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Design and Development Factors in the Production of Hypermedia-based Courseware

Guy M. Poncelet & L. F. (Len) Proctor

Abstract: Hypermedia are becoming increasingly popular tools for courseware authors to use In the design and development of com puter-based instruction. This article assembles guidelines, which have been derived from cognitive and constructivlst learning theory and Instructional design literature, for designing effective hypermedia-based courseware.

Resume: Les auteurs de loglciels d'enseignement utlllsent de plus en plus les hypermedia commes outlls poputaires dans la conceptbn et le perfecttonnement de l'enseignement automatise. Get article reunit les lignes directrices quiproviennentde la theorie d'enseignement congnltif et constructivistes et de la litterature de creation educative dans le but de concevolr du materiel utile artlcule sur rhypermedta.

The development of courseware has been aided by the employment of various authoring systems and languages. One example of a programming language being used as an authoring system is the HyperCard application program for the Apple Macintosh computer platform (Goodman, 1990). HyperCard combines the functions of a database management system, courseware authoring environment, multimedia controller, and computer programming environment (Robinson, 1990). While HyperCard is relatively easy for the novice developer to use, to achieve proficiency in this sophisticated environment requires a considerable investment of time and effort. However, as Clark (1984); Jonassen (1988a); and Roblyer (1988) have pointed out, the effectiveness of instruction is a function of the design of the instruction, not the choice of medium used to present the instruction. Therefore effective HyperCard-based products should be designed by following accepted instructional development guidelines (Smith, 1989).

The application of hypermedia in education settings is relatively new. Given the amount of research about instructional design procedures it seems reasonable to select an appropriate model and apply it to CAI. Unfortunately this procedure does not usually work. Known procedures can only provide

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valuable guidelines, but none of them can be applied directly (Steinberg, 1991). A review of the literature indicates isolated, disparate sources of information regarding the development of instructional hypermedia-based products. The intent of this paper is to bring together many of the available sources of information in order to provide novice developers who choose to use HyperCard as an authoring environment with some courseware development guidelines.

The Influence of Learning Theory

The idea of teaching with machines is not new. Pressey, during the mid 1920s, was one of the first researchers interested in integrating the use of teaching machines into the learning process. He was also responsible for the introduction of a mastery learning paradigm. In this approach, content was broken down into small blocks or units of instruction and presented to the learner in a linear, sequential manner. Each programmed lesson was individualized, self-paced and characterized by immediate reinforcement and active student involvement in the learning process. Although the early machines were mechanical, many of the behaviorist principles developed during their use were carried over and applied to the first generation of computer-based instructional systems (Pagliaro, 1983; Reiser, 1987; Niemiec, and Walberg, 1989). While we do not yet fully understand how people learn, principles derived from learning theories have been employed to produce measurably better instruction (Hannafin & Peck, 1988; Hannafin and Reibner, 1989a)

During the 1970s, cognitive learning theory began to displace behavioral theory in instructional design (Case and Bereiter, 1984). Cognitive theory emphasizes the activity of the learner in acquiring, processing, and structuring information (Fosnot, 1984). Learner activity is based on various processes such as perception, thinking, memory, and the representation of knowledge (Shuell, 1986). Some examples of this approach to teaching and learning include Ausubel's progressive differentiation, Merrill and Scandura's path analysis, and Reigeluth and Men-ill's elaboration theory (Reigeluth & Curtis, 1987). Gagne's events of instruction, which are based on his events of learning, were derived "directly from information-processing theories of instruction" (Steinberg, 1991, p. 38).

In more recent times, the constructivist paradigm has begun to exert some influence on the design of CBI. The constructivist view of education "insists that learning involves discovery, creation, or active reconstruction in an essential way" (Hofmeister and Rudowski, 1992, p. iii). Again, this idea is not new. Piaget was one of the better known theorists who espoused the constructivist view of education (Jonassen, 1990). In this paradigm, the teacher functions as a learning guide and provider of learning environments that are responsive to learner exploration (Seels, 1989). Current developments in mass storage technology and a steady increase in available computing power have prompted the development of large knowledge-bases (Delany and Landow, 1991). If this trend continues, then teachers will have access to the tools to employ a constructivist's approach to computer-based instruction.

Hypertext and Hypermedia

Hypertext is non-linear text. This means that the information is broken into pieces or chunks called nodes, rather than being composed of the more traditional linear form of sentences and paragraphs (Wang & Jonassen, 1990). A node usually consist of a single concept or idea. Physically they are often limited to the amount of information that will fit onto a computer screen (Fiderio, 1988). The nodes are linked together in a logical manner, and the user is often able to decide which link to follow to encounter a related node (Tsai, 1988). A link will frequently lead to nodes that contain information which is related to, or enhances the understanding of the current topic content (Fiderio, 1988).

Hypermedia is a combination of the hypertext idea of logical links and the use of multimedia (Horn, 1989). Multimedia entails the use of the computer to integrate and control electronic media devices such as monitors, videodisc players, CD-ROM players, and other electronic equipment. A more detailed definition has been offered by Locatis, Letourneau & Banvard (1990) where hypermedia is "a computer-based approach to information management in which data are stored in networks of nodes connected by links. Nodes can contain text, graphics, audio, video, source code, or other data that are meant to be viewed through an interactive browser and manipulated with a structure editor" (p. 65). As the authors have suggested, the term hypermedia can be used as an umbrella term for any electronically stored information that is logically linked.

There are many benefits that are possible from the use of hypermedia. The users can access the information in a manner that supports their associative thinking processes, and therefore individualization can be maximized (Tsai, 1988). Hypertext is able to more easily convey knowledge, instead of just information, because the nodes represent concepts and the links are relations between the concepts, much like the semantic network discussed in cognitive psychology (Denenberg, 1988). Users are able to contribute their own knowledge and ideas, and make changes to the information system (Jonassen, 1986). The ease of delivering information in various forms allows the use of the most appropriate media to suit the information content and learner audience (Tazelaar, 1990). The interactivity built into hypermedia systems promotes learner control and fosters the development of positive teacher/learner relationships (Marchionini, 1988).

The influence of cognitivism on learning theory has resulted in a stronger emphasis on the activity of the learner in the processing and structuring of information (Foster, 1986; Gagne & Glaser, 1987), and some researchers even suggest that students are likely to be more capable than teachers at directing their own learning (Laurillard, 1987). While the research regarding the most appropriate quantity and quality of learner control over the learning environment is mixed, there is general agreement from many sources that learners should be more involved in the process (Ross & Morrison, 1989; Schwier & Misanchuk, 1988; Schwier & Misanchuk, 1993; Jonassen, 1988c; Bowers & Tsai, 1990). Most hypermedia systems allow, or encourage, a considerable amount of user interaction and control over the instructional process.

Cognitive researchers suggest that learners use semantic networks, i.e. associative representations of knowledge for the storage and retrieval of information (Denenberg, 1988). A hypermedia system, analogous to a semantic network, can be designed to allow the learners to access information using paths that reflect and support their own associative thinking processes (Tsai, 1988). Each hypermedia stack has nodes (or screens) that contain information or concepts, and links (or buttons) that represent relationships between the information or concepts (Locatis, Letourneau & Banvard, 1990). The learner, through using and browsing such a system, soon learns that "the meaning of any topic is not absolute but relative to its relationships with other topics" (Denenberg, 1988, p. 325). Megarry (1988) suggests that "knowledge is not merely a collection of facts. Although we may be able to memorize isolated facts for a short while at least, meaningful learning demands that we internalize information; we break it down, digest it and locate it in our pre-existing highly complex web of interconnected knowledge and ideas, building fresh links and restructuring old ones" (p. 173).

Hypermedia systems can be easily designed to allow the learners to add or modify information in the system (Bowers & Tsai, 1990). Scardamalia, Bereiter, McLean, Swallow and Woodruff (1989) have suggested that the use of a properly designed hypermedia system should be capable of creating, or positively influencing, the following cognitive-based principles of learning: make knowledge-construction activities more overt, encourage the development of student-created goals, encourage questioning and allow the learner to more easily find answers to the self-generated questions, encourage learning strategies other than rehearsal, encourage multiple passes through material, support varied ways of organizing knowledge, encourage use and exploration of related knowledge, provide opportunities for individual learning styles, provide time to reflect on the knowledge, and finally, facilitate transfer of knowledge across contexts.

Hypertext allows a great deal of user control. Although this is often good there is a genuine danger that the user may get disoriented or "lost" while traversing obscurely-linked information (Barden, 1989). Programs often lack visual and spatial cues to give context and orientation to the user (Fidero, 1988). The quality of user control is as important as the quantity of user control, and educators must learn how to maximize the effective use of learner control in hypermedia systems (Marchionini, 1988). Research evidence suggests that some learners, especially those with less ability or no prior knowledge of the content area, are unsuccessful in learning from unstructured learning environments (Tsai, 1988; Scardamalia, Bereiter, McLean, Swallow & Woodruff, 1989). Hypermedia systems have the potential for storing huge amounts of cross-referenced information. The high level of learner control may result in distraction, missing relevant or important information, or forming wrong interpretations from the information (Jonassen, 1988). As well, research suggests that some students, especially those lacking understanding of the basic concepts of the information being presented, fail to make effective use of the extra information or freedom available in hypermedia systems (Sales & Williams, 1988; Gray, 1989).

Another potential problem with hypermedia is the need for breaking content into manageable-sized chunks or pieces for storage and/or representation in the hypertext system. Breaking certain themes or thoughts into discrete nodes may be detrimental to comprehension of the material by the user. Therefore some types of information may not be easily handled by using hypermedia (Begeman & Conklin, 1988). Generally, information that is inherently non-linear, easily modularized, and voluminous in size is well suited to hypertext development. For example, reference works such as dictionaries, thesauri, encyclopedias and other technical documents are good candidates, while literary works that require character development or a story line are best presented in a traditional, linear manner (Locatis, Letourneau & Banvard, 1990).

Courseware Design Factors

A primary purpose of individualized instruction is to present information that is relevant to the needs of the learner (Jonassen, 1986). Although there are many factors to consider when designing and developing courseware, the issue of how the user interacts with the instruction is of utmost importance (Schwier & Misanchuk, 1988; Hannafm, 1989; Hannafm & Rieber, 1989b; Steinberg, 1991). Learner interaction variables included in this review are learner input, questions, response, feedback, and control. Learner motivation and expectations are learner variables that have not been included in this review. Another important class of variables related to effective courseware design is how the information is presented to the learner (Hartley, 1987). Factors included in presentation design include screen design variables, the size of the informational chunks, and frame variations. The following sections will address these courseware design issues.

Learner Interaction Variables

User interactivity refers to the ability of the learner to exert control over the instruction, in order to accommodate individual differences and needs (Weller, 1988; Jonassen, 1985). This includes active roles for both the learner and the computer system in regard to learner input, practice, feedback, and learner control (Hannafm, 1985; Clark, 1984). Schwier andMisanchuk(1988), citing research from several sources, have suggested that effective learners actively interact with the instruction. The inherent assumption here is that meaningful interactivity should lead to greater learning.

Interactivity imposes active roles on both the computer and the learner

(Jonassen, 1988c). Therefore there must be some facility to allow the user to communicate with the courseware. Generally, the learner interacts with the courseware by typing commands or messages using the keyboard or by using an input device such as a mouse or tablet. The two general types of keyboard-based interaction for learner input include the use of multiple choice response or free-form response (Weller, 1988).

There are also several less commonly used forms of user input. Examples are touch screens and other sound, motion, or light-activated controls, and joystick or paddle. A relatively new input device is the hand-tracker, a glove-like device that allows learner control of the computer or application (McAvinney, 1990). Research has been conducted on using AI techniques to develop speech recognition and speech synthesis systems and natural language interfaces. For the most part, these systems are still in the research stage and not available for general use in education, although some systems may become available in the near future (Lee, Hauptmann & Rudnicky, 1990).

Practice

Research in learning theory suggests that effective practice is one of the fundamental principles influencing human learning (Gagne & Glaser, 1987; Shuell, 1986; Salisbury, 1988). Effective practice is related to the level of learner processing produced by the practice, not the amount of practice (Jonassen, 1988b; Weller, 1988). For example, when measuring the effects of embedded questions in CBI, Hobbs (1987) found that application questions were much more effective in promoting recall and comprehension than simple questions that could be answered from rote memory. Salisbury (1988) has pointed out that skill learning includes three stages. In the first stage, called the cognitive stage, the student learns to perform the skill accurately. The second stage, called the associative stage, includes practice and continues until performance is both fast and accurate. In the final or autonomous stage, the performance of the skill becomes more automatic and rapid.

Salisbury, Richards and Klein (1985) have offered the following list of recommendations for the design of effective practice, based on cognitive learning theory and research (see TABLE 1).

The use of distributed practice activities, varying the rate and type of practice, and the use of a variety of types of questions is motivating and more interesting. The demand on short term memory is also reduced and recall is facilitated (Hooper & Hannafin, 1988). In a study involving college students and interactive video, Philips, Hannafin, and Tripp (1988) found that embedded questions were most effective and that practice was most useful for factual knowledge, rather than higher level learning.

TABLE 1
Recommendations for Effective Practice Drawn from Cognitive Learning Theory

Principle	Design
1. Automaticity of subskills	Accuracy, speed, and the ability to perform the skill without a secondary task causing interference should be used as criteria for mastery.
2. Interference	Have students drill on only a small subset of items at a time. Provide review of old items as new ones are introduced. Initially use cues to emphasize differences among competing stimuli and then fade the cues gradually.
3. Spaced practice	Allow students to specify the difficulty level at the beginning of each session or provide a mechanism to keep track of the items that a particular learner was working on during the last session.
4. Spaced review	Gradually increase spacing between practice of mastered items. Utilize increasing ratio-review.
5. Making meaningless material meaningful	Help students add meaning to the material by utilizing mnemonic devices, mediators, or other memory or organizational strategies, or empha size networks inherent in the content.

Feedback

Feedback is information given to the learner by the courseware, about the appropriateness of the learner's response. Several factors can determine the effectiveness of feedback such as the type of feedback given, the frequency of the feedback, and the delay between the feedback and the instruction (Jonassen & Hannum, 1987). Feedback should provide occasional motivational messages, as well as information about the correctness and/or appropriateness of the response. For example, the use of cumulative records of student performance on questions, and frequent reporting of that performance, provides more effective learning (Schloss, Wisniewski & Cartwright, 1988). Feedback should be mature, positive, and varied. Feedback for an anticipated incorrect response should provide corrective or remedial information, complete with hints, explanations, or cues towards the correct response (Weller, 1988). Cohen (1985) suggested that feedback for correct responses must be suitable for the type of learner. For example he found that, for motivated and knowledgeable learners, feedback after correct responses interfered with the learning process.

