (cf. Glass, 1976) of the effectiveness of pictorial instruction. In this study, the answer to the general question as to whether the use of black-and-white pictorial instruction as a supplement to verbal instruction is more effective than verbal instruction alone is sought. Additionally, attempts were made to identify conditions under which the use of black-ad-white pictorial instruction as supplements to verbal instruction alone. The specific conditions investigated include: Is there a differential effect among learners from different socio-economic backgrounds? Are effects different when pictorial instruction is used for different content areas (e.g., arithmetic, biology, etc.)? Is the effectiveness of pictorial instruction related to the level of difficulty of the content? Is the effectiveness of pictorial instruction related to whether the picture is presnted before,

with, or after the text? Is effectiveness related to the format of the test used (e.g., multiple choice, etc.)? Is there a differential effect when differnt modes of picture (e.g., line drawings, shaded drawings, etc.) are used? Is effectiveness related to the stimulus detail (e.g. detailed, subject-generated, etc.)? Is there a differential effect among learners at the college, high school, and grade school levels? Is effectiveness related to whether the same instructor was used in both experimental and control groups? Is effectiveness related to the time the test was given (e.g., posttest)? and Is effectiveness ralted to the overall objective of the course or unit (e.g., verbal information)?

METHOD

Samples of Studies

Primary studies were initially identified through a search in ERIC, Dissertation Abstracts, Psychological Abstracts, several other library data bases, and numerous secondary sources from reference listings in journal articles. Through this process, a total of 700 studies were identified as those in which the objective was to assess the effectiveness of pictorial instruction. These studies differed widely in nature, approach, design, variables, and measurement procdures. For the purpose of this meta-analysis, four criteria were used in selecting studies for inclusion in the study. First, anecdotal reports and single group non-experimental studies were excluded. Second, studies in which the control group received treatment other than verbal instruction were excluded. Third, studies in which the dependent

variables were maesures other than achievement were excluded. Fourth, studies in which supplements other than black and white pictures were used were excluded. Of the 700 studies, a total of 34 met all four criteria and were used as samples for the meta-analysis.

Coding Information

For each effect, socio-economic status of the subjects was coded as upper middle, middle, lower middle, and lower. Course content are was coded as reported in the sample. Course content difficulties were coded as easy, moderate, and difficult. Time of exposure was coded as before, with, or after text. The format of test used was coded as reported in the samples. Modes of pictures were coded as line drawing, shaded drawing, model, and realistic pictures. Stimulus detail was coded as reported in the samples. School level of subjects was coded as reported in the samples. Time of tesing was coded as posttest, delayed posttest, and embedded questions. Course objectives were coded as reported in the samples.

Data Analysis

The difference between the experimental and control groups in each study was converted into a standardized effect size through the pooled variancemethod suggested by Hedges (1981). Using these effect sizes as the units of analysis, the relationship between each coded independent variable and the effect size was tested through a one-way analysis of variance. The Scheffe post hoc test was used to identify specific conditions under which pictorial instruction is more effective

than under other conditions.

Results

Overall, across all studies analyzed, pictorial instruction, when used as supplement to verbal instruction, was found to be significantly more effective than verbal instruction alone. The overall mean effect size for all the studies was 0.337 ($t = 6.6078$, $df = 151$, $p < .05$). Table 1 shows the differntial effects of pictorial instruction in realtion to particular independent variables, as revealed through a series of one-way analysis of variance F-tests. The significance of the corresponding Scheffe post hoc tests for those independent variables with significant results overall F ratios are also indicated in Table 1.

Insert Table 1 about here

Discussion

The overall findings of this study confirms the general belief that pictorial instruction is more effective than verbal instruction alone, as suggested by Yuile and Marschark (1983) and Tennyson and Park (1980). and departs from the the findings of Duchastel (1980). The overall mean effect size across all comparisons for all studies was 0.337, which was found to be significantly greater than zero. When this mean effect size is interpreted as a z-score analog, it indicates that the mean score on subsequent test among subjects who have received black-and-white pictorial instruction is equivalent to the 63rd percentile

among students who have received verbal instruction alone. In other words, the addition of black-and-white pictures as supplements to verbal instruction will improve a student's test score from the 50th percentile to the 63rd precentile, a gain of 13 percentile points.

