ASSESSING STRATEGIES FOR DEVELOPING EFFECTIVE AND EFFICIENT TEXT FOR DISTANCE EDUCATION: TRADITIONAL AND ELECTRONIC

FRANCIS DWYER
Pennsylvania State University

ABSTRACT

One dimension of the Program of Systematic Evaluation was to examine the instructional effectiveness with which different types of independent variables employed (singly and in combination) in text based learning environments facilitated the achievement of different types of learning objectives. Fifteen thousand college students participated in 45 research studies conducted from 1968-2000. The results of this evaluation provide a number of insights; (a). research studies that focus generally on achievement rather than specifying precisely what constitutes the achievement (facts, concepts, rules, principles, comprehension, etc.) contribute very little to the practitioner who is interested in designing effective textual learning environments, and (b) research studies which conclude generally that independent variables such as visuals, questions, advance organizers, metaphors, feedback etc., can be embedded in text to improve achievement offer little useful guidance to the designer unless they describe these quantitative variables precisely in terms of type of visuals, types of question, types of advance organizers etc. employed and describe the achievement facilitated by these variables to specific types of learning outcomes.

INTRODUCTION

Text continues to be the fundamental communication medium. Its presence is apparent in both traditional (paper based) and the new electronic distance education formats (multi-media, web-based, etc). Text, properly designed is structured to instigate and sustain the learner-content interaction necessary to facilitate optimum achievement. Its structure can help the learner process the information and affects learning by increasing the probability that learners will attend, interact, understand, remember, retrieve and utilize the information presented. However, text design does not exist in isolation but is intimately related to the knowledge structures of the learners, their learning styles, reading comprehension and the types of learning objectives to be achieved. Although inherently possessing the potential to improve learner achievement text has been found to

be consistently unreliable for optimum communication between and among individuals who have had limited opportunities for shared concrete experiences or possess different learning styles (Dwyer, 1978, 1987). Acknowledging the limitations of the use of text alone, considerable research has explored the use of various types and formats of embedded tactics and strategies (independent variables such as :visuals, questions, feedback, metaphors, analogies, advance organizers, etc) used singly and in combinations to improve the instructional outcomes of text based instruction (Ragan & Smith, 1996; Duffy & Cunningham, 1996; Park, 1996; Morey, 1996, Rothkopp, 1996, Hartly, 1996 Braden, 1996). Despite the extensive research that has been conducted in these areas, generic guidelines for the effective and efficient integration of independent variables into text has not been realized. Despite the unpredictability of the learner outcomes when these types of variables are embedded into text based instruction, the prevailing literature continues to endorse the "arbitrary" use of these types of variables as if merely incorporating them into textual material will automatically improve learner achievement. of all types of learning objectives without any sustained evidence as to whether or not the varied types of independent variables are equally effective for all types of learning objectives or whether they might be differentially effective for different types of objectives.

STATEMENT OF THE PROBLEM

Many types of independent variable (visuals, questions, feedback, metaphors, advance organizers, etc.) are routinely being suggested for inclusion in text based instruction to improve its effectiveness in promoting learning. However, at the present time text designers have no way of knowing whether one type of variable embedded in text is any more or less effective than another in facilitating achievement of different learning objectives. Examinations of results of relevant research studies to answer this question typically yields inconclusive results because of the wide variety of "uncontrolled" variables in many of the studies:

- achievement not defined in specific types of learning outcomes
- control groups were not utilized
- numbers of participants in the individual studies were low
- positioning of the independent variables was not discussed(eg., item analysis)
- specifications of the independent variables were not precise or quantified
- test reliabilities were not reported
- content across studies was not held constant
- variables were not defined adequately in terms of type and frequency of utilization
- appropriate experimental designs were not utilized

The purpose of this analysis was to examine the findings of a comprehensive series of research studies conducted in the Program of Systematic Evaluation which were designed to resolve many of the inherent limitations of prior

research related to text design. Specifically, the purpose of this analysis was to examine the validity of the inference currently prevalent in practice and in the literature that one type of independent variable used to complement text bases instruction is as effective an another in facilitating learner achievement of all types of learning objectives.

