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INTRODUCTION

ARTICLES

PROFILES

All correspondence should be addressed to:

Dr. Richard A. Schwier, Editor
Communications/Continuing & Vocational Education
College of Education
University of Saskatchewan
Saskatoon, Saskatchewan
S7N OWO

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Research and Development with Interactive Learning Technologies: Introduction to the Special Issue of *CJEC*

Richard A. Schwier

Long ago, media hardware lost its allure for educational technologists. Decades of comparative studies pointed to few robust differences in learning from different media (Moldstad, 1974; Clark, 1983). Yes, there were some differences reported, but most could be attributed to learner characteristics, instructional design variables, or the contexts of delivery. More recent calls for research in educational technology ask for studies which extend beyond attendant hardware, and rather focus on the characteristics of the instruction and how it differentially influences individuals (Clark, 1983; Misanchuk & Schwier, 1981) and applied developmental problems in instructional systems (Heinich, 1984). Thus, researchers in the field of educational technology have turned their attention to the very variables that seemed so troublesome in the comparative media studies. Interactivity (how individuals interacted with instruction) is a keystone feature of more recent studies. Ironically perhaps, these research questions have been accompanied by radical developments in instructional hardware which help make instruction developed on them much more responsive. Educational technologists are driven by the challenges delivered by researchers and the opportunities offered by hardware to design approaches which exploit interactive rather than passive designs.

But interactivity is only an intermediate step. Intra-activity is what we really hope for. Intra-activity (activity within an individual) is necessary before learning can occur; the statement is axiomatic. The difficulty comes in making intra-activity happen. How can we energize minds to the extent that learning happens? In two-step fashion, we introduce inter-activity, and hope it stimulates intra-activity.

This special issue *of CJEC is* devoted to interactive instructional technologies. During the last several months, I have been privileged to manage the review of a wide range of excellent manuscripts on this topic. Indeed, I have been tutored on the broad definitions of interactive technology that exist in our field. The articles selected for this issue reflect the wide-ranging definitions, but also flow together nicely in three sections. The first section (Hannafin, "Interaction Strategies and Emerging Instructional Technologies: Psychological Perspectives") establishes a context for looking at interaction in instructional technology, including a review of traditional approaches to interaction, an analysis of qualitative and quantitative perspectives on the issue and recommendations for requiring the 'cognitive engagement' of the viewer in instruction. The second section includes two experimental pieces (Tovar, "Effects of Active vs. Passive Review Strategies on Recalling Information From an Interactive Video Instructional Programme"; and Misanchuk, "Learner/User Preferences for Fonts in Microcomputer Screen Displays") which sample concerns related to designing materials to promote meaningful interaction with learners. The third section (Alien & Eckols, "IMPART: A Prototype Authoring System for Interactive Multimedia Vocabulary Tutorials and Drills"; Engel & Campbell-Bonar, "Using Videodiscs in Teacher Education: Preparing Effective Classroom Managers") offers two case studies. The first describes the rationale, design and development of an authoring system for foreign language vocabulary training, and the second article describes the design and implementation of an interactive video-based approach to teaching classroom management.

So, in effect, we attempt to model the topic of this special issue in its construction. The feature articles address the topic of interactivity from a number of directions — conceptual, experimental and practical. I invite you to strike a path through the material, consume those elements that seem most relevant to you, and sample those which may provide a new challenge. The authors have given us a great deal to work with. In short, you should interact with this issue; be an assertive, rather than passive reader.

I would like to take this opportunity to thank Robert M. Bernard, Mandie Aaron, Mary Genova and Patricia Nickel-St. Onge for their help putting this issue together. They have made it a delightful experience, and I have come to know them as committed scholars and new friends.

I would also like to pay a special tribute to Robert Bernard in this, his final issue of *CJEC*. As Editor, Bob has done a remarkable job over the last four years, working tirelessly to improve the quality of *CJEC*. It has been an honour to work with him as a reviewer during his period of leadership. I think it is fair to say that no other individual in Canada has contributed as significantly as Bob to the development of our field during that time. As his colleague I admire him; as his friend I thank him; as his successor I fear his accomplishments. On behalf of the readership of *CJEC*, thank you, Bob, for the outstanding work you have done.