Most research indicates that feedback should be frequent, precise, and occur immediately after the instruction (Grabinger & Pollock, 1989; Jelden, 1987), although some researchers feel that brief delays between the instructional event and the feedback promotes more effective learnirigbf Higher level cognitive information (Hooper & Hannafin, 1988). The delays give the learner more time to place the information into context and thereby assist in effective processing (Hannafin & Rieber, 1989b). The quantity of feedback should be sufficient to help comprehension of the material, but not so much as to overburden the learner (Stead, 1990).

Learner characteristics, subject content, and delivery mode all affect the type, amount, and timing of the feedback (Schimmel, 1988; Wager & Wager, 1985). Feedback should be tailored to match the needs of the learners and the desired learning outcomes by using elaborative feedback techniques such as explaining why an answer is incorrect and providing guidance on how to find the correct answer (Sales & Williams, 1988; Sales, 1988).

Jonassen and Hannum (1987) have offered general guidelines for use of feedback (see Table 2).

TABLE 2
Guidelines for the Timing and Frequency of Feedback in Instruction

Provide feedback immediately after a learner's response when new material is being presented.
Feedback may be given after each response or after a group of responses to similar questions when previously learned material is being reviewed.
Vary the placement of feedback according to the level of objectives.
Provide feedback after each response for the learning of lower level objectives.
Provide feedback at the end of a session for the learning of higher level, more abstract objectives.
Consider providing feedback to higher achieving learners after each group of responses rather than after each response (p. 12-13).

Learner Control

The use of hypermedia in education may require a change in the design of learner interaction with the instructional materials. According to Bowers and Tsai (1990), a concept such as hypertext may force a re-examination of the current concept of learner control in educational materials. The use of hypertext allows the student to control the creation of links and connections within diverse pieces of information and therefore "the learner is actively involved in building the learning environment" (p. 22). Jonassen (1986) has made the same point in his discussion about hypertext design principles.

According to Snow (1980) learner control is based on two assumptions; that learners know what is best for themselves during instruction, and that they are capable of acting appropriately, according to the instructional events. Therefore, the argument for learner control requires that the learner be self-determined, autonomous, and responsible. Jonassen (1986) cited several studies that suggest that the availability of learner control does not necessarily improve learner achievement, but that most learners will learn regardless of the instructional method. There is research evidence to suggest that learners may monitor their own performance and make deliberate changes in their learning strategies during instruction (Winn, 1986). These metacognitive processes are facilitated by experience and training in higher order problem solving skills (Armour-Thomas & Haynes, 1988).

Many researchers feel that greater learner control over the instructional environment is both pedagogically and philosophically appropriate (Jonassen & Hannum, 1987; Ross & Morrison, 1989). Learner control over sequencing and pacing of instruction can be motivating, reduce anxiety, and improve attitude (Weller, 1988). For example, learner versus program control of pacing and sequence in an interactive video lesson on photography was studied by Milheim (1990). Learner control of pacing resulted in significantly higher posttest scores and decreased time on task. There was no significant difference for learner control of sequence. In another study, students who had the option to review, following errors made in CBI lessons, took less time to complete the module than those with forced review (Schloss, Sindelar, Cartwright & Smith, 1988).

Laurillard (1987) suggested that learners should be given more control over the content, their access to the content, and their interaction with the content. Research suggests that learners should be exposed to environments that "foster rather than presuppose the ability of students to exert intentional control over their own learning" (Scardamalia, Bereiter, McLean, Swallow & Woodruff, 1989). Reglin (1989) stated that learners oriented towards high internal locus of control prefer to control their environments and that appropriate treatment can affect locus of control. Isaacs (1990) suggested that, by giving students increasing levels of control in an environment that supports the idea of learner control, the students will learn effective control techniques.

On the other hand, Ross and Morrison (1989) have cited several sources that suggest that more learner control is not necessarily better for all learners, especially low achievers. Kinzie and Sullivan (1989), in a study with high school science students, found that a high degree of learner control in the delivery of CBI caused much more continuing motivation and the ongoing willingness to learn, when compared to program control. But the difference in post test performance and performance during instruction was not significant.

Ross, Morrison and O'Dell (1989) found that undergraduate students in a statistics course had no difference in performance, given varying amounts of learner control. Students who could choose the context of the examples selected a greater number of examples than those who received prescribed contexts, and achievement was positively related to the variety of practice examples chosen by the students.

The amount and type of learner control is dependent on several variables such as learner characteristics, content, and the nature of the learning task (Jonassen & Hannum, 1987; Hannafin, 1984; Steinberg, 1989). Learner characteristics include variables such as internal versus external locus of control, age, or cognitive capability. Content that must be mastered often requires more program control, compared to content with no qualified mastery levels. Familiar learning tasks are best presented with more learner control than totally unfamiliar tasks. Ross and Morrison (1989), have offered a general list of situations where learner control is more appropriate than program control (see Table 3).

TABLE 3
Favorable Conditions for Learner Control in Courseware

- Learners are older and more mature.
- Learners are more capable.
- Higher order skills rather than factual information are being taught.
- Content is familiar.
- Coaching or advisement is provided to assist learners in making decisions and in using strategies known to be effective.
- Learner control is used consistently within a lesson.
- Provision is made for switching unsuccessful learners to program control strategies.
- Learner control is combined with formative evaluation to identify and base revised designs on paths used by effective learners.
- Give special consideration to learner-control strategies that allow learners to select contextual properties of lessons according to individual learning styles, preferences, and interests, (p. 28)

Presentation Variables

Presentation variables include screen design and layout, graphics, text display, chunking of the information, and the type of frames or screens used. Research suggests that learners may read electronic text more slowly than print-based text, and that learners may process electronic text differently from printed text in regard to other factors as well. Some of the learning theory and design criteria used in courseware presentation design originate in text-based research, and as such, may not be directly applicable to the design of courseware without further research.

Screen Design Variables

The effective design of computer-generated text is affected by many variables such as the type, style and size of font used, text density levels, and layout variables such as justification, line length, leading, and spacing (Morrison, Ross, Schultz & O'Dell, 1989; Ross, Morrison & O'Dell, 1988; Hannafin & Rieber, 1989b). The overall look of the screen should provide several functions such as informing the learner of the type of information that is displayed, in what order the information should be processed, and how the information should be used (Gropper, 1988).

Hooper and Hannafin (1986) found that text is processed faster and more efficiently when the text is left-justified, characters are relatively small (approximately 11 point), longer lines are used instead of short lines, and spacing (leading) is increased as the text density is increased. Generally, these factors suggest that low density screens, which have a relatively large amount of white space compared to the actual information, are preferable. These findings were confirmed in a study by Hartley (1987) and in a 1988 study by Morrison, Ross, and O'Dell. In contrast, in a more recent study, Morrison, Ross, Schultz and O'Dell (1989) found that learners preferred high density screen designs, that is less white space in relation to the textual and graphical information. In this study, realistic display materials were used, in contrast to the other studies which used artificial display information, and the authors feel that "it is not clear that preferences for low-density screens similarly apply to realistic lesson materials, especially since the low-density designs present the material in smaller thought units and consequently require an increased number of lesson frames" (p. 54). The authors hypothesize that the contextual properties of the information, as well as the type of information, may affect how the learner perceives the density of the screen, and that more research is needed in this area. Isaacs (1987) suggested the use of syntax and context to determine the length and the end of text lines. This idea was supported by Hartley (1986).

The type of font to be used is often determined by the capabilities of the computer platform. Generally, it is suggested that no more than two or three types and sizes of fonts be used per screen. Often san-serif fonts work better on the computer screen than serif fonts. Use a combination of upper and lower case letters, rather than only upper case letters, with lower case fonts being the easiest to read and understand (Faiola & DeBloois, 1988). For the Macintosh computer platform, Misanchuk (1989) recommended the use of the Geneva font, with Boston as a second choice, and the avoidance of Chicago and Courier fonts.

The use of visual cues such as color (Hativa & Teper, 1988), emphasizing text by underlining or using italics, or using headings or pictorial cues such as arrows or labels can be effective in gaining and keeping the learners' attention during instruction (Faiola & DeBloois, 1988). Bernard, Peterson & Ally (1981) have suggested that pictorial cues provide a meaningful context for abstract verbal information and can enhance learning and retention. Hartley and

Trueman (1985) found that headings aid in search, retrieval, and recall activities by learners. Researchers suggest that it is important to tell the learners, especially when they are young, the significance of the particular visual cue. And it is equally important not to overuse visual cues; only use enough to get the message across effectively and efficiently (Hooper & Hannafin, 1988).

Often drawings, cartoons, animations, illustrations, and graphics are included along with the textual information. In general, graphic embellishments should be simple, clear, and consistently presented (Hartley, 1987). In a review of the literature about illustrations in print-based text, Levie and Lentz (1982) found that under ordinary circumstances illustrations do not enhance the learning of information in the text. The researchers did find that illustrations may be helpful for under-advantaged learners, may provide enjoyment and motivation, may provide reinforcement, and that effective illustrations could be used as substitutes for verbal information. Alesandrini (1984) found that all types of pictures, whether representational, analogical, or arbitrary, helped adults to learn. Anglin (1986) found that prose-relevant pictures helped older learners to recall prose material. Hurt (1987) suggested that literal illustrations are more effective than analogical illustrations. Generally, simplistic illustrations were found to be more effective than realistic illustrations although in some situations, when given enough time, learning was enhanced by realistic materials (Dwyer, 1987).

Animation can serve motivational and attention-getting functions but, according to current research, no extra learning effects can be attributed to the use of animation (Hannafin & Rieber, 1989b), although Zavotka (1987) found that animation improved student performance in interpreting orthographic drawings. Reed (1986) found that graphics in algebra studies were useful in order to supplement the verbal information, provide motivation and attention, and provide learner interaction with the materials. Duchastel (1988) suggested that animation can be very important for comprehension when modelling an unfolding process or procedure.

Chunking

If a learning task involves memorizing strings of text or a list of numbers, mature learners often employ chunking as a strategy to help them overcome the natural limitations of the human memory (Steinberg, 1991). Chunking is the process of organizing, indexing and storing information in such a manner that it can be easily accessed and used for problem solving (Harmon, 1987). This is often accomplished by organizing the information into meaningful or logical sections or "chunks", which facilitates the transition from receiving the information to understanding the information (Casteel, 1988). Computer graphics, diagrams, and illustrations can also be seen as a form of chunking because we see pictures as organized wholes, not dissociated parts (Steinberg, 1991). The chunks are presented on the screen with sufficient white space around the information to provide separation from adjacent information

(Morrison, Ross, Schultz & O'Dell, 1989; Faiola & DeBloois, 1988). In a hypertext database each chunk represents one topic, theme, or idea and is represented by a node or document in the database (Kearsley, 1988).

In order to enhance the effect of chunking, Faiola and DeBloois (1988) suggest that it is important to have a well developed framework or "access structure", which refers to the "coordinated use of typographically signalled structural cues that help students to read texts using selective sampling strategies" (p. 15). The use of headings, indentation levels, spacing, and other such typographical structures would help learners discriminate among different contextual elements. For example, Jandreau, Muncer & Bever (1986) found that phrase-spaced text made a considerable improvement in the comprehension and the speed of reading for poor readers in a research project in England. Casteel (1988) found the same effects among learning disabled students. McBride and Dwyer (1987) found that chunking resulted in a more efficient learning strategy, compared to conventional presentation, although there was no significant difference on a performance task after the instruction. Horn (1989) has made extensive use of the principle of chunking in his method of argumentation analysis. Pre-chunking information into blocks not only helps the reader to comprehend the information, but also helps the writer or author in his or her analysis of the information.

Frame Variations

The idea of frames originated in the programmed learning model of instruction, and modern microcomputer technology, according to Jonassen (1988b), has outgrown this theory. In modern courseware designs a frame represents a computer screen that contains a planned amount of information (Bonner, 1987). Frame protocol refers to the way the screen display area is divided into functional areas used to present the learner with directions, messages, options, and to provide an area for dialogue between the courseware and the learner (Hannafin & Rieber, 1989b).

Generally, a frame consists of a stimulus with some information, a response to be made by the learner, and a prompt that gives feedback to the learner (Leith, 1966). There are six general types of frames used in CBI: information, question, remediation, feedback, menu, and subroutine frames (Morrison & Ross, 1988). Frame-based CBI usually consists of either drill and practice, tutorial, or simulations, and provides for considerable learner interaction. The instructional designer must anticipate learner response and provide suitable responses and motivation through the use of visuals, questions, humour, and other techniques (Bonner, 1987).

Tessmer, Jonassen and Caverly (1989) have pointed out that classroom learning contains a great deal more interactivity between the teacher and the learner than is usually exhibited between a learner and display-question-feedback CBI. In addition to the delivery of text and graphics to appropriate areas of the screen, good courseware should promote learner interactivity by always providing access to some or all of the following options (see Table 4).

TABLE 4
Guidelines for Interactivity

Help key to get procedural information.
Answer key for answering a question.
Glossary key for seeing the definition of any term.
Objective key for reviewing the course objective being worked on.
Content map key for accessing an overview map of the content in the course or lesson.
Options key for seeing a list of learner commands or options available to the learner.
Overview or introduction key for reviewing the introduction to the unit.
Menu key for exiting the lesson and returning to the menu.
Exit key for exiting the course.
Summary key for seeing the summary or conclusions of the lesson.
Review key for reviewing parts of the lesson.
Comment key for recording a learner comment about the lesson.
Examples key for seeing examples of an idea.
Previous frame or next frame for moving forward or backward in a lesson.
Test key for letting the program know when the learner is ready to take a test.
Next lesson key for accessing the next lesson in a sequence (p. 198).

Conclusion

Cognitive learning theory has had a major influence on courseware development guidelines. Although some of the ideas derived from behaviorism, such as feedback, self-pacing, and learner interaction are still relevant today, cognitivism emphasizes an active, aware learner who brings important personal characteristics that influence learning outcomes. Constructivism may further challenge the developer to capitalize on the learner's ability to construct knowledge by using personal experience and interpretation of that experience. Good hypermedia-based instruction may need to be redefined to include building on the prior experiences of the learner, being organized in a manner that is appropriate to the individual, and being set within the context of real-world projects or activities.

CBI authors who choose to use HyperCard as their development tool would be well advised to adopt Apple's policy of maintaining a consistent look and feel for applications by following the Apple Desktop Interface guidelines (Apple Computer Inc., 1989). The larger the stack, and the younger or more disadvantaged learners are, the more important effective stack navigation aids become. In all situations it is of the utmost importance to know the intended audience, the content, the design plan and the capabilities of the development tool well before any extensive projects are begun. Teachers at all levels are in an excellent position to play a key role in the development process.