METHODOLOGY

Instructional content and criterion measures were held constant throughout all studies. Learners were randomly assigned to treatments and each study has a control treatment. Positioning of the varied enhancement variables in each study was implemented via item analyses. Appropriate statistical analyses were implemented; alpha was held at the 0.05 level. Appropriate follow-up analyses were conducted when significant F-ratios were realized. The instructional content employed in all studies was an 1800 word module focusing of the parts of the human heart, their locations, functions and processes during the systolic and diastolic phases. Student receiving the self paced text based formats were allowed to interact with their respective instructional treatments for as long as they felt necessary to comprehend the information being presented. Achievement was measured in terms of facts, concepts, rule/procedures and comprehension. A 20-item test was developed for each of these criterion measures. Items in each individual were combined into an 80-item total criterion test. Average Kuder-Richardson Reliability Formula 20 Reliability coefficients from a random sampling of studies (Dwyer, 1978 are .83 Terminology Test, .81 Identification Test, .83 Drawing Test, .77 Comprehension Test, and .92 Total Test.

CRITERION MEASURES

Following is a description of each of the criterion measures (Dwyer 1978, pp. 45-47).

Drawing Test

The objective of the drawing test was to evaluate student ability to construct and/or reproduce items in their appropriate context. The drawing test provided the students with a numbered list of terms corresponding to the parts of the heart discussed in the instructional presentation. The students were required to draw a representative diagram of the heart and place the numbers of the listed parts in their respective positions. For this test the emphasis was on the correct positioning of the verbal symbols with respect to one another and in respect to their concrete referents.

Identification Test

The objective of the identification test was to evaluate student ability to identify parts or positions of an object. This multiple-choice test required students to

identify the numbered parts on a detailed drawing of a heart. Each part of the heart, which had been discussed in the presentation, was numbered on a drawing. The objective of this test was to measure the ability of the student to use visual cues to discriminate one structure of the heart from another and to associate specific parts of the heart with their proper names.

Terminology Test

This test consisted of items designed to measure knowledge of specific facts, terms, and definitions. The objectives measured by this type of test are appropriate to all content areas which have an understanding of the basic elements as a prerequisite to the learning of concepts, rules, and principles.

Comprehension Test

Given the location of certain parts of the heart at a particular moment of its functioning, the student was asked to determine the position of other specified parts or positions of other specified parts of the heart at the same time. This test required that the students have a thorough understanding of the heart, its parts, its internal functioning, and the simultaneous processes occurring during the systolic and diastolic phases. The comprehension test was designed to measure a type of understanding in which the individual can use the information being received to explain some other phenomenon.

Total Test Score

The items contained in the individual criterion tests were combined into a composite test score. The purpose was to measure total achievement of the objectives presented in the instructional unit.

RESULTS

In examining the instructional effect of visualization and type of visualization used to complement text based instruction on different types of learning objectives, a meta-analytic study was conducted (Baker & Dwyer, 2000). Hedges (1982) weighted mean formula was employed to systematically analyze the effect of embedded visualization and the effect of different types of embedded visualization in Facilitating student achievement of different educational objectives. Eight visualized treatments were developed each containing 37 (redundant) illustrations and designed to visually complement the printed information that students experienced difficulty in acquiring. The control treatment received no visuals, but did contain printed word symbols designating facts and concepts referred to in the text: Treatment 1. Simple line Drawings (b&w), Treatment 2. Simple Line Drawings (color), Treatment 3. Detailed Shaded Drawings (b&w), Treatment 4. Detailed Shaded Drawings (color), Treatment S. Heart Model Photographs (b&w), Treatment 6. Heart Model Photographs (color), Treatment 7. Realistic Heart Photographs (b&w), Treatment 8. Realistic Heart Photographs

(color). Placement of the visualization was guided by item analysis. Nine hundred sixty-four college level subjects participated in four different studies (Dwyer, 1968a, 1968b, 1971a, 1972). Two hundred twenty effect-sizes were obtained.Table 1 presents the effect sizes and type of visualization found to be most effective in facilitating achievement on each criterion measure.

