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# THE EFFECT OF VARIED INSTRUCTIONAL STRATEGIES (VISUAL AND VERBAL) IN COMPLEMENTING PRINTED TEXT

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**ABSTRACT**

The purpose of this study was to measure the relative effectiveness two types of illustrations in facilitating college student achievement of different learning objectives. It also attempted to evaluate whether illustrations were able to improve learning when students were reading textbook-like material which consisted of keywords in English. One hundred and ninety-eight students at National Taiwan University participated in the study. Students took four criterion tests immediately after receiving the respective instructional units. The results of this study indicate that a) the use of illustrations to complement print instruction did not automatically improve student achievement on all types of learning objectives, and b) variation in the amount of realistic detail in illustrations did not make a significant difference in facilitating student achievement on the individual criterion tests.

## INTRODUCTION

Visual illustrations have been commonly used in many instructional settings, from kindergarten to college, to complement print instruction. It seems that the inclusion of illustrations in textbooks is based on the assumption that illustrations are effective in facilitating student achievement on learning. In general, illustrated text requires relatively more time and is more expensive to produce than text-only material. Therefore, it is important to investigate the effects that illustrations have on aiding learning.

Research on the effects of illustrations has resulted in mixed and contradictory findings. By reviewing 55 illustrations-related experimental studies, Levie & Lentz[1] concluded that illustrations could improve learning of print text, but the effects of illustrations depended on how they were used. In an analysis of 74 studies on visualized and conventional instruction carried out in college classes, Cohen, Ebeling, and Kulik[2] reported that visualized instruction had no significant effects on students achievement. In a report of the results of a systematic evaluation on visual learning, Dwyer[3] concluded that "... for specific educational objectives visualization of content material is no more effective than the same instruction without visualization"(p.1).

On the other hand, illustrations consist of many types when used in textbooks. Dwyer[4] listed eight types of illustrations based on the amount of realistic detail possessed by the individual visualized treatment, and he pointed out that an increase in realism in a visual did not always cause a significant increase in learning. It is obvious that if the effects of illustrations are to be studied, the realism characteristics of illustrations should be taken into consideration.

Since 1965, Dwyer and his associates conducted more than 100 systematic research studies[4,5,6]. In these studies, a 2000-word instructional unit describing the human heart, its parts, and its internal process was developed. After receiving different types of presentation, the students received different criterion tests. In a report of overall studies, Dwyer[7] concluded that all types of visuals were not equally effective in facilitating student achievement of different educational objectives. The present study was designed to determine whether the same results would be found when Dwyer's instructional unit was translated into Chinese. However, quite a few textbooks used by college students in Taiwan are in English, and it is not uncommon that in many cases students need to memorize keywords in the text in English. Under these circumstances, students must understand the meanings of keywords first in order to have a complete understanding of the text. The study also attempted to determine whether illustrations can aid learning of text when keywords in the text are in English.

## Related Literature

The effectiveness of illustrations has received wide attention in recent decades. The advantages of illustrations in improving learning were found in many studies. Peeck[8] indicated that illustrations facilitate the learning of some specifiable information in a text. Florence & Geiselman[9] suggested that illustrations with iconic symbols were easier to locate and easier to recall from memory. Anglin[10] found that, in both immediate test and delayed testing, students who read illustrated prose materials achieved significantly higher scores that those students who read the same prose materials without the illustrations. Levin[11] listed eight assumed functions of illustrations: decoration, renumeration, motivation, reiteration, representation, organization, interpretation, and transformation. Levie & Lentz[1] indicated the possible functions of illustrations as: attentional, affective, cognitive,



and compensatory. Other research has shown that visuals also clarify and reinforce printed instruction and assist in understanding relationships and abstract concepts [4,12,13,14].

In many cases, illustrations were used in complement the print or verbal presentation. Schallert[5]regarded illustrations as metaphors in that they increased vividness of the text and represented information more economically. For information that was impossible to be verbalized, illustrations could enable the learner to transend the relationship between events, concepts, etc.

The effects of illustrations to complement print instruction may be explained by the 'cue summation theory' which predicts that learning will be more complete as the number of cues or stimuli in the learning material increases[16]. Gropper[17] pointed out that visual materials were effective in aiding learning in that they functioned as cues, reinforcers, and examples.

The instructional effectiveness of illustrations does not always occur in all circumstances. Levie & Lentz[1] indicated that "illustrations had a significant positive effect on learning illustrated text information and no effect on learning nonillustrated text information" (p. 198). They also reported that, if used simply as decorative stimuli, illustrations did not automatically facilitate students to learn messages contained in the text.