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Influence of Instructional Control and Learner Characteristics on Factual Recall and Procedural Learning from Interactive Video

Gary Coldevin, Mariella Tovar and Aaron Brauer

Abstract: This study examined the extent to which different levels of Instructional control and varied learner characteristics affected performance and time on task, using Interactive video materials to teach a biochemistry laboratory procedure. Subjects (n = 46) were randomly assigned to one of three treatment conditions. In the first (linear control), subjects proceeded through the instruction according to a pre-determined sequence, but were able to control pacing. The second condition (designer) had moderate levels of control and also Included the provision for pacing. In the final condition (learner) a complete array of sequence and pacing options were provided. Subjects were blocked as either high or low in academic ability according to their scores on the vocabulary section of the Nelson Denny Reading Test. A prbr knowledge test and Rotter's Internal-External Locus of Control Scale were administered as additional Indices of learner characteristics. A multrvariate analysis of variance established significant main effects for instructional control and academic ability, The results further indicated that linear control significantly outperformed learner control In facilitating recall of facts. Subjects in the linear conditbn, however, took significantly more time to complete the Instruction than those In the learner controlled treatment. No other significant differences were observed.

R6sum«: Dans cette etude, on a examine I'etendue sur laquelle dIfferents nlveaux de la direction educative et des divers caracteristiques de l'apprenant ont eu un effet sur la performance et le temps d'une tache, en utilisant du materiel video interactlf pour enselgner une procedure de laboratoire en biochimie. Les sujets (n=46) avaient ete assignes au hasard d une des trote conditions de traitement. Dans la premiere condition (le contrdle llnealre), les sujets ont accompli I'lnstruction selon une sequence predetermlnee, tout en etant capabtes de contrdler le rythme. La deuxieme condition (concepteur) avalt des niveaux de contrdle moderes disposal! aussl des moyens de controler le rythme. Dans la dernlere condition (apprenant), une gamme complete d'opttons de sequences et de regulations etalt fournle, L'aptltude academique des sujets fut classee, soit elevee ou basse, selon les points accordes lors du test Nelson Denny Reading Test dans la section vocabulalre. Un test anterteur sur les connalssances et un examen d I'echelle Rotter's Internal-External Locus of Control Scale furent dispenses pour connaitre davantage les caracterisitques des apprenants. Une analyse multlvarlee de variances demontra significatlvement les principaux effets d'une direction educative et d'une competence academique. Les resultats demontrerent en plus que le controle llneaire sur classe de facon significative Le controle de I'apprenant en faclIltant le rappel des faits. Cependent, les sujets en condition linealre prlrent consIderablement plus de temps 6 completer I'lnstruction que ceux qul etalent dans le traitement controle de I'apprenant. Aucune autre difference en importance fut observee.

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Currently among the most touted of the emerging instructional technologies, one which will undergo rapid development leading into the twenty-first century, is interactive video. It is held to be especially promising since it permits the convenient union of the modern microcomputer with its interactive capabilities and the visual expository features of video, while at the same time providing the opportunity to exploit a vast array of instructional designs and strategies. To date, and perhaps understandable because of its novelty, most of the emphasis in interactive video has been on refining its technical development, rather than on empirically validating strategies to improve its instructional effectiveness.

Where research has been conducted, as with the "standard" experimental design that pits a new technology against more traditional forms, much of it has been devoted to comparing interactive video with other methods of instruction, and particularly computer-aided instruction (Dalton, 1986; Henderson & Landesman, 1988-89; Holmgren, Dyer, Hilligoss, & Hillel, 1979-1980; Ketner, 1982; Lawrence & Price, 1987; Schroeder, 1982; Soled, Schore, Clark, Dunn & Oilman, 1989). The practical residue from these studies which might be of immediate use to instructional designers has been limited since the typical finding has been one of no significant differences. The underlying theme of this criticism suggests that research needs to be conducted within instructional innovations, and not between them (Reeves, 1986).

Particularly germane to interactive video is the issue of instructional control, and how design strategies can best be applied that are fully cognizant of individual learner characteristics and the particulars of the material to be taught. Instructional control refers to the degree to which a learner can control his or her path through a particular lesson. Design strategies can range from complete learner control at one extreme to complete program control at the other (Pawley, 1983). Learner characteristics are attributes such as age, academic ability, and prior knowledge which might have a discernable effect on the type of design strategy chosen. The immediate and most compelling rationale for undertaking this type of research is to provide some prescriptive guidelines as to who would best profit from what type of control strategy for which type of instructional task. This is further supported by Ross and Morrison (1989) who insist that research is needed that identifies learner control variables that are relevant and appropriate for different learners and tasks.

Most of the background literature on aspects relating to instructional control is derived from research into computer assisted instruction. And while much of it endorses the inclusion of mechanisms for learner control, the empirical evidence is mixed. In an earlier review, Steinberg (1977) noted that those studies examining learner control either found no differences or found learner-controlled subjects to be the poorest performers. Our current sense of the literature is that positive or negative findings with respect to learner versus program control is very much bound up with student ability and type of instruction. For example, several studies have found program control strategies to be significantly superior to learner controlled treatments in learning mathematical skills (Fisher, Blackwell, Garcia & Greene, 1975; Judd,1972; Ross & Rakow, 1981), and parts and operations of the heart (Belland, Taylor, Canelos, Dwyer & Baker, 1985). Conversely, learner control treatments were significantly superior to program control treatments in mastering computer assisted instruction (Campanizzi, 1978), science education (Kinzie, Sullivan, Beyard, Berdel & Haas, 1987), and cardiopulmonary resuscitation (Hannafin & Colamaio, 1987). And no significant differences were noted between the two strategies in acquiring advertising concepts (Klein & Keller, 1990) nor in preparing and administering intramuscular injections (Balson, Manning, Ebner & Brooks (1984-85).

Research on learner characteristics, by and large, has tended to concentrate on three areas of inquiry. One is concerned with the ability of students and the interaction of aptitude-by-treatment (Carrier, 1984; Clark, 1984; Corno & Snow, 1986). The findings suggest that the higher the academic ability of a student, the better s/he would perform in a learner controlled situation. Another area has dealt with subjects' internal locus of control (Clark, 1984; Copeland, 1988; Hannafin, 1984,1985; Merrill, 1980). This latter focus has examined the degree to which an individual perceives events to be under his/her ability to master and its subsequent effect on performance with respect to program or learner control. Rotter (1966) suggested that learners who load high on external locus of control scales believe that their performance is a function of fate, and they are not motivated to seek reinforcement. Internal learners on the other hand, perceive their own success or failure in terms of the effort that they exert. In a study that examined the interaction between learner control and subjects' locus of control, Holloway (1978) found that high internality subjects performed better when they were able to control their own learning. Clark (1984) proposes that "internally controlled learners may be more able to make effective instructional control decisions than externally controlled learners" (p. 238). In a variation to this trend, Fry (1972) reported that the level of inquisitiveness which students brought to a computer-aided instructional task was directly related to performance on learner controlled programs. Contrastingevidence is provided by Burwell (1991) who found that learner control generated significantly higher recall scores for field dependent students and significantly lower recall scores for field independent students than programmed controlled IV.

The third area of investigation, amount of prior knowledge, has produced the more stable results. High prior knowledge students consistently perform better under learner control conditions than students who enter an instructional task with little or low prior knowledge (Carrier, 1984; Gay, 1986; Hannafin, 1984; Milheim & Azbell, 1988; Steinberg, 1977). Learner controlled subjects as a rule, however, took longer to complete instruction than their counterparts in program controlled environments.

Research examining locus of instructional control and interactions between the learner characteristics noted earlier has not been abundant, and, for the most part, findings have been either inconclusive or mixed. As a result, no general prescription exists with respect to when and how learner control should be deployed, and notably so in interactive video since most of the research background is in related, but less complex media. Taken altogether, some studies have found that performance is improved with learner control, while others have observed opposite effects or no difference across treatments. It is clear, however, that the characteristics which an individual brings to a learning task are meaningful, if not critical, factors and need to be addressed in the design of instruction. In this spirit, the present study examined the influence of learner control in an interactive video environment in order to answer the following questions and test the ensuing hypotheses:

Research Questions

1) Is there a difference on posttest performance between learning groups that are provided with different levels of instructional control (program control, limited learner control, full learner control)?
2) Is there a difference in time spent on the instruction between the three levels of instructional control?
3) Is there a relationship between posttest performance and learner characteristics (prior knowledge, internality/externality)?
4) Is there an interaction between learner ability and instructional control?

Hypotheses

An aptitude-by-treatment interaction was predicted. It was hypothesized that high ability subjects would perform best under conditions of full learner control, and subjects with low ability would perform best under conditions of program control. It was further hypothesized that high internality subjects, and subjects with high prior knowledge, would perform best when allowed to control their own learning.

METHOD

Subjects

Forty six students enrolled at Concordia University (45 undergraduate, 1 graduate) participated in the study. Forty-three were following programs leading to a major in a science discipline (chemistry, biochemistry, biology, or exercise science). The remaining three were pursuing studies in arts-related fields. There were 23 males and 23 females. Subjects volunteered to participate and were each paid a stipend of $ 15.00.

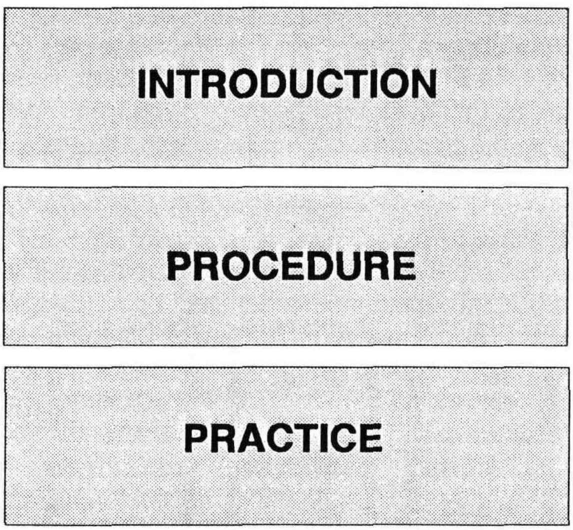
Materials

The materials were created by the authors using a videodisc that had been produced by Doiron (1990), and evaluated by a target audience of undergraduate biochemistry students at Concordia University. The instructional module teaches the materials that are required, and the steps needed, to conduct a biochemistry procedure called the "Swipe Check". Briefly, the Swipe Check is a process whereby suspected areas of radioisotope contamination are detected, recorded, and effectively eliminated. Typically, biochemistry students must be able to demonstrate proficiency with this procedure as they are likely to come into contact with radioactive substances, and must be aware of the potential hazards. Interactive video is a particularly appropriate medium for teaching this topic since it allows effective simulation of a procedure which might otherwise involve exposure to radioactive areas.

Three interactive video programs were produced that provided identical instruction on how to perform a Swipe Check, but differed to the extent to which learner control options were present. These three conditions, similar to Hannafin and Colamaio (1987), were labelled linear control (program control), designer control (limited learner control), and learner control (full learner control).

The instruction was divided into three major sections that formed the basis for either providing or removing instructional control. These three sections were presented in a menu structure comprising introduction, procedure, and practice. Figure 1 presents a facsimile of the menu structure as it appeared to the learner for all experimental conditions.

Figure 1.
Main Menu



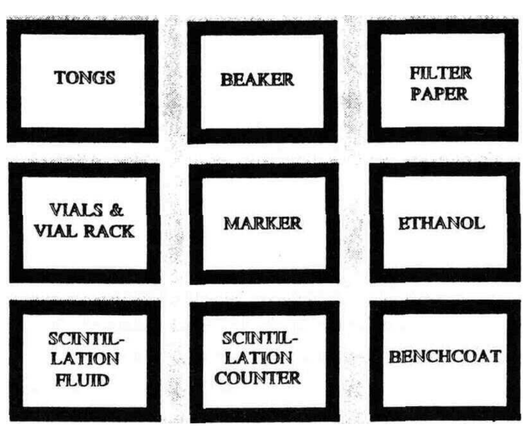
The first section, introduction, presented the learner with two separate video segments appearing in a menu structure. One discussed the hazards of radioactive materials and their implications in the context of the Chernobyl nuclear power plant meltdown; the other introduced the Swipe Check method and explained when and why it should be conducted.

Due to the length and nature of the Swipe Check, the procedure section was further subdivided into six components and was presented in a menu structure as shown in Figure 2. Two of the components presented instruction in terms of the tools and materials that were required. In the first subsection, a still frame video image of each tool was presented in a predetermined order and had a textual description superimposed on it. An additional "chart of tools" subsection presented a text screen that listed all of the tools in a random order as shown in Figure 3.

Figure 2.
Procedure Menu

TOOLS & MATERIALS	A VIDEO PRESENTATION
CHART OF TOOLS	BROKEN DOWN INTO COMPONENT STEPS
A LIST OF THE 14 STEPS	A DIAGRAM OF THE STEPS

Figure 3.
Chart of Tools



The other components provided four ways to learn about the fourteen steps that comprise the actual procedure. One provided a video segment which presented a lab technician carrying out the Swipe Check, with a narrator's voice-over describing each step as he went along. In another component, each step was broken down into individual segments which included a textual description of the step superimposed on the video, and presented in the order in which it should be carried out. The learner's response triggered the video segment to be played as the textual information disappeared from the screen. The third method of instruction provided a textual list of the fourteen steps and simply presented, in order, a written description of each step. Finally, the last component represented the procedure as a diagram, again showing the steps in the correct sequence.

In the last section, practice, the learner was presented with a video segment which displayed a step and had a textual description superimposed on it. The learner could respond by indicating that the step was correct or incorrect; if deemed incorrect s/he was required to supply the step by typing it on the keyboard. If the typed response was correct, a message to that effect was displayed on the screen and a description of the step was provided as reinforcement. If the typed response was incorrect, an appropriate message was issued and the same reinforcement that appeared for correct responses was displayed. There were a total of 14 practice questions (one for each step). A grid showing the status of the practice (those steps that were answered correctly or incorrectly, and in the case of learner control, those steps that were not attempted) was displayed upon completion of the exercise.

The treatments were developed on a Pioneer LD/VS 1 configuration consisting of a videodisc player, a monitor, and an 8-bit computer that was bundled with a keyboard, a mouse, and a touch screen. The interactive video lesson was designed so as to maximize the use of touch screen interface and minimize keyboard entry. In order to make a selection or to control pacing, the learner could touch that part of the screen that corresponded to his desired action. Alien and Carter (1988), Baggett (1988), and Bijlstra and Jelsma (1988) have endorsed the use of touch screen interfaces within interactive video lessons. Keyboard interaction was limited to the practice section, and was only used in the event of an incorrect step to allow the learner to supply the answer. The details of the treatments are discussed below.