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GUEST EDITOR

Richard A. Schwier is a Professor of Education at the University of Saskatchewan, Saskatoon, SK, and Editor-Elect *ofCJEC.*

Interaction Strategies and Emerging Instructional Technologies: Psychological Perspectives

Michael J. Hannafin

Abstract: Interaction strategies for emerging instructional technologies have typically reflected mathemagenic. designer-centered views of lesson design. Recent developments in cognitive psychology, however, have important implications for redefining interaction to include predominantly learner-centered methods. In particular, generative strategies designed to promote individually relevant cognitive processing have important, generally untapped potential. In this paper, the traditional functions of interaction are reviewed, quantitative and qualitative perspectives on interaction strategies are described, and several methods for promoting cognitive engagement via both mathemagenic and generative interaction strategies are presented.

The growth of interactive instructional technologies has been staggering. The relatively crude hardware and software employed even one decade ago have evolved to provide truly extraordinary capabilities. We have witnessed a metamorphosis of computer-based instruction with the advent of state-of-the-art hardware and software, a transformation that has empowered instructional researchers and designers with unparalleled tools for manipulating instructional strategies.

Yet, we are both the beneficiaries of innovation and the victims of our own ignorance. We have embraced the electronic monolith having neither understood nor tamed its powers: We have a clear sense of what technology can do, but are comparatively naive as to how best to employ it instructionally. We describe the instructional capabilities of the ever-expanding arsenal in largely technological or procedural terms, with little regard for the requirements of effective instructional transactions. The elements we comprehend best are those easiest to characterize through descriptions of features, not those of greatest importance to advance a "science of design" (c/Glaser, 1976).

One important step toward advancing a science of design is to better understand the potential of lesson-learner interaction. Virtually every CBI author has lauded the interactive potential of the computer. Yet apart from relatively primitive questioning techniques, little has been done to exploit the

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instructional potential of varied interaction strategies. The purposes of this paper are to analyze the functions of various interaction methods, to assess critically the psychological requirements of methods, and to describe strategies designed to increase the value of lesson-learner interactions.

Functions of Interaction

Interaction can be thought of as accomplishing one or more instructional functions from simply providing procedural control through causing differentiated levels of cognitive processing.

Confirmation. Confirmation is designed to verify that intended learning has occurred. Confirmation typically focuses on learner attainment of intended lesson objectives. Through confirmation, student progress is monitored, branching is executed, and decisions are enforced regarding subsequent lesson activities. Typically, criterion-referenced questions are embedded during a lesson which require that knowledge or skills be demonstrated.

Pacing. In many cases, interaction is required to control lesson pace. Directions such as "Press the <SPACEBAR> to Proceed," or "Touch the Screen When You're Ready to Answer," require a response to govern when lesson procedures will be executed. Pacing options presumably optimize learning by accounting for varied reading and processing rates.

Inquiry. Student-centered inquiry increases access to lesson support based upon uniquely defined needs. In effect, the responsibility for addressing learning needs shifts from the global, largely mathemagenic strategies imposed by the designer to the metacognitive dictates of individual learners. Inquiries often take the form of help routines, or student-accessible lesson features such as current or ongoing performance updates and lists of lesson sections completed.

Navigation. Navigational interaction is concerned with how lesson sections are executed. Interaction provides the learner with controlled access to defined parts of a lesson. Typically, explicit navigational functions are provided via designer-imposed menu options. In other cases, implicit navigational control is provided as a consequence of learner accuracy, such as in repeating or skipping lesson segments in adaptive branching designs.

Elaboration. Elaboration allows learners to combine known with to-be-learned lesson information. The goal is to encourage students to relate successfully encoded knowledge with current lesson content, thereby both enriching the context for understanding and improving the retrievability of new information through association (Wittrock, 1974). Elaboration is accomplished by strategies such as encouraging the learner to compare and contrast existing knowledge with new lesson content or to combine additional relevant information with current lesson content.

Though useful, these functions have not yet yielded particularly innovative interaction methods. Have we failed to identify functions appropriate to the expanded power of emerging technologies? It seems unlikely that the basic functions have changed appreciably v.ith the advent of sophisticated computer-based instructional systems, but certainly the designer's toolkit has expanded dramatically. Our ignorance is not simply limited vision in functions, but limited understanding of instructional transactions. Interaction methods vary not only according to function, but to response requirements and cognitive complexity as well. Though interaction has been traditionally described in quantitative terms, it is clear that varied instructional transactions must be considered.

