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ABSTRACT

The role that illustrations can play in textbooks and other instructional materials is an issue that must appear rather baffling to the instructional materials designer. Focusing primarily on the use of illustrations in textbooks designed for able readers, a literature review has revealed the following: (1) illustrations have been shown in a few instances to facilitate comprehension, although a number of other studies have not been successful in showing this; (2) a number of studies have shown that illustrations can enhance recall, but recall is suspected of often being confounded by comprehension; and (3) that pictures can assist with attitude change in some situations has been demonstrated, while one of their attributes, namely the attractiveness of illustrations, does not seem to have been directly tested. In summary, despite many failures to support the value of illustrations in texts, their value has been confirmed by recent studies and by the long tradition that constitutes the practice of graphic design. Research needs to move on to new frameworks, such as the functional one, where it can help to develop the reasons for illustrations aiding learning and can thus inform future practice. (RL)

Occasional Paper 3

RESEARCH ON ILLUSTRATIONS IN INSTRUCTIONAL TEXT

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The role that illustrations can play in textbooks and other instructional materials is currently an issue which must appear rather baffling to the instructional designer. On the one hand, a long tradition of textbook design based on creative intuition and tacit knowledge strongly supports the value of illustrations in teaching materials, but on the other hand much of the empirical research on the use of illustrations falls rather short of the expected confirmation of this intuitive view. Indeed, the research as a whole is sometimes seen as essentially saying that illustrations are not really that very important, if not in some areas actually harmful (cf. Samuels, 1970).

The state of the art is certainly a confused one and the instructional designer has little option but to disregard the research and continue to rely on his creative instincts when it comes to the practical art, for that is what it is, of textbook illustration. One of the themes of this review will be that research still gives us a very improper view of the area, one which is unduly negative and certainly counter-intuitive. Much of the research up till now has quite simply attempted, and often failed, to demonstrate that illustrations can have an effect on learning. Little however can be learned from the failures, nor much more from the successes. New frameworks are however emerging which provide different perspectives from which to view illustrations in texts and one purpose of this review will be to draw attention to these new frameworks. Denburg (1976-77) put it well when she said that it is not enough to state that illustrations can enhance learning, one must also state why or how it is done.

Background

There are a number of previous reviews of the research on illustrations in text and the reader is referred to these for further discussion of particular studies. The review by Samuels (1970) is generally well-known, especially for its conclusions on the use of illustrations in books for beginning reading

instruction. Carroll (1971) also discusses the area of illustrations although much more succinctly, in his review of learning from verbal discourse. An excellent review is one by Holliday (1973) in which the research is confronted with practice, a theme taken up here, as also by Macdonald-Ross (1977;1978) in two reviews, one a comprehensive review of the research on depicting quantitative information, the other a review of graphics in text. An interesting review by Fleming (1979) has also recently appeared.

The present review covers much of the research on illustrations generally, but specifically avoids the area of quantitative information as Macdonald-Ross' review (1977) does such a good job of it. The reading instruction area will be treated only briefly. While it is the most controversial area, it remains a very specialized one. The main focus of the review will lie in the use of illustrations in textbooks which are designed for able readers. The general question of concern is whether our school and university textbooks profit from being illustrated. The framing of this question leaves out, it should be noted, the recently active area concerned with imagery strategies (cf. Fleming, 1977, for a practical review) as well as reader-generated pictures, as investigated for instance by Snowman & Cunningham (1975) or Rasco, Tennyson & Boutwell (1975). It also leaves out the research on illustrations accompanying instructional media other than textbooks, such as the work on illustrated oral presentations (for instance many of Dwyer's studies, 1972; much of the work of Levin and his colleagues, e.g., Levin, Bender, and Lesgold, 1976).

Framing the research

Illustrations are not a unitary set of components in instructional texts and the term 'illustration' (or picture) is a generic one which covers such diverse elements as photographs, schematic drawings, diagrams, maps, etc. It can be easily suggested therefore that asking whether pictures aid learning is not unlike asking

whether music helps dancing. It depends on the kind of music and it likewise depends on the type and quality of pictures! The pictures in a text can be well chosen or they can be poorly chosen; diagrams can be clear and to the point or they can be ambiguous and difficult to interpret (cf. Macdonald-Ross, 1977, for some detailed criticisms along these lines).

Pictures also need to have a clear purpose to justify their inclusion in a text. Merely including assorted and seemingly relevant pictures here and there in a text and then wondering whether they will help learning is asking for trouble. Thus one difficulty with any research on illustrations lies in the question of appropriateness, which unfortunately is difficult to judge, more so perhaps than with other components of instruction because of the great scope for diversity and creativity within the area of text illustration. It would not be unreasonable to think that much of the ambiguity of the results from pictorial research is tied up with this question.