Linear control. Of the three experimental conditions, linear control provided no options for selection other than for pacing and subjects were under complete control of the program. The lesson began with the presentation of the menu structure as shown in Figure 1. To initiate the lesson, the learner touched any part of the screen which triggered the start of the introduction section. When the screen was touched, the colour of the introduction box changed so that the learner would perceive the event that was about to occur. The learner was forced to view both components of the introduction section (video on hazards of radioactive materials, and when and why Swipe Check method should be used). At the conclusion of the introduction, the main menu structure was re-displayed and the procedure section began with the menu structure appearing in Figure 2. All six components were presented in order from left to right, starting from the top of the screen. Within a component, subjects could neither go back, nor exit. Similarly, once a section had been completed, it could not be re-initiated.

In the practice section the learner was presented with two screens of instructions and directed to complete all fourteen practice exercises. In responding to a question, if the answer was correct, *a/he* would touch a box labelled continue. If it was incorrect, s/he would touch a box labelled make the correction and then, in his/her own words, type the correct response at the[1] keyboard. Feedback and reinforcement were provided at each step, described earlier. There were no provisions to allow the learner to re-attempt a question and the practice could not be terminated prematurely. When the learner finished the practice, a status grid displayed the correctness/incorrectness of each question. The learner was then forced to re-view each step that s/he had answered incorrectly.

Designer control. In addition to providing control over pacing, this condition offered a limited degree of instructional control. Control options were available at the main menu structure but not within the introduction and procedure subsections. The learner could, in effect, choose introduction, procedure, or practice, in any order, by touching the box that corresponded to his/her choice. However, once introduction or procedure had been selected, individual choices, vis-a-vis any of the components that comprised the section, could not be made. The instruction was presented in the same order and used the same touch/ colour protocol as the linear control treatment. Additionally, any one of the three sections could be selected as often as desired but the sequence of the section was always the same.

There was, however, a certain amount of control offered within some of the procedure subsections. In the tools and materials component, the learner could advance to the next, or go back to the previous frame, by touchingan appropriately labelled box on the screen, but could not exit the component. The ability to terminate the broken down into component steps subsection was provided, and was initiated by touching an exit box. This subsection also included the option of interrupting the video segment by touching any part of the screen, which advanced the instruction to the next component step. Furthermore, the learner could go back to a previous component step by touching the appropriately labelled box. A list of the 14 steps contained two text screens of information, and allowed the learner to go back and forth between the screens, and to exit the subsection by touching the appropriately labelled box. The three remaining subsections did not differ from the linear control condition with respect to options.

The practice section differed from linear control to the extent that an exit option was included with each question. The status grid was displayed when the learner had either completed the practice or used the exit option. In the case of the latter, two control options were then available. The learner could either re-select a question s/he had attempted by touching the appropriate part of the grid, or s/he could exit the practice and return to the main menu.

Learner control. This treatment condition offered a full range of pacing and sequence options and used the same touch/colour protocol. At the highest level of control, each section in the main menu could be repeatedly selected in any order. And within sections (specifically introduction and procedure), the subsections could also be repeatedly selected, in any order, by touching the appropriate box. Video segments in the introductory sequence could be terminated at any time by touching any part of the screen. Those components that contained video segments were preceded with a text screen that described this control option.

In a similar vein, the six subsections that comprised the procedure could be chosen at will. Of these subsections, four of them contained additional control options that were not available in designer or linear control. A video presentation could be terminated by touching any part of the screen, tools & materials included an exit option, and individual tools in chart of tools could be viewed by touching the appropriate box on the screen (see Figure 3). Finally, in a diagram of the 14 steps, any step could be played by touching the corresponding part of the diagram. The other two subsections contained the same control options that were present in designer control.

With the exception of the status grid, the practice section was identical to the designer control treatment. In addition to providing an opportunity to re-view attempted questions or exit, the facility to view questions not previously tried was also included.

Design and Analysis

The study employed a completely randomized 3 X 2 factorial design. There were two independent variables, three dependent variables, and two covariates. The first independent variable featured three levels, linear control, designer control, and learner control. In the second independent measure, subjects were blocked as either high or low in academic ability (median point split) as determined by the vocabulary section of the Nelson-Denny Reading Test which has shown good potential for estimating students' academic aptitude (Gabriel & Richards, 1988).

Of the three dependent measures, two were derived from the posttest recall of basic facts and recall of procedure. The third dependent measure was time on task. Rotter's Internal-External Locus of Control Scale and the pretest knowledge scores were both used as covariates. Two independent judges rated both components of the posttest, which consisted of unit ideas. The recall of basic facts measure consisted of 25 items, each worth 1 point. The recall of procedure measure required that the subject identify in the correct sequence, the 14 steps. Each step carried a maximum weight of 2 points, 1 for identifying the step and 1 for specifying it in the correct order. Correlation procedures were conducted to establish consistency among the scoring. The pathways which subjects in the learner control condition navigated through the instruction were recorded by the computer program, and examined descriptively. All effects were analyzed using MANOVA procedures and multivariate post hoc comparisons.

Procedure

Four instruments were used in the study, namely, *a* pretest for establishing prior knowledge levels, the Nelson-Denny Reading Test (Form E), Rotter's Internal-External Locus of Control Scale, and a posttest. The posttest consisted of two parts, namely recall of basic facts and recall of procedure.

Two Pioneer LD/VS 1 systems had been installed in different locations for the purpose of testing. Subjects were recruited from intact biochemistry classrooms and through a student university newspaper advertisement, and were randomly assigned to one of the three treatment conditions when they arrived for their previously scheduled testing session. The subjects did not know in advance that they were going to learn about the Swipe Check, nor did they know which treatment they had been assigned to; they had been advised that they would be participating in an experiment in which they would learn about laboratory safety procedures using interactive video.

Experimentation began with the administration of the pretest, which was designed to measure prior knowledge of the Swipe Check method. Following its completion, subjects began the vocabulary section of the Nelson-Denny Reading Test. This is a 100 item timed-test, and subjects had up to 15 minutes to complete it. Next, the Rotter scale was administered with no time limit.

Before starting the lesson, the testing monitor initiated a computer program that was designed to acquaint the learner with the touch screen interface. The assigned treatment was then started; the subject was told that s/he could take as much time as desired and to simply tell the monitor when s/he had finished. The monitor recorded the time that the subject began and ended the treatment. Upon completion, passages six and seven of the comprehension section of the Nelson-Denny Reading Test were administered as an interpolated task designed to eliminate treatment immediacy effects. The test requires that the subject read a short passage and answer multiple choice questions in a ten minute time frame. Finally, the subject completed the written, open-ended posttest, was thanked for his/her involvement, and asked not to reveal any details of the session to future participants,

Results

A preliminary scan of the pretest data revealed that none of the subjects possessed the facts required to perform the Swipe Check method. Consequently, as the distribution of scores was too homogeneous to be used as an effective discriminator of prior knowledge, the pretest was not included in any analysis.

Similarly, it was expected that the Rotter Internal-External Locus of Control Scale would have provided an appropriate level of discrimination between groups on posttest performance. However, a multivariate analysis of covariance established that the Rotter scale was not, in fact, a significant predictor when regressed on each dependent measure, and it was dropped from subsequent analyses. This lack of predictive ability of the Rotter scale might be explained by noting that the scale measures how an individual perceives events in life, and the extent to which s/he is able to exert influence and control over such phenomena. In all likelihood, the scale is too general and is presumably incapable of predicting how one might use control options in an instructional sequence, which, unlike the scale, is highly specific. The design, therefore, was examined without the use of covariates.

Inter-rater reliability for the posttest, was established at r = .98 for recall of basic facts, and r = .87 for recall of procedure. Final scores for both components of the test were derived by averaging the raters' tabulations. Cell means and standard deviations for recall of basic facts and procedural steps, and time on task measures, are presented in Tables 1, 2, and 3 respectively.

TABLE 1
Cell Means and Standard Deviations for Recall of Basic Facts

		Instructional Group			
Prior Achievement		LINEAR	DESIGNER	LEARNER	Total
LOW	M	18.81	14.25	14.39	15.89
	SD	3.48	3.45	4.83	4.45
	n	8	6	9	23
HIGH	M	20.71	20.67	13.29	18.44
	SD	4.01	2.22	4.32	4.83
	n	7	9	7	23
Total	M	19.70	18.10	13.91	17.16
	SD	3.73	4.20	4.50	4.77
	n	15	15	16	46

TABLE 2
Cell Means and Standard Deviations for Recall of Procedure

		Instructional Group			
Prior Achievement		LINEAR	DESIGNER	LEARNER	Total
LOW	M	23.06	21.67	22.89	22.63
	SD	3.60	3.82	2.60	3.20
	n	8	6	9	23
HIGH	M	24.00	23.33	20.93	22.80
	SD	3.43	2.32	4.55	3.54
	n	7	9	7	23
Total	M	23.50	22.67	22.03	22.72
	SD	3.43	3.00	3.59	3.33
	n	15	15	16	46

TABLE 3
Cell Means and Standard Deviations for Time on Task[1]*.*

Prior Achievement		LINEAR	DESIGNER	LEARNER	Total
		Instructional Group			
LOW	M	104.63	98.83	86.78	96.13
	SD	16.99	11.75	8.76	14.67
	n	8	6	9	23
HIGH	M	89.14	77.33	75.14	80.26
	SD	13.18	10.40	15.21	13.67
	n	7	9	7	23
Total	M	97.40	85.93	81.69	88.20
	SD	16.81	15.17	13.01	16.15
	n	15	15	16	46

'Time in minutes

A multivariate analysis of variance yielded significant main effects for instructional control, $F_{Hote/(}$ (6,74) = 4.25, $p < .01$, and for academic ability, F_{HoftU} (3,38) = 8.01, $p < .01$. However, no significant aptitude-by-treatment interaction was observed. The univariate effects on the three dependent measures are summarized in Table 4.

In an attempt to isolate differences between levels of instructional control, a discriminant function analysis was conducted. A significant difference was noted between linear and learner control. The discriminant function accounted for 43% of the variance, $R^* = .655$, *Wilks'* A = .57, $p < .01$. Group centroids were .87 and -.81 for linear and learner control respectively. The difference in group centroids provide a significant discriminating set of predictors for the two groups. Most of the predictive ability to discriminate between groups, however, is derived from the recall of basic facts and time on task measures. Subjects in the linear condition significantly outperformed their learner control counterparts on factual recall, but they also spent a significantly longer time on task while doing so. No significant discriminant functions were observed for designer and linear, or designer and learner treatments.

Discussion

The results of this study do not support the predicted aptitude-by-treatment interaction. It was found that regardless of ability, subjects in the linear-controlled condition outperformed subjects in the other two conditions. While this is not entirely consistent with previous aptitude-by-treatment interaction research (Cronbach& Snow, 1977;Jonassen, 1985;Snow, 1980),thereareanumber of plausible explanations. Among these, the absence of prior knowledge must be considered as a prominent mitigating factor. Clark (1982), in a review of relevant literature, concluded that learners often select methods of instruction from which they learn the least. Given full control over instruction without the commensurate prior knowledge, learners may choose inappropriate or illogical paths, either as a function of preference or simply because they do not know better. The absence of interaction effects might also be explained by interpreting the characteristics of the high ability learners. Clark noted that high ability students expect a high level of support when given choices, such as additional practice and examples, but learn less when left on their own.

TABLE 4
Univarlate Effects on All Measures.

Source	SS	DF	MS		
		Recall of basic facts			
Control	264.34	2	132.17	9.14	.001
Ability	59.32	1	59.32	4.10	.050
CxA	71.48	2	35.74	2.44	.100
Error	578.59	40	14.47		
		Recall of procedure			
Control	16.69	2	8.35	.73	.487
Ability	.28	1	.28	.03	.876
CxA	28.13	2	14.07	1.24	.301
Error	455.16	40	11.38		
		Time on task			
Control	2036.18	2	1018.09	6.15	.005
Ability	2907.11	1	2907.11	17.56	.000
CxA	184.88	2	92.44	.56	.577
Error	6621.98	40	165.55		

Still another rationalization may be explored in the context of advisement and coaching. It can be assumed that learners who had control over instruction, but did not possess prior knowledge, were ill-prepared to make appropriate choices, or did not make choices that they should have. Hannafin (1984) proposes that learner-controlled instruction should include advisement to aid in decision making. Milheim and Azbell (1988) have further suggested that to include guidance provides the student with a foundation on which s/he is able to make decisions as tocontent and sequence, while at the same time the program can offer suggestions based on a given choice. And Tennyson (1980) has reported consistently lower posttest performance in learner control conditions, because subjects often terminate instruction too early, or do not select important content. Given some sort of guidance, a student would be better prepared to make appropriate and meaningful selection decisions.

An analysis of the paths that learner-controlled subjects chose in the present study is indicative of their poor performance. In most'cases, the students did not follow the sequence that had been prescribed for linear-controlled subjects, but it should not be inferred that the order in which they made selections was inappropriate. Rather, the error of their ways is a function of early termination of many sequences, and/or chosing not to initiate sequences that contained important information. In several instances, subjects began the instruction with the practice section but soon realized that they did not possess sufficient knowledge to continue.

The present study also found that learner-controlled subjects took significantly less time to complete the instruction, a finding at odds with much of previous research (Balson et al., 1984-85; Beland et al., 1985; Goetzfried & Hannafin, 1985;Ross&Rakow, 1981;Schaffer &Hannafin, 1986) which suggests that students in internally-imposed conditions take significantly more time to complete instruction. In this study, there can be little doubt that it is a consequence of poor sequence selection. In fact, since the difference in group centroids, which is a composite compilation of the predictive ability of the three measures, was so divergent, it is fair to conclude that learner-controlled performance was not only vastly inferior, but also very different vis-a-vis time on task.

As previously mentioned, the internality/externality as measured by Rotter's scale did not influence performance, despite the fact that some previous research (Holloway, 1978) has found it to be a contributing factor with respect to instructional control. Additional research is needed using both Rotter's and other standardized instruments before any conclusions may be drawn with regard to whether internal/external ratings can affect performance within different levels of program control. And the hypothesis that high prior knowledge subjects would perform better under self-imposed control conditions was left untested in this study. In the absence of such data one is left with the conclusion of past research which has tended to support the prediction.

To summarize, the results of this study suggest that in the absence of prior knowledge, regardless of ability, and regardless of internality loading on locus of control, superior performance is achieved through, but more time is spent on, externally-controlled mechanisms. This research further supports, in general, the notion that program-controlled instruction is more suitable for procedural learning and the acquiring of basic facts (Hannafin, 1984; McNeil& Nelson, 1991; Ross & Morrison, 1989).