Next, conditions under which the use of black-and-white pictures as supplements to verbal instruction are more effective were identified by by analyzing the overall effectiveness across the conditions specified earlier:

1. Is there a differential effect among different socio-economic backgrounds? The results of this study support the notion that black-and-white picture, used as supplement to verbal learning, produce differential effects among different socio-economic groups. Post hoc tests indicated that the use of pictorial instruction is significantly more effective with the extreme ends of the socio-economic groups i.e., lower (ES = 1.49), and upper (ES = 0.52).

2. Are effects different when pictorial instruction is used for different content areas? Table 1 shows that pictorial instruction produce significantly different effects among different content areas. Post hoc analysis showed that black-and-white pictorial instruction is more effective with courses in electrochemistry (ES = 0.814), prose (ES = 0.624), and arithmetic (ES = 0.52).

3. Is the effectiveness of pictorial instruction related to the level of difficulty of content? An interesting pattern emerged when the levels of effectiveness were compared across different

content difficulty levels. Specifically, black-and-white pictorial instruction was found to have a significant and strong positive effect for easy courses. For moderate and difficult courses, negative effects were found. The implication appears to be that, while pictorial instruction is beneficial to students in relatively easy courses, the use of black-and-white pictures as supplements to verbal learning may be less effective than using verbal instruction alone for moderately difficult and difficult courses. Figure 1 provides a graphic display of the relationship between pictorial instruction effectiveness and course difficulty levels. It should be pointed out that the differential effectiveness between moderate and difficult courses was not statistically significant, indicating that the slight upswing from moderate to difficult level in figure 1 can be attribute to sampling fluctuation.

Insert Figure 1 about here

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4. Is the effectiveness of pictorial instruction related to whether the picture was presented before, with, or after the text? The effectiveness of the use of black-and-white picture for instruction was found to be related to the time of exposure to the picture. It was found that presenting the picture after the text is significantly more effective (ES = 0.748) than when the picture is presented before or with the text.

5. Is effectiveness related to the format of the test used? There was no evidence that levels of effectiveness were different among the format of test used.

6. Is there a differential effect when different modes of picture are used? This study found significant differential levels of effectiveness when different modes of picture are used. Post hoc analysis showed that pictorial instruction is more effective when the picture is realistic (ES = 0.52), or a line drawing (ES = 0.475), or a shaded drawing (ES = 0.311).

7. Is effectiveness related to stimulus detail? Effectiveness of pictorial instruction was found to be related to stimulus detail. Post hoc tests showed that instruction was significantly more effective when the pictures are subject-generated (ES = 0.797), reflect main ideas (ES = 0.361), and are detailed (ES = 0.305).

8. Is there a differential effect among learners at the college, high school, and grade school levels? Although there was no evidence that the level of effectiveness were different among different school levels, the negative effect produced when black-and-white pictorial instruction was used for subjects in kindergarten should be noted. This suggests that perhaps using colored pictures will produce positive effect among this subjects.

9. Is effectiveness related to whether the same instructor was used in both experimental and control groups? It should be noted that when studies in which the same instructor was used in both the experimental and the control groups (ES = 0.265) were compared against those in which different instructors were used (ES = 0.492), the latter showed significantly higher mean effect size. This is suggestive that pictorial instruction

effectiveness may be confounded by the characteristics of the instructor. Unfortunately, information on the characteristics of the instructors used were not available in this study. Data in table 1 however, suggests that, should studies in which subjects were tested within instructors be excluded because of the unknown confounding effect, the general effect size would have been reduced from 0.337 (i.e., 63rd percentile) to 0.235 (i.e., 60th percentile of the control group). However, this smaller effect size is still statistically significant ($t = 4.5120$, $p<.05$), indicating that, had the confounding effects of instructor characteristics been controlled, pictorial instruction would still be generally more effective than verbal instruction alone.