THE NATURE OF INSTRUCTIONAL TRANSACTIONS: QUANTITATIVE AND QUALITATIVE VIEWS

In order to understand instructional transactions, the events requiring interplay between lesson content and the learner, it is important to differentiate among various views of interaction. Damarin (in Jonassen, 1988) proposed six levels of interactivity in courseware: watching, finding, doing, using, constructing, and creating. To date, most interactions address only the first three levels, with comparatively little evidence of using, constructing, or creating during interaction. Jonassen (1985) also developed a taxonomy of interactive lesson designs. In effect, each level requires progressively greater grasp of the meaning and conceptual nuances of the instructional content; presumably each then requires qualitatively different interactions.

Most commonly employed strategies support learning primarily via the raw frequency of interaction. Traditionally, drill and practice advocates have espoused the importance of frequent responses to criterion questions, with associated feedback and supplementary instruction and practice as needed. Recently, however, increased interest in methods designed to deepen processing requirements via practice has been noted (see, for example, Salisbury, 1988). In this section, quantitative and qualitative perspectives on such interaction strategies are examined.

Quantitative Views of Interaction

Increased interaction potential has been identified as a fundamental difference between traditional and emerging instructional technologies (Hannafin, 1985). Traditionally, interactions have been operationalized as objective, quantitative entities; instructional interactions were designed to promote "competence." Bork's (1985) recommended interaction every 15-20 seconds during lessons typifies quantitative views of interaction. Such views reflect the fixed interval reinforcement schedules espoused by early behavioral psychologists as well as the recommendations of early programmed instruction theorists (Hannafin & Rieber, 1989a). Likewise, interaction can be viewed quantitatively as the number of questions (or fixed ratio schedule) embedded during an instructional module. Presumably, the increased opportunity to produce task-relevant responses (and presumably to receive feedback) increases in proportion to the number of questions posed.

Other quantitative applications include the emphasis on the so-called "congruence" between the adopted performance standards reflected in objectives and the corresponding implications for the number of assessment (practice as well as posttest) items. Such standards are common elements in the typical instructional systems design (ISD) models in widespread use. [See, for example, Dick & Carey (1985); Sullivan & Higgins (1983).] In such cases, successful responses to a prescribed number of test items that are aligned with the content and standards of the objective are taken as evidence of mastery or competence.

An underlying premise of quantitative views of interaction is that learning is causally regulated by external factors such as response frequency or interval. Quantitative emphases are typically rooted in the same behavioral influences that were applied first to PI and subsequently to early CBI (Hannafin & Rieber, 1989a). Many believe that quantitative methods permit a needed degree of structural and procedural control over lesson design and execution. Students demonstrate objective, tangible evidence of learning in order to assess subsequent instructional needs; consequently, the strategies employed tend to be bounded by the content of the corresponding lesson.

Qualitative Views of Interaction

Qualitative views reflect a stronger cognitive psychology influence, and place a substantially greater emphasis on the learner's role in mediating interactions. Learners are not viewed simply as responders to the externally generated lesson questions or queries, but as controlling the degree to which information is selected, organized, and integrated (Mayer, 1984). In effect, we are concerned with the manner in which instruction fosters cognitive engagement - the intentional and purposeful processing of lesson content.

Cognitive engagement is mediated by a number of factors. It is influenced by the nature of the presentation stimuli, the associated response requirements, and the consequences of the responses (Hannafin & Rieber, 1989b). Responses made with minimal effort offer objective (quantitative) evidence of interaction, but little about the degree to which the relevant concepts have been processed, associations with prior knowledge made, and meaning assigned.

Cognitive engagement is also influenced by the degree to which prior knowledge exists to support the encoding of new knowledge. Though lessons often require a significant degree of new learning, it is neither necessary nor wise to "dis-engage" lesson content from the wealth of available knowledge from which learners can make reasonable associations and inferences, and within which the knowledge is to be subsumed. Activities that cultivate intentional processing by detaching current content from prior knowledge are simply unlikely to engender the kind of assimilation needed to promote meaningful learning (Mayer, 1984).

One aspect of meaningful learning that is generally unavailable for much rote learning is the degree to which insight is gained: Knowledge encoded with little meaning may be retrievable under specified conditions, but typically provides few implications for related knowledge. Meaningful learning, on the other hand, is more completely integrated within existing schemata, presumably increasing both the utility of the knowledge and the potential for transfer to untaught problems.