Additional research is needed to examine the effects of learner control for higher order learning, a lacuna which has been recognized but appears to have been largely overlooked. Future research should also investigate the effects of including adaptive control strategies to advise students of alternative learning pathways, if it appears that their course is likely to have debilitating or dilatory effects. There is substantial evidence to suggest that adaptive learner control strategies can yield positive results and put learners into a better position to make informed decisions, if they are advised appropriately (Clark, 1984; Cohen, 1984; Hannafin, 1984, 1985; Merrill, 1980; Milheim & Azbell, 1988). Thus, building upon this background, an important and sustainable area for investigation would be methods or types of advisement formats which best conform to learner characteristics. In short, matching learner variables with production techniques for varied instructional tasks should increasingly represent the cutting edge of research into interactive video design strategies, as this dynamic technology becomes more commonly accesssible.

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Computer Graphics in ESL Student Learning of Language and Content: A Case Study

Gloria Tang

Abstract: This paper describes the procedure of a course which integrates the teaching of academic English, science content knowledge, and computer skills. It reports on the student learning outcomes and discusses the role of computer graphics in ESL student learning of language and content at the secondary level. The course, conducted in a com puter laboratory in a school in Vancouver, was based on the Knowledge Framework (Mohan 1986) and the goal was to provide opportunities for the ESL students' academic and cognitive development to continue while they were In the process of acquiring academic English.
Observations and Interviews yielded results which indicate (1) that computer graphics aid ESL student learning of academic language and content, (2) that ESL students are capable of acquiring computer skills, academic knowledge, and academic English simultaneously in the computer laboratory, and (3) that the computer laboratory provides a facilitative, non-threatening environment for ESL students' language socialization and acculturation. Further research is recommended.

Resume: Cet expos6 decrit la procedure d'un cours qui integre i'enseignement de I'anglals conventlonnel, les connalssances des sciences et derinformatlque, Il rend compte des resultats de I'etudiant et examine le role de I'informatique graphique dans I'apprentlssage de I'anglals tongue seconde (ESL) et son contenu au niveau secondaire. Le cours, dlrlg6 dans un laboratolre Informatique dans une ecole a Vancouver, etalt base sur le Knowledge Framework (Mohan 1986) et permettait aux etudlants d'anglais langue seconde d'apprendre I'anglais tout en poursuivant leur evolution academlque et cognitive.

Les resulfats d'observations et d'entrevues indlquent que premlerement, I'informatique aide les etudlants en anglais langue seconde d apprendre la langue academlque et son contenu, deuxlemement, ces etudlants sont capable d'acquerir les techniques de I'informatique, les connalssances academiques et I'anglals simultanement dans le laboratoire de I'informatique, et trolsiement, le laboratoire de I'informatique procure aux etudlants un environnement accessible et non menacant pour la socialisation et 1'acculturation. Des techerches additlonnelles sont recommandees.

PURPOSE OF THE STUDY

This paper reports on the findings of a case study (Merriam 1985) conducted in a multicultural class in a secondary school in Vancouver. It describes the procedure and results of a teacher's successful attempt to integrate the teaching of computer skills, academic language, and content knowledge through computer graphics in an English as a second language (ESL) class.

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The objectives of the enquiry were (1) to discover whether or not computer graphics aid ESL student learning of language and content in a specific situation and (2) to evaluate the degree of success of a course which integrated the teaching of language and content and computer literacy.

Multicultural classes have become a common phenomenon in many Canadian schools because of the influx of recent immigrants from different parts of the world. Immigrant or ESL students are usually placed in ESL classes until they are linguistically ready to join their English-speaking peers in content classes. However, research findings show that the development of the "academic aspects of language proficiency involves a complex array of linguistic competencies" (Cummins 1989, p. 32), that it is a long-term process, and that it takes from 4 to 8 years (Collier 1987) for ESL students to reach native-speaker levels of academic language proficiency. This means that ESL students are denied equal opportunities to access content knowledge for a long time. It is, thus, imperative that ESL students be allowed to access academic knowledge and develop their cognitive skills while they are in the process of acquiring academic English proficiency. This paper examines a course which addresses this issue.

An underlying assumption of this study is schema theory (Bartlett 1932; Carrell 1983), which maintains that understanding knowledge expressed in spoken or written language requires students to be able to relate new knowledge to prior knowledge. For students who join an English-speaking school system for the first time, prior knowledge is defined as the sum total of the experiences the students bring with them from their home country. How can ESL students' prior knowledge be activated by English-speaking teachers in English-medium classes? This paper explores the feasibility of using computer graphics to activate prior knowledge. Another issue addressed in this paper is language socialization. In order that ESL students will learn as comfortably as their English-speaking peers in class, some educators feel that ESL students should be initiated into the social practices, the academic language functions, and the culture of the English-speaking classroom.

A possible answer to the above concerns is to design courses which integrate the teaching of academic language, content, and learning tools/strategies which are common across languages, e.g., graphics. This paper reports on one such course, a course in which the teacher used computer graphics (1) to teach content knowledge, (2) to access ESL students' background knowledge, and (3) to initiate the ESL students into the academic language functions of the English-speaking classroom.

THE CASE STUDY

The Participants of the Study

This case study (Merriam 1985) describes an on-going science course conducted in the setting of a Macintosh laboratory in a secondary school in Vancouver. I observed 26 lessons over a period of eight weeks, interviewed the students and teacher, and examined the students' assignments.

The class was made up of 15 recent immigrant students, six boys and nine girls. The students were from various countries: India, Nicaragua, El Salvador, China, Hong Kong and Vietnam. They spoke a variety of languages. Their length of residence in Canada ranged from two months to three years. All the students, with the exception of one boy from Hong Kong, could communicate in English. However, the students had difficulty with the academic language demands of the curriculum. The content of the course was new to most of the students. Only two of them had encountered some of the topics in their first language. They assured me that they could vaguely recall a little of the knowledge. Three of them, who had attended another course in the Macintosh Laboratory, had acquired some computer skills; the others had none. None of the students in this group had received any training in computer literacy before they came to their present school.

Philosophy and Theoretical Framework

The Course Observed

The course was part of a large-scale project, the Vancouver School Board Language and Content Project (Early, Mohian & Hooper 1989). The project was mounted jointly by the Vancouver School Board and the Language Education Department at the University of British Columbia to increase the academic achievement of those students classified as ESL or low English proficiency students. The aim of the project was to enable ESL students to acquire the academic and cognitive skills needed in content area classrooms so that they would be able to enjoy the full benefits of education. It was concerned with "the language barrier to academic achievement for ESL students and with methods of implementing coordinated language learning to reduce this barrier" (Early et al. 1989, p. 107). It was based on the Knowledge Framework (Mohan 1986), an organizing framework for integrating language and content. A brief overview of the Knowledge Framework follows.

The Knowledge Framework

According to Mohan (1986), there are certain knowledge structures which are common across subject areas. These structures can be used to integrate the teaching of academic language and content across the curriculum. Knowledge structures include classification, principles, evaluation, description, temporal sequence, and choice/decision making (see Figure 1). They are rhetorical patterns found in discourse. These structures are common across languages and cultures. They can be defined as thinking skills realized in the macrostructure of written text and oral discourse as well as in graphic form. These thinking skills are the same thinking skills listed in the learning objectives of various elementary and secondary school curricula. Some examples of the thinking skills associated with each knowledge structure are shown in Figure 1.

Each knowledge structure has a specific set of linguistic and cohesive devices (e.g., First,.. Next,.. Then,.. Finally are devices which characterize a sequence) and a list of graphic representations. Using the Knowledge Framework to organize the teaching of content enables the teacher to systematically develop language skills and content knowledge in ESL students. The Knowledge Framework also helps students to transfer learning across subject areas. For example, students can transfer the learning of classification from classifying flowering and non-flowering plants in Biology to classifying imports and exports in Social Studies. In other words, the Knowledge Framework is an organizing framework which helps in the encoding and retrieval of knowledge (Rieber 1989). Graphic representations of knowledge structures, on the other hand, are schemata which assist learning across languages and cultures. They also lower the language barrier for ESL students.

Figure 1.
The Knowledge Framework and Related Thinking Skills.

CLASSIFICATION	PRINCIPLES/ CAUSE-EFFECT	EVLAUATION
Classifying Categorizing Defining	Relating cause and effect Generalizing Drawing conclusions	Criticizing Justifying Evaluating
Naming Comparing and contrasting Describing	Following instructions/procedures Arranging information in chronological order	Stating preference Making decisions Recommending
DESCRIPTION	TEMPORAL SEQUENCE	CHOICE/ DECISION MAKING

Graphic Representation of Knowledge Structure

Knowledge structures can also be presented in a graphic form. There are specific graphic forms for each knowledge structure, e.g., a tree for classification, and a timeline for sequence. Graphic forms and graphic conventions of textbook illustrations have been found to be common across content areas and across languages and cultures (Tang, in progress). Graphics might have the potential for eliciting students' background knowledge acquired in their first language. Recent research results indicate that graphics can enhance ESL student learning of content knowledge and language (Tang 1992). However, findings of ethnographic studies show that students tend to skip over graphics and textbook illustrations or give very little attention to diagrams in instructional materials (Evans, Watson & Willows 1987; Tang 1991b). To make sure that students pay attention to graphics, it is necessary to ensure that the graphics in instructional materials are interactive. Textbook or printed graphics are static, but computer graphics can be dynamic and interactive. Results of research in computer graphics have been positive and have provided some support for using computer graphics in instruction (Alesandrini 1987). Rieber"s (1990) studies have yielded findings which suggest that animated presentations can promote the learning of science concepts in English-speaking students under certain conditions. This study attempts to discover whether or not computer graphics can enhance the learning of science concepts in secondary ESL students.

Description of the Course

Structure of the Course

The course observed was a beginner ESL science course specifically designed for ESL students who found the academic language of science demanding. The subject matter was based on the textbook used by regular classes. The teacher had reorganized and rewritten the materials for the Macintosh Classic microcomputer. The aims of the course were threefold: the teaching of academic English through content, the teaching of science concepts, and the teaching of computer literacy. Greater emphasis was put on computer literacy (60%) than on science concepts (40%). The teacher integrated language and content: he was teaching computer literacy through science, science through the computer, and English through science and computer literacy. He employed the Knowledge Framework to organize his lessons and to effect the integration of language and content. While presenting science knowledge, the teacher systematically drew the students' attention to the linguistic devices of a particular knowledge structure, e.g., sequence or classification. He also used graphic representations to lower the language barrier for the students, to enhance the visual impact, to elicit background knowledge, and to make the links in the integration.

In lesson preparation, the teacher consulted the textbook and reference materials on the same topic and either transferred or created instructional materials on HyperCard for Macintosh computers. HyperCard is a software tool which "provides new ways to organize, display, and navigate through information. And it gives non-programmers the capability to design and write their own applications" (Markman 1988, p. 333). It allows the user to customize information, to modify existing stacks, to illustrate them, to copy information from one stack into another and to "peer behind the buttons to see and modify the scripts that make them work" (Markman 1988, p. 335). Classroom tasks included creating cards (computer skill), copying a diagram on the card (computer and content), labelling a diagram (content and language), and writing a paragraph based on the diagram (language and content). The end product was a stack of cards which the students had made on the computer showing (1) the knowledge they had acquired regarding life functions and (2) the language they had learned to use to demonstrate their knowledge.

The Macintosh Laboratory

Fifteen Macintosh Classic machines were connected to a server in a network. The microcomputers were arranged so that the students sat with their backs to the teacher. While giving an explanation, the teacher could observe the computer screen rather than the students' facial expressions. According to the teacher, the screens provide more information on the students' understanding and ability to follow instructions than their facial expressions do. The screen of the teacher's machine was connected to a projection unit that sat on an overhead projector. Each student was assigned a machine and given a three-and-a-half-inch diskette which they were to use throughout the course.

Lesson Procedure

In the first lesson, the teacher introduced the students to HyperCard. He explained that HyperCard was a software program that was made up of a 'stack' of screens or, in the program's metaphor, "cards" arranged one behind another. He explained the use of the diskette, and he familiarized the students with the computer screen by drawing their attention to some of the functions listed on the screen, such as Tools, Objects, and Files.

In subsequent lessons in which he presented computer skills and content knowledge through the computer, the teacher followed the same pattern with minor variations in each lesson. The instructional sequence is outlined below.

1. The teacher gathered all the students to the front of the room, near his computer and the chalkboards. He presented content information by drawing a graphic, such as a diagram of the digestive system, on the chalkboard. He used graphics and questions to elicit background information and he built background knowledge by presenting the information orally with the help of chalkboard diagrams and written or oral texts.
2. He then projected his computer screen on the overhead projector. Usually the projector showed the same graphic as the one he had drawn on the chalkboard. The repetition of the image was for reinforcement and for linking the computer graphic to the drawing on the chalkboard.
3. He explained the computer tasks and demonstrated on his computer the process from beginning to the end. For example, he said, "Go to File, click and hold, go to New Stack and let go. Click on Field tool. *Go to* Objects, click and hold, go to New Field and let go." The computer screen was projected on the overhead screen.
4. When the task had been successfully completed, he went to one of the students' computers and demonstrated the steps of the task over again while he verbalized all the steps and asked occasional questions.
5. The students then went to their own computers to perform the computer task that had been demonstrated twice. The students were encouraged to discuss the procedure with a neighbour. Meanwhile, the teacher gave individual help when necessary.
6. The students performed an assigned content task which involved copying text passages, constructing text passages, labelling diagrams, or answering questions.

7. When the students had finished the task, they reported to the teacher who would then check each student's work and give immediate feedback.

Computer Tasks

The computer skills which the students were expected to learn included the following:

- accessing a program on the microcomputer,
- demonstrating on-screen text and icon applications,
- accessing a file,
- demonstrating typing and drawing,
- moving the mouse,
- creating and accessing a card,
- making, naming, and moving buttons of various shapes, sizes, and types,
- making and manipulating fields,
- choosing desirable fonts,
- converting teacher's file to own file,
- typing in simple programs,
- demonstrating the working of the programs.

Language and Content Tasks

The teacher integrated the teaching of language and content in various ways. For example, he taught science concepts by using the language of sequence and, at the same time, he taught the language of sequence by discussing the human digestive system. In presenting the different steps of copying a card, making a button, or writing a script, he used the language of sequence. Consequently, the Knowledge Framework was the device which effected the link among computer skills, science knowledge, and academic language.

The subject discipline was science and the topic was life functions. Students were expected to learn the parts and functions of various systems including the respiratory system and the processes of life functions such as digestion and blood circulation, and principles such as response to stimuli. In the presentation of knowledge, the teacher made use of graphics both on the chalkboard and on the computer screen. He was aware of the principal knowledge structure of each phase of instruction and used the language items characteristic of that knowledge structure.