10. Is effectiveness related to when test was given? Another interesting pattern that emerged from the ANOVA was the relationship between effect size and time of testing. Among the 149 effect sizes analyzed, those associated with a delayed posttest showed a high mean effect size. Those associated with an immediate posttest showed a smaller mean effect size. Only one among the 149 effect sizes was associated with an embedded test in which subject were tested throughout the course. If the single case of the embedded test is ignored because of inherent instability, it can be speculated that black-and-white pictorial instruction has a stronger long-term effect than short-term effect, as indicated by the fact that subjects tested later showed a higher effect size than those tested immediately after the completion of the course. This generally, confirms Haring and Fry's (1979) finding that pictures facilitated immediate and delayed recall. Additionally, it was found that pictures had

more effect on delayed recall than immediate recall.

11. Is effectiveness related to the overall objective of the course? Effectiveness of black-and-white pictorial instruction was found to be related to the objective of the course of instruction. It was found to be significantly more effective for courses in which the objective was to teach concrete concepts, intellectual skills, verbal informacion, rule, discrimination, or attitude.

further investigations are needed in the areas of non-black-and-white pictorial instruction (for example, colored pictures), course content areas not discussed in this study, and the efficacy of pictorial instruction with special population (for example, gifted students).

TABLE 1

Mean Effect Sizes ($\bar{X}ES$), Standard Deviation, Number of Effect Sizes, and F Tests For all Independent Variables.

Variable	$\bar{X}ES$	SD	N	$F(df_1 df_2)$	P
1) Socio-Economic Status	0.2516	0.5116	64	2.665(1,62)	0.031
Upper	.5200*	.0001			
Upper-Middle	.2690	.2402			
Middle	.2311	.5013			
Lower-Middle	.5022	.7080			
Lower	1.4900*	.0001			
2) Course Taught	0.3366	0.5685	152	6.487(1,150)	0.001
Arithmetic	.5200*	.0000			
Prose	.6244*	.6913			
Electro-Chemistry	.8137*	.6856			
Biology	.1731	.2403			
Reading	.1727	.6146			
3) Content Difficulty	0.0432	0.4921	19	5.471(1,17)	0.111
Easy	.6660*	.6478			
Moderate	-.2467	.1350			
Difficult	-.1609	.4647			
4) Time of Exposure	0.3692	0.6240	131	5.407(1,129)	0.006
Before Text	.2600	.2948			
After Text	.7475*	.6866			
With Text	.2866	.6283			
5) Format of Test	0.3553	0.6143	149	0.755(1,147)	0.386
Multiple Choice	.3746	.5889			
Essay	.4306	.5780			
Combination	.4517	.3656			
Oral	.2495	.7317			
6) Mode of Drawing	0.3366	0.6007	151	3.088(1,149)	0.005
Line Drawing	.4753*	.6141			
Shaded Drawing	.3108*	.3347			
Model	-.0020	.3300			
Realistic Picture	.5200*	.0010			
7) Stimulus Detail	0.3554	0.5668	117	2.533(1,115)	.044
Subject-generated	.7969*	.8783			
Detailed	.3050*	.4118			
Simple	.2357	.3634			
Association	.1367	.0723			
Main Ideas	.3609*	.6510			

TABLE 1 (CONTINUED)

Variable Value	$\bar{X}$ES	SD	N	$F(df_1 df_2)$	P
8) School Level	.3366	.6164	152	2.8525(1,150)	.0564
College	.1874	.6017			
High School	.2754	.2172			
Middle School	.4840	.3865			
Elementary	.4624	.6584			
Kindergarten	-.0350	.8977			
9) Same Instructor for Experimental and Control Groups	.3366	.6204	152	4.4157(1,150)	.0373
Same	.2648*	.5985			
Different	.4923*	.6659			
10) Time of Testing	.3553	.5869	149	13.3357(1,147)	.0004
Post test	.2871*	.5325			
Delayed Post	.6786*	.8407			
Embedded Question	1.8400*	.0000			
11) Objective of Course	.3366	.5929	150	5.4579(1,148)	.0209
Overall achievement	.3835	.3950			
Error	-.1700	.5574			
Time On Task	-.0419	.4461			
Concrete Concept	.5185*	.7513			
Defined Concept	.1387	.4384			
Intellectual Skill	.6900*	.0000			
Verbal Information	.4153*	.7215			
Motor Skill	.2533	.1568			
Rule	.5917*	.3618			
Discrimination	.9500*	1.0811			
Problem solving	.2033	.3495			
Attitude	1.3750*	1.4779			

* Post hoc Scheffe tests indicated that the mean effect size for this subcategory was significantly different from other subcategories.