TABLE 1. TREATMENTS AND EFFECT-SIZES FOUND TO BE MOST EFFECTIVE ON EACH CRITERION MEASURE FOR EACH CRITERION MEASURE ACROSS THE FOUR STUDIES

	Terminology	Identification	Drawing	Comprehension	Total Test
Text Based Instruction	Line Drawing (Color) 0.64	Line Drawing (Color) 0.99	Line Drawing (Color) 0.82	Line Drawing (Color) 0.87	Line Drawing (Color) 1.08

The coding process in this assessment was greatly simplified by virtue of the similarities through all studies in terms of treatment content, criterion measures, and illustration type. The large number of effect size from the four studies was a result of the method of computation and the fact that the four studies were analyzed separately. The initial effect-size measure was a comparison of a control group receiving verbal information versus the eight experimental groups receiving the same verbal information complemented by different types of illustrations. Subsequent effect-size measures were calculated using the treatment containing the lesser amount of visual stimuli as the control treatment. This procedure was followed in calculating effect-sized on each of the five criterion measures. Since each measure was computed while holding all other variables at a particular level, studies incorporating multiple illustration types yielded multiple effect-size measures. Effect-sizes of 0.5 were considered to be significant. Table 2 illustrates the specific type of visualization found to be most effective in facilitating achievement of each criterion test when ANOVA procedures were conducted on data from each of the individual studies.

TABLE 2 TREATMENTS FOUND TO BE MOST EFFECTIVE IN FACILITATING ACHIEVEMENT ON EACH CRITERION MEASURE FOR EACH STUDY.

	Dwyer 1968a	Dwyer 1971a	Dwyer 1972	Dwyer 1968b
Terminology	Control (No Visuals)	Control (No Visuals)	Control (No Visuals)	Control (No Visuals)
Identifications Drawing	Control Simple Line (Color)	Detailed Shaded Simple Line (Color)	Heart Model Simple Line (B&W)	Detailed Shaded Simple Line (B&W)
Comprehension	Control (No Visuals)	Control (No Visuals)	Control (No Visuals)	Control (No Visuals)
Total Test	Simple line (Color)	Control (No Visuals)	Heart Model (Color)	Simple Line (Color)

Following is a listing of studies and the types of variables which were examined in terms of the effectiveness in facilitating achievement of different types of

educational objectives in text based instruction. Forty five independent studies involving more than 15,000 high school and college level students participated in these studies examining the instructional effectiveness of the varied types of independent variables used to complement text design. ANOVA procedures were implemented in analyzing the data generated in each of the cited studies. Following is a sampling of the categories of variables examined and their associated references.

Visualization	Questions	Objectives
Elaboration	Notetaking	Chunking
Advance Organizers	Concept Mapping	Metaphors
Job Aids	Feedback	Learning Style Variables
Rehearsal Strategies	Learner Perceptions	Visual Interaction Strategies

Realistic Detail Dwyer, 1968a,b; 1971a;1972; Arnold & Dwyer, 1975;Dwyer, C, 1978; Wu & Dwyer, 1990

Questions Dwyer, 1970; 1971a,b,c,; Vance & Dwyer, 1968; Lee & Dwyer, 1992; Myung & Dwyer, 1992; Slater & Dwyer, 1999

Feedback Dwyer, 19171, Wood & Dwyer, 1971

Learning Style Parkhurst & Dwyer, 1983; Joseph & Dwyer, 1984; Akambi & Dwyer, 1989; Alemar & Dwyer, 1993; Moore & Dwyer, 1997

Elaboration Jennings & Dwyer, 1985, Jackson & Dwyer, 1985; Williams & Dwyer, 1996)