The tasks which the students had to perform and the knowledge which they were expected to acquire included labelling diagrams, filling in blanks, completing charts, constructing sentences to show cause-effect, and writing paragraphs to show sequence of events (see Figure 2). The tasks set on the same topic were related. Each task was based on a graphic and built on a previous task.

For example, they had to label a diagram of the respiratory system. Then the students had to make a chart, to sort, to sequence, and to write down the name and functions of each part of the system beginning from the nasal cavity. The next task was to write a paragraph based on the information in the graphic they had just completed entitled Respiration, following the path of air from the nasal cavity to the lungs and out again. Before the students started writing, the teacher told

Figure 2.
Examples of Computer Graphics with which Students Interacted.

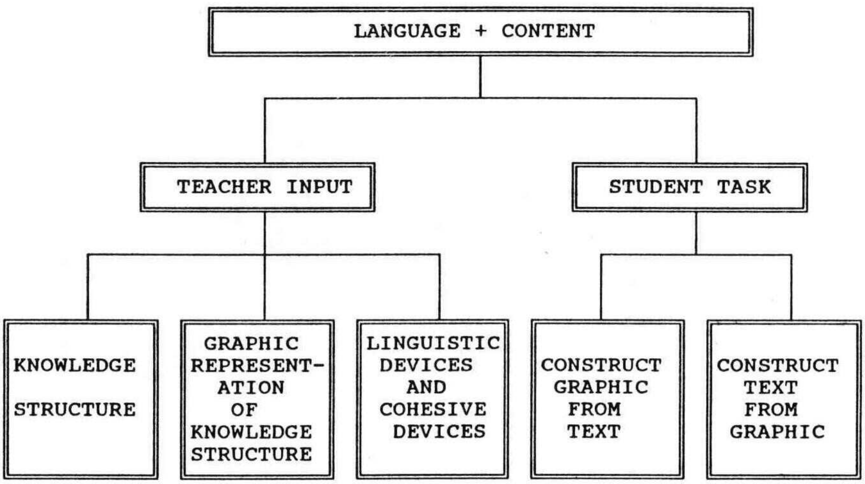
Type	Form	Topic	KS	Tasks
LIFE FUNCTIONS |				
Abs	Chart	Life functions	Cl	1. Make table of content by creating and stacking buttons. 2. Label buttons.
INGESTION |				
Rep	Picture	Ingestion in animals and plants	P	1 . Draw pictures, draw arrows, label pictures. 2. Write paragraph to explain picture.
DIGESTION |				
Ana	Diagram	Human digestive system	S	1 . Learn sequential order of organs. 2. Label organs.
Abs	Chart	Digestive system	C1	1 . Create chart. 2. Put organs of the digestive system in sequence. 3. Complete chart by filling in functions of each organ.
Abs	Pictorial	Journey of a hot dog through the digestive system	S	1 . Study chart. 2. Write a paragraph based on the information in the chart.
[RESPONSE TO STIMULI |				
Ana	Diagram	Response to stimuli	P	1. Draw eye. 2. Type program. 3. Demonstrate how the program works.
Abs	Chart	Response to stimuli	P	1 . Create chart. 2. Write sentences showing cause-effect.

Type: Representational (Rep)
Analogical (Ana)
Abstract (Abs)

Knowledge Structures (KS) : Description (D)
Classification (Cl)
Sequence (S)
Principles (P)

them explicitly that the paragraph involved writing about a process and that there were special linguistic devices for that type of writing. While going over the passage of air through the respiratory system, he put the linguistic devices of sequence on the chalkboard, e.g., When air enters.first it goes... Then it passes... Next... etc. He further instructed them to try to use those terms in their paragraph. In short, the teacher was following a classroom model of instruction (see Figure 3) which has been found to have positive effects on ESL student learning of language and content (Tang 1991a).

Figure 3.
A Classroom Model.



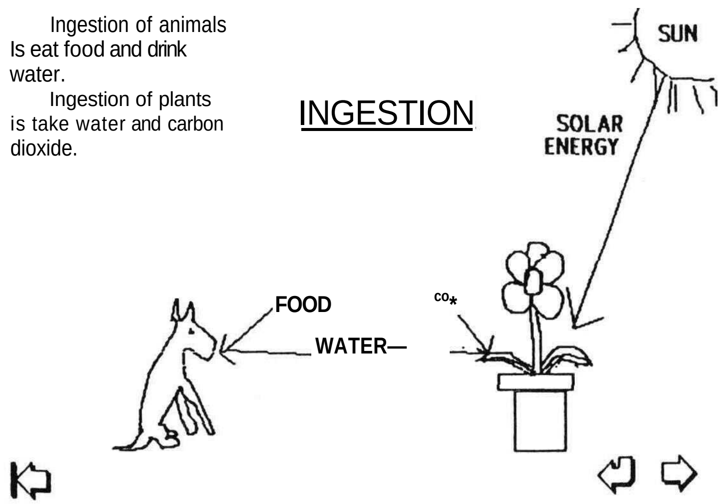
FINDINGS OF THE CASE STUDY

Computer Graphics

Computer Graphic Types with which Students Interacted

Observation of the lessons showed that every concept in science could be visualized and all illustrations found in printed materials could be shown on the computer screen. Representational pictures (Levie&Lentz 1982)which had been scanned from reference books, analogical graphics (Alesandrini 1987) such as representations of the digestive system and abstract graphics (Alesandrini 1987) such as tree graphs, classification charts, and sequence diagrams were used to illustrate new concepts and to elicit student writing. They were either teacher-provided or student-generated. Figure 4 is an example of a student-generated graphic.

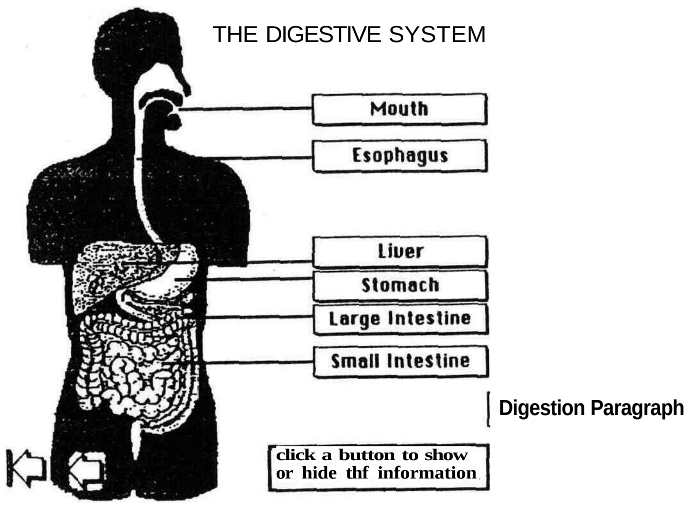
Figure 4.
Student-Generated Graphics.



Some of the graphics were static; others were dynamic and interactive. The static graphics were textbook illustrations (see Figure 5) on screen which could appear or disappear at the click of the mouse or the touch of a key or two. Some of the diagrams and charts used for labelling and completion exercises were similar to printed worksheets. The difference between printed and computer graphics was that the desired page, or the desired section of a page with the definition of the term could be accessed by clicking on a button with a label, e.g., small intestine (see Figure 5). Another difference was that the cells in the computer chart could scroll. Consequently, writing did not have to be constrained by the size of the cell.

An animation is a type of graphic which could only appear on a screen. It was produced by writing a program and could be designed to be interactive. For example, in creating visuals to show the principle of response to stimuli, the students had to make three cards and draw three versions of the same picture, such as an eye with a different-sized pupil. They then had to create buttons and write a short program so that by clicking on a button, they could demonstrate how the size of the pupil responds to different intensities of light (see Figure 6).

Figure 5.
The Digestive System.

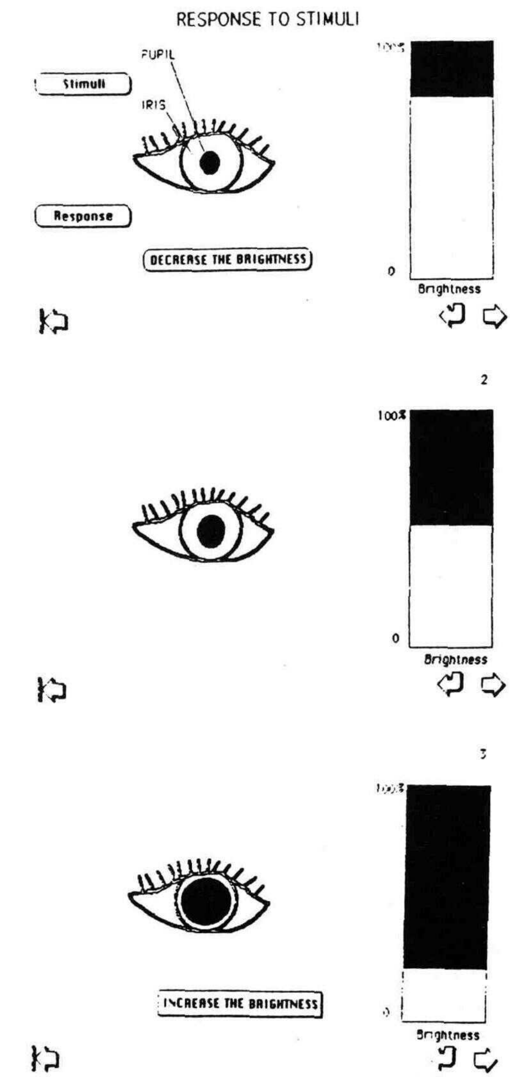


Examples of the graphic types with which the students had to interact and the tasks they had to perform are shown in Figure *2*. In short, the students interacted with a large quantity and variety of graphics. Each was a representation of a knowledge structure.

How Students Interacted with Computer Graphics

The students interacted with graphics in different ways: labelling diagrams, filling in blanks, describing, explaining processes, interpreting principles, copying pictures, creating charts, and drawing pictures. Their attention was directed to the graphics and all assignments were based on one or two graphics. Thus, while doing their assignment, they kept going back to the graphic to look for additional information. Sometimes the students were forced to refer to the computer graphic because it was the only one available. Other times the students chose the computer graphic instead of the one in the textbook. However, when the same graphic appeared on the chalkboard and computer screen, equal number of students referred to the chalkboard as to the screen.

Figure 6.
An Animation.



Discussion on the Effect of Computer Graphics on ESL Student Learning

Language and Content

Oral interviews and examination of the students' written work showed that all the students could understand the concepts presented when the teacher employed graphic representation of knowledge structures to present content knowledge. They showed understanding of the processes of the various life functions; of the cause-effect relation of stimulus and response; and of the functions of the systems learned. They could also express in short paragraphs their understanding of the information, such as the digestion of a hot dog and the functions of various organs. It was evident from interviews and questioning that the students could recall the information from their short-term memory. However, how long the students could retain the knowledge and how much of the knowledge could be retained was not investigated. Future research is recommended.

The representational pictures which showed the cycle of ingestion helped them to understand the principles of ingestion. The labelled diagrams of the various systems enabled them to understand the sequential order of the organs in a system and how the system works. The chart of the functions of each organ helped them to write a paragraph because the organs were arranged in the right order and because the functions appeared alongside the organ. They could, thus, produce a paragraph by copying some phrases from the chart and linking them by the linguistic and cohesive devices, e.g., First . . . Next . . . and Then. . ., suggested by the teacher.

Questions on the information which had been represented as computer graphics were more readily answered than questions which required the students to read a passage or to look for a picture in a book. By clicking the mouse, they accessed the right picture, looked at the chart and without much difficulty knew the right phrase to choose. In this respect, a computer graphic had advantage over a textbook graphic. The students were aware of the advantage, i.e., convenience of access, and made use of it. However, the graphic type in which the students were most interested and the one which was most attention-getting was the animation. An example follows.

The graphic which explained the principle of response to stimuli was created by a simple program. It was interactive and it made the concept easier to understand. After looking at the picture, clicking on the button increases the brightness, and watching the picture of the pupil become smaller, all the students could explain the principle of how the pupil responds to light. Some of their responses were:

> "When I am in the darker place, the pupil will change it smaller."
>
> "When I turn on the light, the pupil goes small. If there is little light the pupil goes bigger." and
>
> "When we get into bright room, the pupil will be smaller when we go into dark room the pupil will be bigger."

Even the student who could not quite explain it in English readily told me in Cantonese what the graphic showed. Furthermore, the graphic seemed to be able to hold their attention for a long time. Thus, "presenting information on a computer, particularly in an interactive format, seems to have some useful motivational and attention attracting characteristics" (Reynolds & Baker 1987, p. 172) for ESL students. Of all the graphics presented in the course, this was the most attention attracting. In the program, they changed the wait time from 50 (computer time units) to 30 several times for fun and to test how quickly one picture dissolved into the next (see Figure 7). It appears that "it is this dynamic and interactive aspect of computer graphics that is so appealing to learners (Alesandrini 1987, p. 159) and holds great promise for facilitating ESL student learning. However, the value of this graphic should not be overstated on the evidence of one example. Rieber (1990) points out that "given the track record of animation research, the efficacy of animation as a presentation variable is obviously very subtle and difficult to draw out" (Rieber 1990, p. 139) and that animated presentations can promote learning only under certain conditions. Further investigation is needed to establish the value of animations in ESL student learning.

Figure 7.
A Computer Program.

```
On mouse up
Repeat 2 times
Visual effect dissolve
Go next
Wait 50
Ends repeat
End mouseup

On mouseup
Repeat 2
Visual effect dissolve
Go back
Ends repeat
```

Linguistically they had learned or were learning to write a paragraph showing the sequence of events and to answer questions showing cause-effect relations, and so forth. It is true that there were mistakes in their writing and speaking, but they were cohesive texts because all students attempted to use the linguistic and cohesive devices the teacher had emphasized. This finding supports my conjecture that linguistic devices characteristic of a knowledge structure have to be explicitly taught (Tang 199 la) and Long's (in press) assertion that learning of form is enhanced if learners' attention is drawn to it. Some samples of the students' first drafts are shown in Figure 8. The final drafts were almost perfect in accuracy because the students were alerted to errors and inaccuracies during individual conferencing when the teacher provided immediate feedback.

Figure 8.
Students'Paragraph Writing.

Nancy's Respiration Paragraph

When I inhale the air, it enter my Nasal Cavity to breath in oxygen and it passes through to the pharynx. The it goes to Epiglottis, from the Epiglottis it moves down to the larynx and that the air goes to my Trachea. Then from the Trachea it goes to the Bronchi and the airs spreads out all through the lungs into the Alveoli. The oxygen from the air it goes to the alveoli. From the lungs.