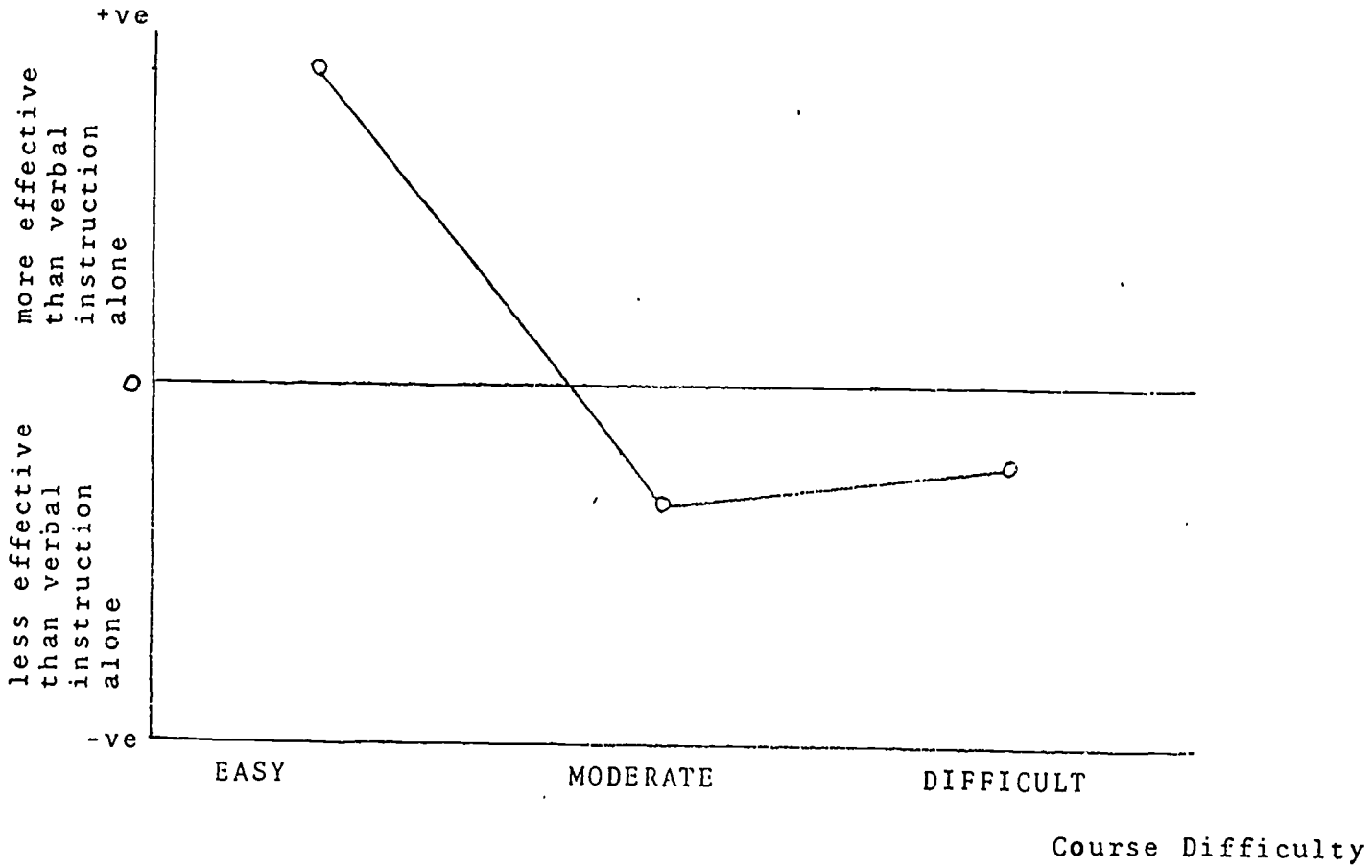

FIGURE 1: Relationship between Course Content Difficulty and Effects of Pictorial Instruction.

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