Objectives Arnold & Dwyer, 1975a,b

Image Size Dwyer, 1970

Visual Interactive Strategies Bennett & Dwyer, 1994

Rehearsal Strategies Dwyer, Dwyer & Moore, 1993; Cha & Dwyer, 1991

Concept Mapping Smith & Dwyer, 1995; Roshan & Dwyer, 1998

Advance Organizers Dwyer, 1971a; Ruthkosky & Dwyer, 1996

Chunking McBride & Dwyer, 1985

Student Perceptions Dwyer, 1969,1971a

Overt/Covert Rehearsal Dwyer & Dwyer, 1993; Dwyer, Dwyer, & Moore, 1993; Dwyer, 1989

Note-taking Walko & Dwyer, 1990

Metaphors Williams & Dwyer, 1999

Job Aids Spaulding & Dwyer, 1999

DISCUSSION

In the meta-analysis examining the global effect of visualization across all studies significant effect sized were found for each criterion measure (Table 1) indicating that in general visualization is an important instructional variable for facilitating student achievement. However, follow-up analyses within each study (Table 2) revealed that for some educational objectives text instruction without visualization was as effective as the visually complemented instruction and that identical types of visualization were not equally effective for all types of criterion measures. One interpretation might be that on the terminology criterion, where fact acquisition was achieved by association, visualization was not needed by college level students. On the comprehension test where students were required to acquire an understanding of the internal processing associated with the internal functioning of the heart static visuals alone, regardless of the amount of information they contained, were unable to instigate the level of information processing necessary to achieve the intended learning outcomes. These findings indicate that global recommendations for using visualization to facilitate achievement is not a valid recommendation unless it is for a specific type of visual and learning objective. Additionally, of the two hundred twenty effect sizes calculated ninety nine were negative indicating that there instances stances where text alone was more effective than the visualized presentation and when visual by visual comparisons were examined some visuals were significantly more effective than others in facilitating achievement of specific learning objectives. Visualization, like the other variables cited (questions, feedback, advance organizers etc.) are quantitative in that there are many types of questions, feedback strategies, advance organizers etc. Visualization examined in the meta-analysis was dichotomized into eight types of visuals and many more are possible. The process of generally suggesting that varied independent variables: e.g., visuals, questions, advance organizers, job aids, etc., be embedded in text to improve achievement is questionable.

ANOVA procedures conducted in the above cited studies examining the effect of embedding visuals, questions, feedback strategies, elaborations, objectives, chunking, metaphors, job aids, etc. yielded conclusive results. Generic suggestions that these types of quantitative variables embedded in text will automatically improve all types of achievement at the knowledge acquisition level(facts, concepts, rule, procedures, comprehension understanding) is misleading. Like in the visual meta-analysis study, many of the control treatments were found to be as effective and in some cases more effective than varied embedded treatments. In comparing the effects of many of the varied qualitative dimensions within the individual generic independent variables if was found that for specific learning outcomes treatment effects were differentially effective in facilitating achievement of different types of educational objectives. In many instances the control group achievement was similar to the enhanced treatments. In terms of facilitating achievement it was also found that many of the quantitative levels within a variables (eg, visualization ... eight types) although structurally different were found to be functionally identical in facilitating achievement of certain types of

learning objectives. ANOVA conducted on the above cited studies reveal a similar pattern of results. The following examples related to visualization, questions and feedback illustrate the pattern of findings.

Visualization

All types of visualization are not equally effective in facilitating achievement of different types of learning objectives.
- Some types of visualization are significantly more effective than others in facilitating achievement of specific learning objectives.
- Certain types of visualization are equally effective in facilitating achievement of specific learning objectives.
- For certain types of learning objectives visualization is ineffective in complementing text-based instruction.
- Specifically designed static visuals are equally effective as animated visualization in complementing text-based instruction.

Questions

All types of questions are not equally effective in facilitating achievement of different types of learning objectives.
- Some types of questions are significantly more effective than others in facilitating achievement of specific learning objectives.
- Certain types of questions are equally effective in facilitating achievement of specific learning objectives.
- For certain types of learning objectives the use of questions are ineffective in complementing printed instruction.
- Question placement is a critical variable in the use of questions to facilitate achievement of specific learning objectives

Feedback

All types of feedback are not equally effective in facilitating achievement of different types of learning objectives.
- Some types of feedback are significantly more effective than others in facilitating achievement of specific learning objectives.
- Certain types of feedback are equally effective in facilitating achievement of specific learning objectives.
- For certain types of learning objectives the use of feedback is ineffective in complementing text-based instruction.