Sewell & Moore[18] concluded that learners preferred instructional texts which were complemented by illustrations. But, it seemed that learners' preference had no significant relationship with learners' achievement. In a study by Dwyer[19], students who selected their preferred treatment (text with color illustrations) did not achieve higher scores on the criterion tests than those students who received treatment without illustrations. The presence of illustrations may impede the learning of content that is not illustrated. Vernon[20] also pointed out that illustrations might distract attention for the rest of the text.

The inconsistent conclusion of many of the illustration-related studies may be explained by the fact that many studies did not specify learning objectives in their studies. Dwyer[4,5] indicated that the use of visual materials to complement print instruction was not equally effective in all instructional settings for all types of educational objectives. Using literal illustrations and analogical illustrations in an experimental study, Hurt[21] concluded that the achievement of different instructional goals might require the use of different types of illustrations. Wager[2] also contended that one of the most common problems in visual research was that the researchers did not identify the domain of outcomes in the experimental studies. He indicated that in order to improve the generalization of visual research, it was necessary to specify learning objectives.

## Methods and Procedures

Subjects of this experimental study consisted of one hundred and ninety-eight undergraduate students enrolled at National Taiwan University. Twenty-six of the subjects were solicited from the College of Science, while the rest were from the College of Liberal Arts.

The content material employed in this study was a Chinese translation with some modification of Dwyer's instructional unit. It was a 2000-word instructional unit describing the human heart, its parts, and the processes which occur during the systolic and diastolic phases[4,5]. The content material was selected specifically because it provided a hierarchy of several types of learning objectives, extending from the learning of basic facts, concepts, etc. to complex problem solving.

All students participating in this study received their respective instructional unit in textbook-like format. Students were randomly assigned to one of five treatment groups. Students in Treatment I, the control group received Chinese text without illustrations. Students in Treatment Group II received the same instructional text which was complemented by twenty simple line drawings of the heart which were illustrating basic information presented in the text. Students in Treatment Group III received the identical text; however, their instructional text was complemented by twenty detailed shaded drawings. Students in Treatment Group IV received a text only version of the instruction, however, approximately 200 relevant English keywords were embedded in the text. For example, whenever the words "aorta" was mentioned in a sentence, it was spelled in English while the other words in the sentence were in Chinese. Students in Treatment V received the text complemented by simple line illustrations along with the same English keywords recevied by students in Treatment IV. Students in each treatment group were allowed to interact with their respective instructional unit for a long as they felt necessary to acquire the information being presented.

## Criterion Measures

Immediately after receiving the instruction, students took four self-paced criterion tests. They were allowed to take as much time as needed to complete one criterion test before proceeding to the next. Students in all five treatment goups received identical test items. Since the instructional units for Treatments IV and V consisted of English keywords, the test items for these two groups used English terms whenever appropriate. For example, when a keyword terms such as 'tricuspid' valve appeared in test items for Treatment Group IV and V, it was spelled out in English while other words in the sentence were in Chinese.

Test items were designed to evaluate student achievement of specific learning objectives. Test I, Drawing Test, was to evaluate student knowledge of specific locations of the parts of the heart. Students were required to draw a diagram of the heart and place the numbers of the listed parts in their respective locations. Test 2, the Identification Test, consisted of 20 multiple-choice items to evaluate student ability to identify numbered parts on a line-drawing of a heart based on information received from the instruction. Test 3, the Terminology Test, consisted of 20 multiple-choice items to measure student knowledge of specific terms, definitions, facts related to the heart. Test 4, the Comprehension Test, also consisted of 20 multiple-choice items to evaluate student understanding of the heart, its parts, and its internal activities during the systolic and diastolic phases. Scores received on these four tests were combined in an 80-item Total Criterion Test, which was designed to measure students' total understanding of the concepts presented in the instructional material.



Each correctly answered item was scored as one point. The reliability coefficient for each test employing Kuder-Richardson Formula 20 was: Test 1, r=0.86; Test 2, r=0.84; Test 3, r=0.81; Test 4, r=0.74; Total, r=0.94.

## Results

Significant differences were found to exist among the means on four of the five criterion tests (Drawing Test, $F=10.51$, $df=4/193$, $p<.001$; Identification Test, $F=9.08$, $df=4/193$, $p<.001$; Terminology Test, $F=7.04$, $df=4/193$, $p<.001$; Total Criterion Test, $F=7.86$, $df=4/193$, $p<.001$). Insignificant differences were found to exist in the comprehension test. The Scheffe Procedure was used to analyze differences among the means. The alpha level of significance was set at the .05 level.