A related difficulty would seem to lie in the type of prose materials which are illustrated and in the sophistication of the readers. An illustrated version of a children's story is very different from an illustrated college textbook. Thus, the more one thinks of the scope of illustrations, both in variety and in setting, the less one is surprised by the lack of consistency of the research over the years. The effect this should have on us is to temper our natural propensity for generalization and also to view with some healthy degree of diffidence the conclusions derived from the research. Indeed, research conclusions are only part of the picture, limited by the extent of the questions we ask about illustrations.

After taking a look at the beginning reading controversy, I shall examine the effects of pictures in three domains: in comprehension, in recall, and in motivation. Comprehension and recall are often difficult to separate, especially in measures of learning based on texts used in the early years of schooling, and it is with some hesitancy that the distinction is used. However, this distinction does make sense from a pictorial point of view, for the explicative function of

illustrations can be very different from their retentional one (cf. Duchastel, 1979a). The distinction is also made in a number of the research studies, although usually not in strong operational terms unfortunately.

I shall also mostly be concerned with those studies where pictures have had some effect, for little can be said of the remainder, except that their lack of effect is possibly a result of the special difficulties involved in this area of research. Indeed, it is taken nearly as axiomatic, on other grounds, that illustrations can assist learning and that their use should be encouraged in book design. The grounds for such a position are those on which rest the long tradition of good graphical text design.

The Learning to Read Controversy

The issue concerning the role of pictures in learning to read is whether basal reading books should be illustrated or not. There is general agreement that pictures can play an important motivational role in arousing the young reader's interest and making more pleasant the difficult task of learning to read. Where viewpoints do differ is in whether the actual process of acquiring a sight vocabulary (learning the meanings of printed words) is aided or not by pictures illustrating those words. In his well-known review, Samuels (1970) has concluded that pictures can actually interfere with learning new words. The explanation offered is that pictures can, to some degree, pre-empt the printed words as the basis for the oral response of the child. If the child can make the appropriate response by simply looking at the picture, why bother fully processing the printed stimuli? On the other hand, Denburg (1976-77) reports evidence that pictures can facilitate the learning of new words. Her explanation is that pictures can act as extra cues which can help the young reader process the printed stimuli. When the child gets into trouble with a given word, the picture is there to help him or her along.

Both explanations are probably right in their own way. Whether pictures will help or hinder a child in making sense of new words will depend on the degree to which the child is led by the demands of the task to use the pictures either as crutches or as aids in processing the printed stimuli. The contrasting strands of evidence from the research indicate the complexity of the situation and the need to further refine the investigations in this area in order to directly analyze the processes involved and find out why and under what conditions pictures help or hinder the acquisition of new words.

It is regrettable however that this issue is discussed in terms of learning to read, for it is but a small part, albeit an important one for sure, of the total process of developing fluent reading. Learning words is one thing; deriving meaning from a sentence or a paragraph is much more again. This latter consideration renders the situation even more complex, for to then say that pictures should not be encouraged in learning to read tasks is seen as a much bolder position to take. The use of pictures in texts can often involve delicate trade-offs: it may hinder one aspect of learning, while facilitating to a greater extent some other aspect. This may well be the case with learning to read. Intuition carries the day here for, as we have seen, research has as of yet barely oriented itself in the proper direction and much remains to be done.

Can pictures be shown to facilitate comprehension?

Of the many studies which have attempted to show a facilitative effect on comprehension, many have failed to do so (Vernon, 1953, 1954; Burdick, 1959; Weintraub, 1960; Koenke, 1968; a number of the studies by Dywer, reported collectively in 1972; Yancey, 1972). The Vernon studies are well known and often criticized for their lack of rigor, for example by Holliday (1973) and Macdonald-Ross (1977). They illustrate quite well some of the difficulties of pictorial research alluded to earlier in this review and as such, they stand as important landmarks in the area. The studies by Dwyer are also well known. His concern was to explore the

relationship between the degree of realism in pictures on the one hand (on a continuum from abstract linear sketches of the human heart to realistic color photographs of the heart) and various types of learning outcomes on the other hand. His research thus shows a sophisticated sensitivity to the complexity of the area and is very important in that respect. His results essentially show that more realism does not necessarily lead to more learning, a conclusion which follows from practical intuition. One of his measures of learning was a comprehension test and on this test, results were generally not encouraging, for illustrations often failed to enhance learning over that of a control group without illustrations. This aspect of the work however has been rightly criticized by Holliday (1973) for not having optimized the explicative function of the illustrations. In other words, the pictures used were not the best which could be developed for explicative purposes and thus constitute poor materials with which to examine comprehension effects. They were well suited for other purposes however, as we shall see in the section on recall effects.