A number of possible explanations may be offered to explain the general-global in-effectiveness of the various types of independent variables reported in this examination (although there were many instances where specific levels of variables embedded in text were significantly effective in facilitating learner achievement of specific types of educational objectives. It may be that the level of learner interaction (level of information processing) with the content stimu-

lated by the type and level of the independent variable was not sufficient to collapse information into knowledge and move it from short term into long term memory. It was also found that for certain audiences (high prior knowledge, high I.Q, internals, field independents) that the text-based instruction without enhancements was as effective as the enhanced text formats. It is also possible that the structure imposed by the unfamiliar independent variables (concept maps, chunking, elaborations etc. may have had the tendency to interfere with learners' conventional style of learning (text based only) and thereby impeded rather than facilitated learning. For example, verbal elaboration treatments significantly increased the time learners took in interacting with the content but achievement did not exceed that achieved by the control. However, rearranging content (utilizing chunking strategies) was found to significantly reduce the time needed to interact with the instruction, but the level achievement was not influenced. The "novelty" of the varied embedded variables may also have a negative effect on learning. For many students this may have been the first time they had experienced the opportunity to inter-act with these specific types of variables. Since they had no prior experience with these kinds of variables they were unprepared to profit from inherent benefits they possessed. It may be that achievement would have been facilitated had training sessions been conducted familiarizing the student with the purpose of the variables and how to take advantage of their inherent benefits.

The results of this evaluation provide a number of insights; (a). research studies that focus generally on achievement rather than specifying precisely what constitutes the achievement (facts, concepts, rules, principles, comprehension, etc.) contribute very little to the practitioner who is interested in designing effective textual learning environments, and (b) research studies which conclude generally that independent variables such as visuals, questions, advance organizers, metaphors, feedback etc., can be embedded in text to improve achievement offer little useful guidance to the designer or practitioner unless they describe these quantitative variables precisely in terms of type of visuals, types of question, types of advance organizers etc. employed and describe the achievement facilitated by these variables to specific types of learning outcomes.

Direct Reprint Requests to:
Francis Dwyer
Pennsylvania State University
310 B Keller Building
University Park, PA 16802-1303
Email: fmd@psu.edu

REFERENCES

Akambi, M. & Dwyer, F. (1989). Effect of students' prior knowledge level on their ability to profit from visualized inductive and deductive instructional strategies. *International Journal of Instructional Media. 16*: 69-78.

Alemar, I. & Dwyer, F. (1993). The effects of learning style and variations in color-coding strategies (b&w and color) in facilitating student achievement of different educational objectives. *International Journal of Instructional Media. 20*: 61-70.

Anglin, G. & Towers, R, (1996). Visual message design and learning: the role of static and dynamic illustrations. In Jonassen, D. ed., *Handbook of Research for Educational Communications and Technology.* New York: Simon & Schuster Macmillan, pp. 755-794.

Arnold, T. & Dwyer (1975). Realism in visualized Instruction. *Perceptual and Motor Skills. 40*: 369-370

Arnold, T. & Dwyer, F. (1975). An empirical evaluation of the use of educational objectives as guidelines for the development of instructional units. *California Journal of Educational Research. 25*:115-119.

Baker, R. & Dwyer, F. (2000). A meta-analytic assessment of the effect of visualized instruction. *International Journal of Instructional Media. 27*: 417-428

Bennett, L. & Dwyer, F. (1994). The Effect of Varied visual Interactive Strategies in Facilitating Student Achievement of Different Educational Objectives. *International Journal of Instructional Media. 21*: 23-32

Braden, R. (1996). Visual Literacy. In Jonassen, D. ed., *Handbook of Research for Educational Communications and Technology.* New York: Simon & Schuster Macmillan, pp. 491-520.