On the Drawing Test, students receiving the simple line treatment (Group II) and detailed, shaded drawing treatment (Group III) achieved significantly higher scores than students receiving the treatment without illustrations (Group I and Group IV) (Table 1).

**Table 1**

Scheffe Procedure Showing Mean Comparisons: Drawing Test

| Treatment Group | N | Mean | S.D. | Results |
|---|---|---|---|---|
| I | 38 | 7.94 | 4.62 | II>I |
| II | 40 | 11.67 | 6.14 | II>IV |
| III | 41 | 11.97 | 4.82 | III>I |
| IV | 40 | 6.32 | 3.89 | III>IV |
| V | 39 | 9.33 | 3.66 | |

On the Identification Test, students receiving the simple line treatment (Group II) and detailed, shaded drawing treatment (Group III) achieved significantly higher scores than students receiving the treatment consisting of English keywords, but without illustrations (Group IV). Students of Group III achieved significantly higher scores than students receiving the treatment without illustrations (Group I) (Table 2).

**Table 2**
Scheffe Procedure Showing Mean Comparisons: Identification Test

| Treatment Group | N | Mean | S.D. | Results |
|---|---|---|---|---|
| I | 38 | 12.23 | 4.31 | II>IV |
| II | 40 | 15.22 | 4.46 | III>I |
| III | 41 | 15.73 | 3.16 | III>IV |
| IV | 40 | 10.82 | 4.83 | |
| V | 39 | 13.28 | 4.57 | |

On the Terminology Test, students receiving the simple line treatment (Group II and Group V) achieved significantly higher scores than students receiving the treatment without illustrations (Group I and Group IV). Students receiving detailed shaded drawing treatment (Group III) also achieved significantly higher scores than students of Group I. (Table 3). On the Comprehension Test no significant differences were found between students receiving the varied treatments (Table 4).

**Table 3**
Scheffe Procedure Showing Mean Comparisons: Terminology Test

| Treatment Group | N | Mean | S.D. | Results |
|---|---|---|---|---|
| I | 38 | 10.55 | 3.88 | II>I |
| II | 40 | 14.25 | 4.70 | II>IV |
| III | 41 | 13.68 | 3.50 | III>I |
| IV | 40 | 10.82 | 5.14 | V>I |
| V | 39 | 13.76 | 3.43 | V>IV |

**Table 4**
Scheffe Procedure Showing Mean Comparisons: Comprehension Test

| Treatment Group | N | Mean | S.D. | Results |
|---|---|---|---|---|
| I | 38 | 10.10 | 4.03 | Analysis of variance indicated no two groups were significantly different at the 0.05 level. |
| II | 40 | 12.30 | 4.32 | |
| III | 41 | 11.50 | 3.83 | |
| IV | 40 | 11.12 | 4.21 | |
| V | 39 | 12.48 | 3.73 | |



**Table 5**
Scheffe Procedure Showing Mean Comparisons: Total Criterion Test

| Treatment Group | N | Mean | S.D. | Results |
|---|---|---|---|---|
| I | 38 | 40.84 | 14.28 | II>I |
| II | 40 | 53.45 | 18.02 | II>IV |
| III | 41 | 52.90 | 13.14 | III>I |
| IV | 40 | 39.10 | 16.54 | III>IV |
| V | 39 | 48.87 | 12.59 | |

On the Total Criterion Test, students receiving simple line treatment (Group II) and detailed, shaded drawing treatment (Group III) achieved significantly higher scores than students receiving the treatment without illustrations (Group I and Group IV) (Table 5).

The main results were concluded as follows:

1. The use of illustrations to complement textbook-like instruction did facilitate student achievement of most but not all of the learning objectives.
2. The effects of illustrations diminished when students received the treatment which contained English keywords. With the exception of the Terminology Test, no significant differences were found to exist among students receiving the simple line treatment-plus-English Keywords and students receiving the treatment without illustrations.
3. Variation in the amount of realistic detail in illustrations did not effect student achievement.

## Discussion and Conclusion

Illustrations were found to be effective in facilitating student achievement on the Drawing Test. This finding supports the stimulus generalization theory [16] which indicates that when the test situation is similar to the learning situation, maximum learning is achieved. On the other hand, the Drawing Test evaluated student knowledge of spatial information provided in the illustrations. The exposure to illustrations during the instruction becomes a substantial factor for learning the information.

Illustrations were also found to be effective in facilitating student achievement on the Identification Test and Terminology Test. Students required verbal and spatial information to achieve on those two criterion tests. Illustrations and the keywords accompanying the illustrations provided appropriate stimuli.