Weintraub's study (1960) stands apart from the others in the area as the only one, apart from the many reading instruction ones, in which illustrations had a deleterious effect on learning. The study was conducted with second graders and the lower comprehension of the group of children with illustrations is possibly due to a distraction effect similar to the one revealed by Samuels (1970).

There are a few studies which have found a facilitory effect of illustrations on comprehension (Weisberg, 1970; Rasco, Tennyson & Boutwell, 1975; Royer & Cable, 1976). Weisberg's materials dealt with the North Atlantic ocean floor and it is easy to see that terrain profiles and a map would be helpful. The materials in one of the experiments conducted by Rasco et al. (1975) presented the arithmetic concepts of intersection and empty set to fourth and fifth graders, with or without accompanying drawings; these facilitated the comprehension of the fourth graders.

In other experiments reported in the same study, the illustrations depicted the attributes of concepts involved in a text on revolutions and here also they aided comprehension of the material. The Royer & Cable materials dealt with the internal structure of metals and the illustrations were specifically designed to increase the comprehensibility of the passage. The effects of illustrations were found to increase transfer effects to a related passage, transfer being the sole dependent measure used in this study.

In summary, illustrations have been shown in a few instances to facilitate comprehension, although a number of other studies have not been successful in showing this. It is difficult to judge however to what extent these latter studies constitute a good test of the hypothesis in question. Is the effect of illustrations on comprehension just a small one or are the research difficulties just big ones? Anyone's experience with science texts would lead one to believe that the latter is more probably the case. Type of content must inevitably be considered here: some materials just do not need explicative illustrations to be understood, while others most certainly do. Considering this, one wonders whether the global question of general facilitation is worth asking at all.

Can pictures be shown to facilitate recall?

Recall is sometimes undoubtedly confounded with comprehension, for a text which is better comprehended will be better retained (cf. for instance Dooling & Lackman's interesting study of comprehension effects, 1971). However, recall effects do make sense in the textbook illustration field because of the strong memory one can have of pictures as opposed to that of words (cf. Paivio, 1975).

The Vernon studies mentioned previously (1953, 1954) generally failed to enhance recall of the main ideas of the text although there is some indication, unclear as it is, that those ideas which were illustrated were better recalled.

Both Samuels and Carroll mention a successul study by Halpert (1943) with primary school children. Dwyer (1972) has also found some recall effects with college students although not consistently. His studies illustrate well the difficulty of separating out comprehension effects from those of recall. Dwyer's Identification Test required the students to identify various heart structures shown on the drawing of a heart. His Terminology Test required the recall of structure names within sentences dealing with physical or functional attributes of the heart. While recall is certainly involved in responding to both of these tests, the degree to which it is independent of comprehension is difficult to assess.

Peeck (1974) conducted a very interesting study, which shows great sophistication in pictorial research. He provided fourth graders with an illustrated story in which pictures and text sometimes conflicted, but not always; for instance the text might say that "the hippopotamus pulled the tablecloth off the table" but the picture would show a king doing so. The group of children with pictures recalled correctly illustrated text contents better than those without pictures, and did no better on those parts of the text which were not illustrated. As for the incongruous information (where text and pictures conflicted), those with pictures tended to opt in their responses for the pictorial information rather than the text information. The impact which pictures can have can thus be quite a strong one in illustrated stories. Peeck also examined retention a week later and there were indications that the pictorial content was better remembered than the verbal content, although the effect was somewhat confounded, because of the particular design employed, as he himself acknowledges. The importance of the study lies in the beginning interest shown in later retention effects of illustrated texts, for this constitutes the real test of the retentional role of illustrations. A recent study by Duchastel (1979b), in which retentional effects were of primary concern, failed to find retentional facilitation two weeks later for an illustrated text on energy.

In summary, a number of studies have shown that illustrations can enhance recall, although recall is suspected of often being confounded by comprehension. Most studies have examined only immediate recall effects and few have therefore tested the strong version of the hypothesis which predicts better long-term retention of illustrated texts.

Can Pictures be shown to increase interest?

One of the main reasons for illustrating books has long been to make the books more attractive and more appealing to the reader, as well as more marketable of course from the publisher's point of view. Indeed, the enhancement of interest is one of the reasons put forth by those who believe that even basal readers should be illustrated. While there is undoubtedly much market research conducted by publishing firms to support this intuition, I am aware of no educational studies which have directly examined the issue. Here again then, the issue is carried on intuitive grounds, and not unreasonably so.