Clearly, both quantitative and qualitative interaction methods are important. Yet, it seems equally clear that we have relied heavily on quantitative methods to the virtual exclusion of qualitative approaches. We have, for the most part, transferred our largely quantitative notions to the design of emerging technologies. Such designs are successful for training individuals in what to do, but not for gaining deeper understanding or for acquiring the insight necessary for cognitive development. In addition, we have generally failed to alter dramatically the nature of instructional transactions. They remain essentially objectives-driven and convergent in nature, much as they were before the advent of sophisticated computer technologies. As technological capabilities expand, we must likewise expand our notions of interaction if both technological and human processing capabilities are to be optimized.

LOCUS OF INTERACTION STRATEGIES

Designer-Centered Interaction

Designer-centered strategies are generally mathemagenic in nature, that is they are "...concerned with the effective management of instructional processes relevant to the attainment of instructional objectives" (Rothkopf, 1970, p. 326). Activities such as embedding criterion questions and asking the student to list lesson events are examples of designer-centered interactions. Such strategies reflect what must be learned from a lesson, and offer a variety of methods to satisfy the external requirements for which the lesson was designed. In effect, designer-centered interactions are "strategies for the masses," designed to promote cognitive processing specifically related to externally-defined standards.

Learner-Centered Interaction

Generative interactions, on the other hand, emphasize methods requiring greater learner responsibility for assessing learning needs and seeking appropriate information (Wittrock, 1974). Such methods attempt to optimize the meaningfulness and efficiency of instruction by permitting learners to apply metacognitive skills to identify learning needs rather than to adopt activities across learners. Typically, learner-centered methods provide devices such as menus and indexes to permit user-assigned lesson access needed information.

Though the rationale for, and locus of, mathemagenic and generative methods are quite dissimilar, we have done little to maximize the potential of either method in typical computer-mediated instruction. Designer-centered activities do not inherently invoke shallow processing of information, nor do learner-centered methods necessarily deepen relevant processing. There are occasions where strict mathemagenic methods are essential and others where they are neither required nor desirable. For instance, mathemagenic methods are often limited to simple criterion questions with fairly routine and predictable consequences while other substantially more integrative methods exist, such as posing questions requiring the establishment of relationships among various lesson concepts. Likewise, presumed generative methods often assume the form of relatively simplistic menus that simply mirror the lesson structure already established. It is essential that both task and cognitive requirements for various interaction methods be evaluated systematically before appropriate methods can be prescribed.

INTERACTION AND EMERGING TECHNOLOGIES: COGNITIVE REQUIREMENTS

Bork (1982) described three components of interaction: the student's response, the analysis of the response by the computer, and the conditional reaction of the computer based upon the student response. This exchange mirrors the $S \rightarrow R \rightarrow S^R$ paradigms of behavioral psychology: Stimuli are presented in the form of a question, responses are produced in the presence of the controlling stimuli, and reinforcement is conditionally provided in the form of the computer's reaction. Notably present in this definition is an emphasis on physical actions and computer analysis; notably absent is an indication of student processing or purposeful manipulation. These are more or less inferred by virtue of the student responses. In addition, the emphasis on the computer's reaction as a necessary component of interaction has been questioned since it is basically a technological adaptation based upon more fundamental design logic (Jonassen, 1988).

Floyd (1982) defined interactive video as "...any video program in which the sequence and selection of messages is determined by the user's response to the material" (p. 2). Essentially this definition applies across a range of interactive video applications, including, but not limited to, instructional applications. This definition is satisfactory as a starting point, but it must be qualified for instructional applications. The strongest evidence for effective instructional transactions is guided learner mediation of relevant instruction and not simply technologically differentiated presentations. If we produce varied sequences for different learners but fail to stimulate appropriate processing, have we designed interactive instruction? Conversely, if lesson execution is undifferentiated by virtue of student response, should we conclude that the lesson is not interactive instructionally?

For instructional purposes, then, we are less concerned with the physical evidence of interaction than with the cognitive activities that the lesson is designed to engender. For present purposes, effective instructional transactions require a student response bised upon the information, events, or processes depicted via technology and the appropriate cognitive restructuring associated with transaction. The response itself may be purely cognitive, such as the judgements, analyses, and inferences made while reading this article. Unlike Floyd's definition, it is of primary importance that cognitive processing be mediated by the transaction and of secondary importance that lesson execution be differentiated.