The Comprehension Test was designed to evaluate students' understanding of complex procedures and processes that were less easily depicted by illustrations.

The test emphasized mainly on students' verbal information obtained from the instructional unit. The advantages of illustrations disappeared on the Comprehension Test.

However, the effects of illustrations on learning were not found when students receiving their treatements consisted of English keyword. English is a second language for Chinese students. It seems that those English keywords related to the heart were difficult for them to comprehend. One possible explanation of the loss of advantages of illustrations is that information conveyed by the text was complex, thus requiring students to interact more with that information. Under those circumstances, students needed to sustain their attention in order to process the complex information and paid less attention to information provided by illustrations.

Simple line illustrations were found to be as effective as detailed, shaded drawings in facilitating student achievement on the different criterion tests. This result seems to indicate that simply increasing the realistic detail in illustrations does not automatically increase its instructional effectiveness. The assumption of realism theories that learning will be more effective as the number of stimuli in the learning situation increases is not supported by this study. One possible explanation is that the difference of he degree of realism between simple line illustration and detailed, shaded drawing is so small that no significant difference could be found when employed in instruction.

The results of this study indicate that visualization is an important instructional variable in improving student achievement. In this study visualization was used as a rehearsal strategy to focus student attention on the critical learning attributes and to allow time for the incoming information to remain in short-term memory long enough to be elaborated upon and encoded for long-term memory. Anderson[23], Murray & Mosberg[24], Atkinson & Shiffrin[25] and Lindsay & Norman[26] have contended that the longer an item of information is maintained in short-term memory by rehearsal, the greater the probability that it will be retained for retrieval. The different visual rehearsal strategies did not promote differential learning. Even though the visuals increased in realistic detail from simple line drawings to detailed shaded drawings may not have been sufficient to instigate increased levels of information processing prerequisite for students to effectively interact with the instructional content and subsequently perform on criterion tests measuring achievement of the more complex educational objectives.

Specifically, the study supports the finding that illustrations are differentially effective stimuli in facilitating student achievement of different objectives. However, the effects of illustrations need further study when the instructional unit consisted of keywords which students have difficulty to comprehend. Different presentation methods may be needed to aid the learning of different educational objectives. The results of this study indicate: first, the use of illustrations to complement self-paced print instruction does not automatically improve student achievement of all types of learning objectives; and second, variation in the amount of realistic detail in illustrations does not make significant differences in facilitating student achievement. Additionally, on inspection of the mean achievement on the



instructional criterion tests indicates that visualizations can significantly improve student performance when used to complement print instruction. However, the use of visualization alone does not maximize student achievement. Apparently, visualized instruction needs to be complemented with additional kinds of learning strategies which will enhance the rehearsal function and move greater quantities of information from short-term into long-term memory. Additional research is needed to examine the instructional effectiveness of varied types of learning strategies as they impact singly and in combination on various types of visualized instruction.

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# EFFECTS OF USING INSTRUCTIVE QUESTIONS WITH FLOW DIAGRAMS AND TEXT PRESENTATIONS

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**ABSTRACT**

This study examined the influence of instructive questions on diagrams and texts to teach verbal chains. One hundred twenty-nine college students were randomly assigned to one of four stimulus treatments: Text Only (Control), Diagram Only, Text with Instructive Questions, or Diagram with Instructive Questions. Overall, flow diagrams were more effective than texts as a presentation type when teaching verbal chains. The groups that studied diagrams scored significantly higher on a comprehension test than the groups that studied texts $F(1,125)=22.44$, $p<.05$. However, instructive questions, when used as prompts or as study organizers did not enhance the instructional effectiveness of the diagrams or texts. The groups that received instructive questions as an adjunct to the presentation mode scored significantly lower on the comprehension test than the groups that did not receive the adjunct questions $F(1,125)=8.14$, $p<.05$. Further analysis indicated no interaction among the independent variables.

## EFFECTS OF FLOW DIAGRAMS AND TEXTS INSTRUCTIVE QUESTIONS ON LEARNING VERBAL CHAINS

Research on diagrams is important for two reasons, First, most of the messages transmitted by electronic media are print oriented (Jonassen, 1982). For example, two of the primary instructional applications of computers are word processing and text presentation in the tutorial mode. Second, there is a resurgence of interest in print materials, based upon the increasing importance of cost effectiveness as a selection criterion for instructional materials. Thus, instructional technology is refocusing its concerns on the internal structure and design of instructional mate-