A related issue concerns the extent to which pictures can be used to support attitude change. Vernon (1953) investigated this issue with pictures on slum conditions which accompanied short texts on tuberculosis and childhood illnesses. She reports that the pictures did create a considerable impression on many of the students, but her results as a whole are not very clear-cut. On the other hand, Samuels (1970) reports and comments on an interesting study by Litcher & Johnson (1969) who brought about favorable racial attitude change through the use of multiethnic pictures in a second grade reader.

In summary, that pictures can assist with attitude change in some situations has been demonstrated, while one of their main attributes, namely attrativeness, does not seem to have been directly tested. There seems little doubt however that an attractively illustrated book will be preferred to the same book without pictures. Research on this issue would likely only prove to be tautological.

Frameworks for research

Research up till now has had relatively little impact in the area of text illustration. At least, that is what would seem to follow from the research reviewed above. Among the attempts aimed at confirming the value of text illustration, more seem to have failed than to have succeeded in doing so. Nevertheless, the overall picture can certainly be construed as rosier than it is often portrayed to be in the literature. That illustrations can assist learning, in terms of comprehension and recall, has been demonstrated in a number of studies and that is all that is needed to substantiate a continued belief in their value in textbook design.

The research has been successful in showing that there may be some danger in the improper use of illustrations, such as in certain arrangements in primers aimed at teaching a sight vocabulary. Much more needs to be done here however to establish which arrangements of illustrations are harmful and which are helpful and whether certain trade-offs of effects are warranted (for instance, greater interest at the expenses of slower learning). The issue will undoubtedly continue to be a complex one.

The research has also been instrumental in countering extreme beliefs, such as the one that the more realism contained in pictures, the better these would be. Dwyer's research (1972) has largely dispelled this belief.

On the other hand, Dwyer's numerous studies with the same basic materials and illustrations also confirms the fickleness of the area, i.e., its basic sensitivity to slight changes in conditions. Indeed, in Dwyer's research, a number of seemingly unimportant variables were found to interact with the illustrations (variables such as size of pictures, school grade, etc.) Coupled with the more fundamental difficulties mentioned in the introduction, this capricious nature of the area can well lead one to not ponder at length on the many failures to confirm the value of illustrations in text.

There have been some attempts at analyzing the area of illustrations with a view to establishing frameworks to guide future research. Dwyer's consideration of degree of realism is exemplary in this respect. There have been some brave attempts at establishing taxonomies of illustrations (Fleming, 1967; Twyman, 1979) although with little consequent enthusiasm for them in the field, perhaps because of the inherent difficulties of basing taxonomies on the physical attributes of pictures instead of on their communicative intent (cf. Knowlton, 1966; Novitz, 1977; Duchastel, 1979a).

In the same vein, isotype has been developed (Neurath, 1974) as a set of principles to guide graphic designers in the area of depicting quantitative information (cf. Macdonald-Ross, 1977). More generally, Smith (1960) ha developed a number of creative principles for textbook illustration, although these do not fit into any overall theoretical framework. Both sets of principles can be useful to the educator involved in text illustration; whether however they will lead to strong research frameworks is more doubtful. What they certainly do in any case is to lead the way towards a functional framework for illustrations and away from the initial framework based on physical attributes. This shift, which can prove to be important for future pictorial research, is toward a viewpoint which states that what a picture looks like is of secondary concern; primary concern needs to focus on what a picture does in its particular context. The functional approach needs to replace the morphological one in research on illustrations.

Much of past pictorial research shows an intuitive awareness of the functional approach, although there have been few attempts to systematize it. Knowlton (1966) provides a lead by categorizing pictures as either realistic, analogical or logical. The realistic picture is used to represent something directly (e.g., what a dodo bird looks like), while the analogical picture presents a simile (e.g., in a biology book, a picture of two lumberjacks moving a felled tree, the tree representing a

bone and the lumberjacks being the muscles--an example given by Knowlton). As for logical pictures, they schematize what is being represented (a road map being a good example). Thus, pictures "work" in different ways to achieve their effects and the way they do this can usefully be considered in future research.

A more global functional approach has been developed by Duchastel (1979a) in which illustrations are considered as having attentional, explicative and/or retentional roles. In other words, illustrations can be included in a text in order to interest and motivate the reader, in order to help explain a point being made in the prose, and in order to enhance long-term recall of the prose. These functions are not mutually exclusive and considerations of emphasis (or trade-offs) enter into the practical process of designing illustrated texts. This approach is a strongly functional one and may represent one likely direction for future pictorial research.

To sum up, despite many failures to support the value of illustrations in texts, their value has been confirmed by some studies and in any case it is strongly supported by the long tradition which constitutes the practice of graphic design. Research needs to move on to new frameworks, such as the functional one, where it can help to develop the reasons why illustrations can aid learning and thus inform future practice.

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