Cha, D. & Dwyer, F. (1991). Effect of varied and embedded rehearsal strategies in facilitating student achievement of different educational objectives. *International Journal of Instructional Media. 18*: 373-388.

Duffy, T. & Cunningham, D. (1996). Constructivism: implications for the design of instruction. In Jonassen, D. ed., *Handbook of Research for Educational Communications and Technology.* New York: Simon & Schuster Macmillan, pp. 170-198.

Dwyer, F. (1968b) An experiment in visual learning at the eleventh grade. *The Journal of Experimental Education. 37*: 1-6.

Dwyer, F. (1968). Effect of varying amounts of realistic detail in visual illustrations designed to complement programmed instruction. *Programmed Learning and Educational Technology. 3*: 147-153

Dwyer, F. (1968). The Effectiveness of Varied Visual Illustrations Used to Complement Programmed Instruction. *The Journal of Psychology, 70:* 157-162.

Dwyer, F. (1969). Student perception of the instructional value of visual illustrations. *Medical & Biological Illustration. 19*: 42-45.

Dwyer, F. (1970a). Effect of image size on visual learning. *Journal of Experimental Education. 39*: 35-41.

Dwyer, F. (1970b). Effect of questions on visual learning. *Perceptual and Motor Skills.* *30*: 51-54.

Dwyer, F. (1971a). An experimental evaluation of the instructional effectiveness of black and white and colored illustrations. *Didakta Medica. 3*: 96-101.

Dwyer, F. (1971b). Assessing student's perceptions of the instructional value of visual illustrations used to complement programmed instruction. *Programmed Learning and Educational Technology. 8*: 73-80.

Dwyer, F. (1971c). Effect of questions on visualized instruction. *The Journal of Psychology. 78*: 181-183.

Dwyer, F. (1971d). Questions as advanced organizers in visualized instruction. *The Journal of Psychology: 78*: 261-264

Dwyer, F. (1971d). Effect of knowledge of objectives on visualized instruction. *The Journal of Psychology 77*: 219-221.

Dwyer, F. (1972). The effect of overt responses in improving visually programmed science instruction. *Journal of Research in Science Teaching. 9:* 47-55.

Dwyer, F. (1975). Color as an instructional variable. *Didaktik der Medizin 26*: 899-904.

Dwyer, F. (1978). *Strategies for Improving Visualized Instruction.* Learning Services, Box 784, State College, Pa.

Dwyer, C. (1986a). An experimental assessment of varied visualized rehearsal strategies in facilitating immediate and delayed retention. *International Journal of Instructional Media: 13*; 291-302.

Dwyer, C. (1986b). The effect of varied rehearsal strategies in facilitating achievement of different educational objectives as measured by verbal and visual testing. *Journal of Experimental Education. 54*: 73-84

Dwyer, F. (1987). *Enhancing Visualized Instruction: Recommendations for Practitioners.* Learning Services, Box 784, State College, Pa.

Dwyer, C., Dwyer, F. & Moore, D. (1993). Effect of covert and overt rehearsal strategies used to complement visualization possessing different amounts of realistic detail. *International Journal of Instructional Media. 20*: 53-70.

Dwyer, C. (1998). The effect of varied practice activities in complementing visualized instruction. *International Journal of Instructional Media. 16:* 243-280.

Hartley, J. (1996). Text Design. In Jonassen, D. ed., Handbook of Research for Educational *Communications and Technology.* New York: Simon & Schuster Macmillan, pp. 634-664.

Hedges, V. (1982). Estimation of effect size from a series of independent experiments. *Psychological Bulletin. 92*: 490-499.

Jackson, R. & Dwyer, F. (1995). Effects of varied elaboration strategies in facilitating student achievement of different educational objectives. *International Journal of Instructional Media. 22*: 353-361

Jennings, T. & Dwyer, F. (1985). Instructional effect of differential cueing strategies in facilitating student achievement of different educational objectives. *International Journal of Instructional Media. 12*: 8-20

Joseph, J. & Dwyer, F. (1984). The effects of prior knowledge, presentation mode and visual realism on student achievement. *Journal of Experimental Education 52*: 110-121.