Kristina's Respiration Paragraph

When air inhaling, it enter to my nasal cavity, air passes through the pharynx. Next the epiglottis open to let air go to larynx and passes through the trachea. Aflerthisitgodowntobronchi. Then it spreads out all through the lungs. It goes to alveoli.

Activating Prior Knowledge

Did computer graphics help the ESL students to access prior knowledge acquired in their first language? Interviews with the students showed that they recognized universal or common graphics such as diagrams of the digestive system, circulatory system, and graphics showing the principle of photosynthesis. The students from Hong Kong were able to tell me in Cantonese what the diagrams were about, e.g., "This is the process called photosynthesis. Plants take in carbon dioxide and water and sunlight. They make sugar and oxygen." Another student could tell me in Cantonese that the diagram was about blood circulation. He guessed the meaning of "Vein" and "artery" in Cantonese because he had seen the diagram before. However, he could neither pronounce the words nor express in English what the diagram described. It is difficult to decide whether and how much schema (Carrell 1983) or prior knowledge learned in their first language affected their learning. I noticed that for one of the students, a familiar diagram or chart was like a key word. Whatever the question, his response was the same. For example, the respiratory system invariably elicited the ready response, "Breathe in oxygen and breathe out carbon dioxide." From time to time, he volunteered an unexpected answer translated directly from Cantonese which was grammatically incorrect but which might make good sense.

Computer Literacy

All the students became computer literate in varying degrees. The amount they learned and retained depended on the individual student. Beginners who had never touched a computer before the first class of this course sought individual help throughout. However, at the end of the eight-week period, all the students had a completed stack of cards to show and tell. They could do all the basic tasks such as starting up and shuttingdown, moving from card to card using command keys or the mouse, typing, changing font size and type face, and erasing. They could make line drawings to decorate their cards and they could change special effect specifications which, according to them, was like magic. They seemed more interested in the latter because of its interactive characteristic. Some of them could verbalize the procedure. An example follows:

> At first I put a program into this button. And then the button will do what I type. Will do what the program say. The pupil will bigger or this table will be the brightness grow more or little. When you click this button the pupil will smaller and the dark will smaller too.

A very highly motivated student who wanted to outperform his classmates could remember everything. He remembered how to create new buttons, a task which most beginners did not. He even attempted to do something extra to his program to impress the teacher. Those who had attended another course in the computer laboratory in the previous terms could remember all the tasks taught. However, none of them could trouble shoot. If anything unexpected turned up, e.g., a blank chart appeared instead of a completed one, they were perplexed. Nevertheless, it can safely be concluded that all students in this course had become computer literate in varying degrees. They did not exhibit any computer fear and some would like to take another course to become more proficient in computer skills.

Attitude, Language Socialization and Acculturation

All the students found going to the computer laboratory much more interesting than having classes in the classroom. The three non-beginners loved the computer. They liked to improve their computer skills and one of them seemed interested in trying out new skills. He kept asking questions about using the scanner. Most of the beginners were not as comfortable with the computer: they were bewildered by the scrolling field and found the terms Card, Field, and Button confusing. However, they were proud to be able to do what they had learned, particularly the special effects. Towards the end of the course, all the students expressed interest in taking computer courses.

The students who had taken a typing course found it easier to write on the computer than on paper. All were aware of the strength of the computer as a writing tool: it made editing, changing, and rewriting their paragraphs easier. A student from Hong Kong recalled what he had to do back home when he made a mistake in his essay writing; he had to recopy the entire essay. He preferred doing corrections on the computer. Another student who did not like drawing on paper liked drawing on the computer.

Computer graphics appeared to have the potential for effecting language socialization: they played a part in initiating the ESL students into the social practices or academic language functions of the English-speaking classroom. These practices included listening to and reading academic discourse to comprehend knowledge and speaking and writing academic discourse to express content knowledge.

What was most remarkable was the initiation of ESL students into the culture of the Canadian classroom. The atmosphere the teacher had created was friendly and non-threatening. The students soon learned to respond to and enjoy the teacher's sense of humour, and anticipated a joke on the screen, e.g., "Task one. Smile to your teacher." or "Your teacher is a great guy."

All the students seemed willing to communicate with their peers, including those who spoke a different first language. The setting of the laboratory was more conducive to student-student interaction. In the class observed, the students who were more proficient in English and who were often the only students to contribute in class were not the best in computer literacy, and some of those who were usually too afraid to make mistakes and speak in class were more proficient in computer skills. Often the quiet students gave instructions to the less quiet ones. This reversal of roles gave the usually quiet students a chance to gain self-confidence and self-esteem.

Generally, the students were willing to ask questions, to initiate dialogue with the teacher, to engage in group discussion, and to cooperate with their classmates in problem solving. Though the question was not investigated, the non-threatening and friendly atmosphere of the computer laboratory appeared to have helped in the socialization of the ESL students into the culture and academic and social practices of the Canadian classroom. It would be worthwhile to conduct further research to address this question.

SUMMARY AND CONCLUSION

Findings of the study show that computer graphics, both static pictures and animations, have the potential for aiding ESL student learning of science concepts. There are indications that the animation can hold students' attention for the longest time, supporting Rieber's (1991) assertion that animation is an effective attention gaining device. However, results show no evidence that one type of graphic is more facilitative of learning than the other. There are also indications that computer graphics can activate some of the students' prior knowledge acquired in their first language, but the question needs further investigation. It is also difficult to determine how much of the student learning is affected by the computer graphics. Nevertheless, taken globally, the ESL science course appears to have succeeded in attaining its objectives.

The students understood all the science concepts presented (content learning). They could express their understanding in oral and written form (academic language learning). They were also learning to write paragraphs using the linguistic and cohesive devices of different knowledge structures (awareness of knowledge structures). They had to perform tasks which involved classification, description, principles, sequence, evaluation, and choice (the Knowledge Framework). Moreover, they became computer literate in varying degrees (computer skills). These findings indicate that the Knowledge Framework is a useful device for teaching and integrating the instruction of science concepts, academic language and computer skills. Besides, students' attitude towards the course was positive. Furthermore, the atmosphere the teacher created helped to initiate the students into the cultural and social practices of the Canadian classroom.

However, this paper has described only one slice of life of one classroom within a limited time frame. It has shown only one course which integrates language, content, and computer studies. It is one person's construction of the reality of one case and is expected to be read as such.

Finally, further research in similar courses which integrate language, content, and computer skills is needed; and studies for investigating computer graphics and the long-term retention of knowledge and use of language are warranted.

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Literacy and Cultural Discourse: The Relativity of Print

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Abstract: Literacy performance is not universal but must be understood within the context ot a group of people with particular cultural values and characteristics. This paper describes the literacy functioning of a group of participants within a Newfoundland setting. The results suggest a number of Implications, especially, for literacy assessment and programming.

Resume: La performance en alphabetisatlon n'est pas un concept unlversel mate on doit la comprendre d l'lnterieur du contexte d'un groupe de gens qul partagent des valeurs et des characterlstlques culturelles partlculieres. Cette etude decrlt le fonctlonnement de I'alphabetlsatton d'un groupe de participants au sein d'un milieu terre-neuvien. Les resultats suggerent un nombie d'lmplicatfons surtout en ce qul concerne revaluation et la mfce en oeuvre des programmes en alphabetlsatton.

Literacy within the North American context has generally been viewed from an "outside-in" perspective. That is, authorities (including the media) decide who shall be literate, and when and how. A good example of this is the Southam Literacy Survey (1987), a measure of the functional literacy levels of Canadian adults. The survey questionnaire, consisting of two forms, one of 10 items and one of 14 items, was administered to 2398 Canadians. The illiteracy rate in Newfoundland, based on a sample of 105 respondents was recorded as 44 percent, yet 4 of the items on the forms dealt with organizing a meeting, a task of no relevance to many people taking the test. From the "outside-in" perspective, literacy implications are usually described in terms of the benefits that should follow naturally from literacy development.

Research is needed to determine how people value literacy and how literacy levels interact with the total functioning of the individual in relation to others and to his/her environment. Only by understanding this context can authorities, and government agencies in particular, respond most effectively to perceived literacy needs. Smith (1986) emphasizes the need for such research:

> An ethnography of literacy (or illiteracy) that is true to its cultural roots will examine without preoccupation both the social consequences of the particular illiteracy under investigation and its various levels of meaning to individuals. It

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> will be sensitive to the entire web of relationships human beings find themselves enveloped in (p. 271).

The purpose of this study was to investigate how residents in a Newfoundland setting responded to particular literacy tasks.

Participants and Methodology

The participants consisted of a core group of nine individuals and a peripheral group of about 10. The core group might be classed as of lower middle class socioeconomic status and lived mainly in an urban area. There were five females and four males; the age range would be approximately 35 to 65 years. This study continued over the course of a year.

An ethnographic approach guided the collection and analysis of the data. Hill (1983) argues that "the ethnographic approach allows for an in-depth investigation since the researcher lives in the community studied for an extended period of time and attempts to understand the social phenomena investigated from the point of view of community residents themselves" (p. 28). The data reported here are part of a larger study with an overall purpose of studying the interaction of cultural values and literacy. One area on which the author focussed concerned the relationship of background knowledge, and oral language in interpreting and using print. Wilcox (1982) suggests that within *a* larger study one is able "to select among phenomena in the process of research" (p. 499).

Overall, the researcher's role was that of participant-observer and since he had recently arrived in the community it was only "natural" that he would ask questions re different practices. Mishler (1986) states that an ethnographic method bases its interpretation of data with in a particular cultural context so the researcher was always careful to speak as if he were attempting to function effectively (which was true) within this context and questions asked reflected this intent. There was no attempt, for example, to have respondents hypothesize, conjecture, nor did the researcher raise practices from other cultures/geographic areas for comparative discussion. According to Kerby (1991) participants frequently become "locked into a mode of life that may not change in any essential way over many years (and). . . repeat the same routines" (p. 38). The challenge was to tap into the participants' personal consciousness of then- routines and to understand the situation as they perceived it, which Guba and Lincoln (1985) refer to as interpretative inquiry,

Literacy Discourses

In order to understand literacy (utilization of print) among a particular segment of Newfoundland society, it is important to understand the notion of discourse, for as Gee (199 la) states, "Learning to read is always some aspect of some discourse" (p. 6). Gee defines discourse as "a socially accepted association among ways of using language, of thinking, and of acting that can be used to identify oneself as a member of a 'social network' " (p. 3). Discourse may be primary or secondary. All people, through beingpart of a family or other close knit group, acquire primary discourse. Gee explains:

> All humans, barring serious disorder, get one form of discourse free, so to speak, and this through acquisition. This is our socio-culturally determined way of using our native language in face-to-face communication with intimates (intimates are people with whom we share a great deal of knowledge because of a great deal of contact and similar experiences) (p.7).

Oral language is the key medium within the primary discourse. Gee adds that the acquisition of this discourse, the primary discourse, comes through "primary socialization within the family" (p. 7) and extends outwards. If the expanded circle of relatives and/or friends is homogeneous enough that they share a primary discourse, this cultural group functions as a "society of intimates" (p. 7). As such they possess information not available to others outside this discourse.

As people encounter others outside the intimate circle, they relate to them via a secondary discourse which "requires one to communicate with non-intimates (or to treat intimates as if they were non-intimates)" (Gee, 199 la, p. 7). Secondary discourses build on and extend the uses of language from the primary discourse. In many instances, written language is the common language medium within a secondary discourse.

Interrelating Print and Background Knowledge

The observed data on the respondents were coded and catgorized in terms of how they function vis a vis each other for the purpose of utilizing print information. The results are summarized under a number of general statements.

1. Oral language is used as an interpretative vehicle for written language within primary discourses.

Print is ordinarily part of a secondary discourse. However, there are occasions when print events are brought into the primary context as part of the participants' daily functioning. While sales flyers, for example, originate within a marketing discourse or context and the use of language in these flyers is usually generated by marketing strategies and needs, the use of sales flyers is important in the context of daily living within a primary discourse.

It seems that in the Newfoundland context the use of print within the primary discourse depends on oral language as an interpretative mechanism. Sales flyers are a significant part of oral language interactions and participants regularly comment on, and share information pertinent to using flyers. One participant may check with another whether he/she noticed a particular sale, or may comment that he/she was able to take advantage of a particular sale. Frequently, items on sale are not publicized in flyers but are advertised on signs adjoining the business and it is only through oral language that many people will be aware of the sale. Such sales may include a bargain on milk (an expensive commodity in Newfoundland) at a service station, or on cheese at a corner store. Sometimes there are "in-store" specials, *a* knowledge of which is also shared by word-of-mouth. It is also common that when a person plans to buy a "bigger" (in value) item, he/she checks with the store manager to see if and when a sale of such an item might be forthcoming.

Gee (1991b) states that "language is always something that is actively constructed in a context physically present or imagined, by both speaker/writer and hearer/reader through a complex process of inferring that is guided by but never fully determined by the structural properties of the language" (p. 93). In the case of sales flyers, the use of oral language embodies a larger context - that of family/friends and the economic conditions. The language itself is not important but rather its effect of enabling someone to capitalize on a "bargain". Because of a strong oral language network "complete" print information is not necessary for that functioning to occur.

Other instances in which oral language supercedes print in providing for interpretation include dealing with the lack of identifying, directional or locational information. For example, the addresses of stores, theatres, or other institutions are frequently not included in announcements/ advertisements as this knowledge is generally known. In the case of one flyer, not even the name of the store was indicated, since people were able to associate the flyer format with the particular store. Interpreting print via background knowledge and oral language interaction as done by the Newfoundland respondents is as Freire (1991) states, a form of "re-writing" the context by transforming it. No longer is the print of the flyer autonomous; no longer is the secondary discourse of the print crucial to its use. The context of sales flyers is analysed and utilized to the advantage of the participants who capitalize on sales through oral language, either through seeking more information, or sharing existing information. For these participants, the word "literacy", according to Courts (1991) suggests a state of being and a set of capabilities through which the literate individual is able to utilize the interior world of self to act upon and interact with the exterior structures of the world around him (or her) in order to make sense of self and other" (p.4)

2. Background knowledge is essential in communicating via print within primary discourse.

According to Freire (1991) "reading the world always precedes reading the word, and reading the word implies reading the world" (p. 144). In order to interpret print and communicate the meaning, it is first essential that the participants read the world. Participants must know the address of stores; they must know that corner stores and service stations publicize sales via advertising boards/signs; they must know that certain stores (especially supermarkets) promote sale items at certain times during the day (maybe around noon, or a couple of hours before closing, especially on Saturday nights when some stores close at 10:00 P.M.

Having read the world and having acquired a certain body of information enable the participants to act more effectively within their environment. For example, participants know on which days various businesses release sales flyers so not only do they wait until the final sales flyer in the sequence is released to do comparative shopping, but also they plan their shopping route so that they travel the shortest distance between home and stores and back again.