Interaction Modes

The vehicles through which cognitive engagement is elicited via emerging instructional technologies have expanded dramatically. Yet, all modes of interaction are not equally effective for all aspects of learning. The physical and cognitive requirements of typing, for example, exist along a continuum based upon response demands that range from single keystroke through complex typing of phrases, sentences, and paragraphs. In some cases, typing provides an appropriate method for interaction; in others, the cognitive and physical requirements of typing have long been known to confound true assessments of learning. In general, the simpler the typing requirements, the less externally valid the response as a measure of interaction; the more demanding the typing requirements, the greater the probability of underestimating true learning.

Touchscreens provide perhaps the least physically demanding and least abstract method of interaction commonly available. They also permit the use of natural visual images in lieu of descriptive text where it is useful to minimize text processing requirements. Whereas touching reduces many of the confounding effects during interactions, it generally limits the nature of the interaction inherently to simple response formats. Low-level touching poses only nominal processing requirements, an advantage where simple effortless procedural control is desired but a disadvantage when the goal is to elicit high levels of integration. Many systems employ devices such as a mouse to permit the student to click on answers, or to "point" to or select from various screen displays. Such devices are slightly more abstract than simply having student touch the same parts of the screen due to the requirement to maneuver across a table-top rather than directly on the image (Hannafin & Peck, 1988). However, many of the same potential limitations exist for pointing devices as for touchscreens. They tend to encourage very simple responses, allowing users to proceed through lessons with minimal mental effort — a phenomenon rarely sought during instructional applications (Salomon & Gardner, 1986).

Attempts to develop "natural language" interfaces, designed to normalize the interaction between user and machine in human terms, have been among the most widely publicized developments in the human factors field. For many applications, the ability to simply state a response appears ideal. Yet voice recognition technology remains frustratingly slow to develop, and has been wrought with unfulfilled promise. Numerous problems persist with regard to user dependence, limitations in active vocabulary, discriminations among homophones, contextual meaning, and colloquial usage to name but a few.

Instead of liberating both designers and students, most voice recognition technologies require interaction that is neither natural in syntax nor typical in form.

Simulators and more recently stimulators (computer-managed working versions of the actual devices to be manipulated) provide a measure of reality unavailable in most lesson designs. Generally, simulators that approximate retrieval contexts during instruction, as well as the performance requirements within the retrieval context, provide the closest match available among the cognitive, affective, and sensory aspects of performance (Hannafin & Rieber, 1989b). Three-dimensional flight training stimulators, for example, are designed to capture as many relevant factors affecting performance as possible. Interactions, therefore, assess not simply knowledge or simplified pieces of a complex task, but performance under circumstances nearly identical to those ultimately required.

Ideally, interactions permit responses that optimize cognitive engagement while matching the performance requirements of a lesson. However, we are typically limited to available input formats. Few systems enable voice input, some support touchscreens, and virtually all provide keyboards. We cannot be certain that the optimal input technologies will be available whenever needed, but we can provide a measure of confidence in the interactions based upon the manner in which the methods elicit, heighten, and sustain cognitive engagement.

EXTENDING INSTRUCTIONAL TRANSACTIONS: STRATEGIES THAT PROMOTE COGNITIVE ENGAGEMENT

Table 1 (see following page) contains a summary of the basic interaction functions, the assumptions inherent in the different interactions, sample interaction methods, and additional strategies designed to heighten cognitive engagement. The following is a brief description of selected engagement activities. The activities include both mathemagenic and generative methods for heightening the degree to which the lesson content is engaged and processing is deepened.

Fault-Free Questions

Fault-free questions cause the student to process lesson content in ways that are unique to the individual. Typically, complex responses are constructed, requiring the interrelating of multiple aspects of a lesson, or the integrating of various lesson concepts within uniquely evolved learner schemata. Responses are not evaluated - cognitively, in fact, the correctness of the response is relatively unimportant compared with the elaboration provided to support encoding and the additional pathways that are created to aid in retrieval (*cf* Wittrock, 1974). Fault-free questions can be mathemagenic in nature, requiring the student to compare and contrast various aspects of the