Lee, M. & Dwyer, F. (1992). Developmental analysis of the effects of adjunct questions and visualization on student learning. *International Journal of Instructional Media. 19*: 157-169.

McBride, S. & Dwyer, F. (1985). Organizational chunking and postquestions in facilitating student ability to profit from visualized instruction. *Journal of Experimental Education 53*: 148-155.

Moore, D. & Dwyer, F. (1997). Effect of color-coding on locus of control. *International Journal of Instructional Media. 24*: 145-151.

Morey, E. (1996). Feedback Research. In Jonassen, D. ed., *Handbook of Research for Educational Communications and Technology*, New York: Simon & Schuster Macmillan, pp. 634-664.

Myung, G. & Dwyer, F. (1992). Developmental analysis of the effects of adjunct questions and visualization on student learning. *International Journal of Instructional Media. 19*: 157-170.

O'Neil-Ruthkosky, K. & Dwyer, F. (1996). The effect of adding visualization and rehearsal strategies to advance organizers in facilitating long term retention. *International Journal of Instructional Media. 23*: 31 -38.

Park, O. (1996). Adaptive Instructional Systems. In Jonassen, D. ed., *Handbook of Research for Educational Communications and Technology*. New York: Simon & Schuster Macmillan, pp. 634-664.

Parkhurst, P. & Dwyer, F. (1983). An experimental assessment of students' I.Q level and their ability to profit from visualized instruction. *Journal of Instructional Psychology 10*: 9-20.

Ragan, T. & Smith, P. (1996). Condition-based models for designing instruction. In Jonassen, D. ed., *Handbook of Research for Educational Communications and Technology*. New York: Simon & Schuster Macmillan, pp. 541-569

Roshan, V. & Dwyer (1998). Effect of embedded graphic mapping strategies in complementing verbal instruction. *International Journal of Instructional Media. 25*: 389-397.

Rothkopf, E (1996). Control of mathemagenic activities. In Jonassen, D. ed., *Handbook of Research for Educational Communications and Technology*. New York: Simon & Schuster Macmillan, pp. 879-896.

Slater, R. & Dwyer, F. (1999). The effect of varied Interactive questioning strategies in facilitating student achievement. *International Journal of Instructional Media. 23:* 245-255.

Smith, K. & Dwyer, F. (1995) The effect of concept mapping strategies in facilitating student achievement. *International Journal of Instructional Media. 22*: 25-31.

Spaulding, K. & Dwyer, F. (1999). Effect of job-aids in facilitating learners' cognitive development. *International Journal of Instructional Media. 26*: 87-104.

Stephens, J. & Dwyer, F. (1997). Effect of mnemonic strategies in facilitating student achievement of different educational objectives. *International Journal of Instructional Media. 24*: 75-88.

Vance, L. & Dwyer, F. (1988). Effect of question response mode in facilitating verbal instruction. *International Journal of Instructional Media. 15*: 272-281

Walko, J. & Dwyer, F. (1990). Effect of varied note taking strategies in complementing visualized instruction. *International Journal of Instructional Media. 17*: 293-301.

Williams, B. & Dwyer, F. (1996). Interactive effects of mixed-chunk elaborative feedback in facilitating student achievement. *International Journal of Instructional Media. 23*: 245-255

Williams, V. & Dwyer, F. (1999). Effect of metaphoric (visual/verbal) strategies in facilitating student achievement of different educational objectives. *International Journal of Instructional Media. 26*: 205-211

Wood, G. & Dwyer, F. (1989). The additive effect of visualization and overt response/visual feedback in facilitating student achievement of different educational objectives. *International Journal of Instructional Media. 16*: 57-67.

Wu, M. & Dwyer, F. (1990). The effect of varied interactive strategies (visual and verbal) in complementing printed text. *International Journal of Instructional Media. 17*: 41-50.