Background knowledge also allows them to be more critical shoppers. For example, participants note such detail in sales flyers as the number of tissues in a box, the number of sheets in paper towels. Critical reading also occurs in assessing the cost for utilities; for example in evaluating heating costs, participants note the number of days from one billing date to the next, so that the cost of heating "per month" may be evaluated against 28 days or 31 days.

3. *Those not sharing the necessary background knowledge are at a disadvantage.*

Because of the emphasis on background knowledge in the Newfoundland context and the presence of restrictive print information, these people not sharing this knowledge as participants are disadvantaged. As an example, an instructor in a local college was to visit a workplace site for a group of college students in a nearby community. The contact person in the community gave the instructor directions, "After you pass the sign entering the community, come straight down the road and then up a steep hill and you will see Smith's Garage on your left; you just can't miss it.". The instructor drove to the community, down the road and up the hill and soon found she was well beyond the community without having found the site. She called her contact from a pay phone. All she said she saw along the way was an ESSO and a Petro Canada station. The contact interrupted, "That's it" she said, "the ESSO station on the way up the hill." But the instructor continued, '1 didn't see a sign 'Smith's Garage'". "Oh, I don't believe there is one" said the contact, but everyone knows it is Smith's".

A second example concerns a memo from a University department which read, "This is to advise that effective immediately budgetary items which were normally referred to person-X should now be referred to person-Y". This assumes that new staff in particular know which budgetary items were referred to person-X. It also forces those outside the primary discourse to become part of it through the preferred mode of oral language. For a new staff member to operate effectively, he/she would have to find out which budgetary items are now referred to person-Y and this communication would likely occur through oral language.

A final example not only illustrates the disadvantage of the person outside the primary discourse but also the categorization of that person as being an outsider. The example refers to voting in a municipal election in which the public announcement in the local paper did not indicate who qualified as a citizen eligible to vote. This meant that a recent arrival had to ask to find out this information. The first response of the person asked was, "Oh, where are you from" How long have you been here? etc.".

4. Assessing literacy must be congruent with the respondents' discourse.

The four items on the Southam Literacy Survey questionnaire relating to setting up a meeting would not be functional for the respondents of this study. Whereas the tasks in the questionnaire were termed "functional" this was hardly the case. Firstly, the meeting is a ficticious one and of no relevance to the respondents who judge the value of a meeting in terms of the issues to be discussed. Furthermore, the matter of setting-up and arranging meeting space is the function of "others", the setting-up is usually under the control of a secondary discourse and is usually authoritative in nature as when a government or union official calls a meeting about the Northern cod moratorium or a school board to explain its decision to construct a new school. In fact, there may not even be a notice of a meeting, the information being communicated through the "grapevine method". Since participants tend to know participants who have a stake in the issue, the information gets passed selectively and effectively.

The task of making physical arrangements for the meeting is the responsibility of the person hired by the premises where the meeting will be held and not that of the general public.

Ironically, literacy evaluators from outside the primary discourse may find themselves "illiterate" in that context in the sense that the context operates on minimal print and considerable background knowledge , the latter which they will likely lack. Literacy assessment is relative to the task at hand and the discourse which guides the task's meaning.

5. Not only does the use ofprint vary by discourse, but the organization of discourses may vary by geographic / cultural region.

This is stated more as a hypothesis because data from other contexts (urban/ rural, geographic regions, cultural groups) are needed to confirm it. In addition to the 19 respondents on whom the previous data are based, data from an additional 10 residents (mainly in a rural area) led to the above statement.

Certainly, in *a* primary discourse, oral language takes precedence over written language. Within the Newfoundland context, the significance of oral language and background knowledge to capitalize on and compensate for minimal print cues may differ from that in other geographic/cultural regions. The predominance ofbackground knowledge and oral language (discussed in relation to statement #1 above) is also highlighted by an incident at a neighbourhood gas bar where a couple of pumps were out of order. The management did not think to place an "Out of Order" sign as the regulars would know and those who didn't would soon find out by trial and error. The assumption was that the customers would come to this conclusion rather than thinking they were not operating the pumps correctly.

When print occurs within a secondary discourse (under the control of an agency/institution) it is usually viewed as formal, impersonal, and authoritative. While oral language is essential for interpreting print in a primary discourse its role is almost negligible in interpreting print in a secondary discourse and takes on more of a role in sharing. Oral language is used to "read out" the written language, the meaning of which then stands on its own outside the primary discourse but may be an object of discussion within the primary discourse. Even newspapers may be viewed in this way. The print takes the event away from the peoples' control. The print refers to events "outside" the people rather than being integral to their lives. It is an "independent, objective" account of an event. For example a person may talk of a death announcement in the paper (citing the wording) in a very different way and with different information than in discussing the event in a social context. It is like describing a snapshot of the event rather relating it from personal knowledge. Newspapers are often read in short intervals interspersed with talk about what has been read. For example, *a* person notes an item of interest and then immediately phones someone who is also interested to chat about it. This is not unlike reading in the workplace when short periods of silent reading are interspersed with talk to share and interpret what has been read (Mikulecky, 1982).

Oral language is also interjected into secondary discourse from a humanistic or an expectation of personal interaction. As an example, after a major storm during which thousands of households were without electricity and hundreds of calls were received at the Light and Power Company, a company official returned calls to check if the caller had had the power restored and if things were functioning adequately. In fact, it is not uncommon for *a* citizen to phone the premier on a certain matter and talk to him directly.

When print is associated with institutional and traditionally powerful organizations such as the government and the church, and functions to direct or control, it takes on an authoritative meaning which is generally accepted rather than questioned. A parish bulletin, for example, had the effect of regulating the behaviour of parishioners through the following statement:

> Notice: It has been brought to my attention that continuous fighting and arguing is still going on at the Parish card games.. .This must stop immediately, so that the people who like to attend the card games can relax and enjoy themselves. So I am asking the people who attend the card games to report to me the name/ names of the person/persons who is causing the trouble and that person/persons will be asked to stay away from the card games so that the rest can enjoy themselves.

Discussion and Implications

Policy makers must realize that literacy is not an easy term to define. It is perhaps best defined in terms of its relativity. Certainly, the concept of discourse is essential in understanding literacy and the nature of a discourse may vary across regions and cultures. In some contexts, the broader defintion of literacy, that of making sense out of all signs and symbols, may be most appropriate. A knowledge of the geographic/cultural context, the mutually-held goals, the shared knowledge and the operational routines is essential to understanding literacy.

"Print literacy" according to Courts (1991), "is best defined as a meaning-making process rather than a simple coding or decoding of meanings already presented as given" (p. 3). He continues, "It has not been an overemphasis on meaning-making processes that has caused the literacy problem, but an overemphasis on fragmented contexts, an overemphasis on bits and pieces of knowledge with little focus on relationships among the fragments" (p. 3). In a Newfoundland context, making sense of print literacy must also include the support of background knowledge and oral language. It is recommended that in Adult Basic Education literacy classes the emphasis should be on meaning-making. Analysis of word structure and language patterns should not be dealt with in isolation but within *a* larger context which provides meaning through the use of background knowledge and oral language interaction. Institutional programs should reflect the community contexts in interpreting print.

For example, a notice (of something pertinent to the learners' lives) may be displayed and a segment of print read and discussed in terms of their background knowledge that enhances its meaning. A notice of a meeting to discuss the "cod moratorium compensation package", for example, can lead to much discussion and sharing of experiences (personal and otherwise), reacting critically, and drawing implications. Even the place of a meeting may be given extended meaning through a discussion of its location, the ease of getting there (on a bus route), parking facilities, etc. The need to attend to word structure should arise from such an exercise rather than initiate it.

The interrelationship of print, oral language,and background knowledge may also be used in writing assignments. Writing directions, memos, and personal and business letters may first be discussed in terms of what the reader (audience) may know and how much information needs to be conveyed. This kind of activity could be extended to writing narrative, essays, or argument where print takes on greater prominence in terms of the meaning to be conveyed.

Because of the predominance of oral language, talk should constitute the transition from home to school. Too often, schools immerse beginning students in secondary discourse literacy events. These are often foreign to the students and sometimes result in irrelevancy and failure. Students should be provided with opportunities and should be encouraged to "talk their way through" various print activities. That is, students should talk about the familiarity of the activity, where and when it would be found, how it would function in their lives, etc. Occasionally, stories could be dramatized. Social studies projects in which the students talk to/interview residents from the community should be organized. People from the community should be encouraged to act as resource people for various school topics/activities.

Policy makers should be suspect of surveys conducted by "outside agencies" that purport to be functional and profess to measure the degree to which a person can operate with print. The goal should not be one of evaluation, of determining what is right or wrong, better or worse. Rather, the goal should be one of determining what is.

Any literacy assessment should only be interpreted in terms of "assessment for what?" If, in the case of the Southam Literacy Survey, it is to compare the literacy levels of people across the country, then only items that are common to all respondents (assuming that this is possible) should be used. If the assessment is to determine to what extent a person can cope with expectations in a workplace setting, then items pertinent to that workplace setting must form the basis of the assessment. If the purpose is to determine to what extent a person can function with written language in terms of critical reaction, such as might occur in a university context, then the assessment might require the individual to present an argument, a critique, or write an essay.

If the task is to assess the functional use of literacy for people in their "everyday" contexts, that is, the degree to which participants can *get* on with their daily lives with and around print, then tasks pertinent to that goal must be provided. In the case of the respondents in this study, such tasks would have to consider the support of oral language and background knowledge in interpreting print (often restrictive) and as this study has shown, the people would function quite well and even better than "outsiders" to that cultural context. In general literacy assessments must distinguish between describing what is versus suggesting what should be.

Adult literacy (basic education) programs must also be distinguished in terms of their purpose. A program aimed at helping adults function better within their everyday contexts is one focus; preparing adults to enroll in trades/workplace programs is another, while providing for adults to obtain a general educational diploma is a third. When adults do not see the connection and relevance between what is expected of them in an adult literacy (basic education) program and the nature of their functioning after the completion of the program, there is usually little motivation and investment of effort.

Promotional campaigns aimed at informing the populace how illiterate it is by quoting survey statistics may fall on deaf ears. Participants within the primary discourse described above do not perceive themselves as illiterate; in fact, it is the "outsider" who cannot function via print in this primary context. Such campaigns should focus on literacy opportunities (programs) of which individuals may take advantage. Once the opportunity/program is described in terms of what it is intended to achieve, the individual can decide whether or not participation in this will be meaningful for him/her.

The Relativity of Discourse and Print

The significance of print tends to be relative to the discourse in which it occurs. Print is not ordinarily a focal point in primary discourse and when it becomes interwoven with the lives of participants in a Newfoundland geographical/cultural context, its interpretation is considerably dependent on oral language and background knowledge. However, discourses may also be relative to the geographical/cultural context in which they occur. The primary discourse described in this paper as part of a Newfoundland geographical/cultural context may actually be considered an "extended" primary context because of the tendency to remove certain print activities from their ordinary secondary discourse contexts (business, government, etc.) and incorporate them into the daily functioning of the participants. The predominant use of background knowledge often putting "outsiders" at a disadvantage may be unique to the Newfoundland context; this however, can only be determined through further research comparing discourses across geographical/ cultural contexts.

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Book Reviews

Diane P. Janes, Editor

Preparing Instructional Text — Document Design Using Desk-top Publishing by Earl Misanchuk. Englewood Cliffs, NJ: Educational Technology Publications, 1992. ISBN 0-87778-241-5 (US $32.95; CDN $42.18)

Reviewed by William R. Hanson

Earl Misanchuk has crafted a useful guidebook for those who are serious about designing and producing printed instructional materials. Misanchuk states up front that this book is for you, if you are an educator who has primary responsibility for the preparation of instructional materials using desk- top publishing techniques, and if you want to produce effective instructional materials, not necessarily win awards. This book is for a very specific audience, but for the right person it is a valuable resource.

In setting a context for the semi-technical guidance to come, Misanchuk makes two very important points. The first is, that this book was necessary because of the importance of established research to document design. He distinguishes between intuitive, "trustingyour tummy" design and research-based design. The book has extensive reference to research that says something works and something else doesn't work as well. He also points out design issues that are unresolved by research and open for further investigation.

Misanchuk's second point is the distinction between desk-top publishing (DTP) and desk-top publishing for instruction. DTP for instruction is different from DTP for advertisements, magazines or newsletters. This book focuses on instruction.

The operating system platform that Misanchuk uses for illustration or examples is Macintosh, but his instructions translate easily into other operating systems and applications. Chapter 3, "Using the Computer Wisely," is *a* useful treatment of items like dashes, quotation marks and word wraps, and utilities like scrapbooks, style sheets and outliners. This chapter is made interesting by contrasting how it was with the typewriter to how it is now, with the computer.

Any competent graphic designer would not need Chapter 4, "Initial Design Considerations," but the average teacher, instructor or professor venturing into this field will benefit from this research-based advice. Chapters 5, 6 and 7 deal with techniques like access structure (pagination, headings and indexes, orienting devices) and the obligatory fonts, type, leading and kerning. Misanchuk provides clear explanations of what these are and how to use them effectively in instructional materials.

Chapter 8 tackles a primary issue in graphic design, the principles of page layout. The author handles this potentially huge issue clearly and concisely. He uses the words simplicity, consistency, balance, symmetry, unity, harmony and rhythm, to give page layout life and meaning to the reader. Chapter 9 (Tables) and Chapter 10 (Data Graphics) offer solid, research based advice on what works and what works better.

The final Chapter 11, "Illustrations and Other Graphics," was the most fascinating and frustrating to this reviewer. It was fascinating because of Misanchuk's connection between illustrations and different types of learning. This heavily referenced section is a strong blend of instruction, visual literacy and the subtle impact of document design. This chapter was frustrating because of the absence of graphic examples in what is a rich opportunity to save a thousand words. This omission perhaps reflects Misanchuk's understanding of his audience. Educators who have hands-on access to DTP for instruction do not have access to sophisticated illustration applications. Well illustrated, this chapter could have saved several thousand words, but then it would only whet the appetite of a reader who does not have, or who could not operate, Adobe Illustrator on a Mac. The audience this book is published for is a selective, but important group of educators.

Earl Misanchuk practices what he professes. Preparing Instructional Text is a book that demonstrates the principles, techniques and technology application the author is advocating. When you read it, you notice that the presentation is what you are reading about. (It is Bookman font, ragged right justification and easy to read and refer to.) The research emphasis is strongly supported by extensive author references at the end of each chapter and the book. It also includes an author and subject index.

REVIEWER

William R. Hanson is a Teacher-Librarian at William Aberhart High School in Calgary, Alberta. He is a lifetime member of AMTEC.

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