TABLE 1
Summary of Interaction Functions, Assumptions and Strategies

Interaction Function	Psychological Assumptions	Typical Interaction Strategies	Additional Engagement Strategies
Navigation	metacognitive skills orientation to lesson components	menus option buttons	structure hypertext options ask why section(s) selected
Query	supporting prior knowledge metacognitive skills assimilation of answers to schema	query-structured menu natural language questions options for more information references to related info	ask for predicted answer ask why question is important ask to identify related questions and concepts
Verification	retrieval of encoded knowledge to STM learning strengthened via	embedded questions appropriate feedback for responses conditional branching	ask for confidence estimates ask students to generate questions that assess skills employ real-time responses
Elaboration	supporting prior knowledge strengthened encoding spread of activation among related nodes increased ease of retrieval	"think about" strategies induced introduce relationships with familiar content examples provided	ask for other instances where concepts apply ask for explanations of why answers correct or not employ cooperative dialogue to broaden available input
Procedural Control	metagocnitive skills STM not overtaxed	"Press <SPACEBAR> to Go On..." "Touch the screen when you've seen enough to answer"	ask for summaries in own words ask to record notes or unclear points ask to generate questions

lesson content. For example, students might be asked to compare and contrast the structure of a particular element with one recently presented. The interaction should deepen learning of each element in accordance with lesson objectives, while supplying elaboration that supports the conceptual relationships ofboth. Likewise, fault-free questions can be generative, requiring that uniquely assigned meaning be applied to lesson information. Questions that prompt the student to generate examples to explain a concept to another child, sibling, or colleague require that knowledge be not simply acquired but restructured in ways that promote utility.

Queries

By allowing the learner to pose questions rather than simply to answer them, a fundamental shift in the nature of the instructional strategy occurs. The interaction shifts from being essentially mathemagenic, designer-centered in nature to generative, student-centered in nature. Students can elicit information based upon schema-driven needs-to-know, ensuring greater integration than imposed questions. Queries can be made using fixed choices, where learners select from among defined options (e.g., who, what, when, or where) based upon need to know. Such methods standardize those features of the knowledge base to be made available for student queries. In some cases, questions can be generated more uniquely by individual students without the obtrusiveness of the supplied structure. Student queries may take the form of keyword searches, or in certain cases may query more deeply through a series of clarifying comments and prompts.

Real-Time Responding

Real-time refers to the ability to interact with phenomena as they occur. Real-time responding allows the element of time, as either a critical factor in assessing performance or as a motivational device, to be factored into interaction methods. In some instances, real-time interaction is integral to successful performance, such as simulated engine stalling during flight training. In others, however, they simply permit students to control events generatively as they unfold during lesson execution. For instance, students might be told to stop the lesson as soon as sufficient information has been obtained to support a differential diagnosis during an instructional sequence depicting patient case history and medical symptoms. The added element of real-time helps to create a "living" instructional environment, where students respond to actual events as they unfold, and not merely to descriptions of the events.

Notetaking

Some lessons encourage students to elaborate via electronic notetaking. Peck and Wambaugh (1988), for example, developed a simple mouse-based system for both selecting notes from the script of an interactive video segment and for annotating both lessons and notes. Again, such methods can be primarily mathemagenic or generativ - in nature. The student may selectively record verbatim transcripts to support learning of particular objectives, or may elaborate lesson information with individual analyses, anecdotes, and other learner-generated comments. The system broadens potential interaction to permit inspection (and recording) of key points normally presented only aurally, to locate key points in the notes or script, and to accumulate and manipulate notes via word processing software. Such methods open a wealth of interaction alternatives, much of which have a considerable empirical foundation in non-electronic form.

Predicting I Hypothesizing

Salomon and Gardner (1986) have cautioned that mental effort is mediated by perceptions of self efficacy and the perceived demand characteristics of the medium. In effect, it is often necessary to structure activities to increase the demands of the task in order to ensure high levels of cognitive engagement. Causing students to make and justify predictions during a lesson has important consequences. Students build an anticipatory set of expectations regarding subsequent events. In effect, students generate propositions, which in turn organize a schema. New information can then be evaluated relative to predictions and not only presented. Such methods are useful for a variety of learning tasks, including a good deal of scientific and mathematical content as well as prose and social studies.

Hypertext

Hypertext refers to text access methods that permit user-assigned pathways through instructional content. Hypertext interactions may range from directly addressing given words or concepts within a lesson to navigation through the supplied structure of the knowledge. Jonassen (1986) described three levels of hypertext: Node-link, structured, and hierarchical. Node-link essentially provides random access among all nodes within the available content, such as through the use of indexes, elaborate menus, or direct queries by the student. Structured hypertext permits access across sets of logically organized nodes, such as through top-level access to defined lesson segments or activities. Hierarchical hypertext further prescribes access according to hierarchical relationships presumed within the lesson. Control decisions could be based upon making the content structure apparent to the student or imposing starting points within nodes based upon the presumed hierarchical structure of the task or lesson.

Cooperative Dialogue

Recently, considerable work has been published concerning the utility of cooperative learning techniques in computer-mediated learning environments. [See, for example, Carrier & Sales (1987); Johnson & Johnson (1986); and Mevarech, Stern, & Levita (1987).] Cooperative interaction, featuring groups of two-to-four students, can provide an unusually rich method for promoting cognitive engagement. Typically, one-on-one CBI is limited only to the perspectives provided by the computer and those introduced by the student. The potential for elaboration, competing perspectives, and plausible alternatives, therefore, is necessarily reduced. Cooperative learning, however, provides a variety of techniques designed to stimulate dialogue, provide needed explanations and supporting rationale, and to otherwise elaborate basic content. In addition, such methods help to overcome many of the logistical problems resulting from insufficient numbers of computers.

CLOSING COMMENTS

The quest for a meaningful perspective from which to understand and guide interaction in the face of rapidly evolving technology is no small matter. We cannot be certain of the form technology will assume in the future, but it seems certain that it will continue to change. It is no longer adequate to simply describe interactions in terms of either the input technology employed or the physical characteristics of the responses made - these will certainly change over time. We need a richer understanding of the psychological requirements associated with instructional tasks and responses, and a sense for how to extend design science beyond the methods that have evolved through the years. If we do not acquire a richer understanding, then we will fail to understand how best to utilize the capabilities of future technologies; if we do not understand the capabilities of the technologies, then we will have doomed the potential of such developments by our ignorance.

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AUTHOR

Michael J. Hannafin is Director at the Center for Instructional Development and Services, Florida State University, Tallahassee, Florida 32301-4829.

Create the Wave: the Third Educational Technology

CALL FOR PROPOSALS

Dear Colleague:

AMTEC, the Association for Media and Technology in Education in Canada, is Canada's national association for educational technology professionals. The annual *AMTEC* conference will be held in St. John's Newfoundland, June 9-12, 1990, at Hotel Newfoundland.

You are invited to submit a proposal to present a session at *AMTEC '90.* The conference theme "Create the Wave: The Third Educational Technology" recognizes the challenges facing educational technologists in the decade leading up to the 21" century and the ways these challenges may be met.

The theme allows for a wide range of theoretical and practical presentations. It focuses attention on the processes through which educational technology becomes an integrated part of educational planning and development. Within this framework, the *AMTEC '90* Program Committee welcomes session proposals in the following streams:

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Media Production
Computer Applications
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School Librarianship
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Those individuals or institutions whose proposals have been accepted will be asked to develop a session paper. A selection of papers relating to the theme will be published. The publication will be available during the conference.

Effects of Active vs. Passive Review Strategies on Recalling Information from an Interactive Video Instructional Programme

Mariela Tovar

ABSTRACT: The purpose of this study was to investigate the effect of two review strategies on recalling information from an interactive video program. The strategies compared varied in terms of the amount of overt activity required from the learners. The conclusions suggest that the question of interactivity must be examined more closely to take into account: a) the quality of the strategy provided; and b) how different types of strategies work depending on learners and desired learning outcomes.

One of the most attractive features of interactive video for instructional designers is the possibility of integrating the visual capabilities of video with the interactive capabilities of the computer (Alien, 1986; Scheffer & Hannafin, 1986; Smith, 1988). Although some interactive strategies can be incorporated into any kind of medium, the processing capacities of the computer facilitates the design of interactive instructional programs.

Blum-Cohen (1984) defines an interactive program as one where "the student is actively involved in responding to an instructional lesson..." (p.19). Thus, at the heart of the concept of interactivity is the notion of active participation of students during the learning process.

The facilitative effects of progressively interactive video instruction were examined in a study by Scheffer and Hannafin (1986). The authors investigated the effect of four versions of an interactive video program ranging from linear video to a fully interactive variant using questions, branching, and remediation on achievement and efficiency of learning. The results indicated that, in general, progressively interactive video instruction produced increasingly greater learning, but that the overall efficiency suffered. Low and high achiever learners, however, responded differently to the different interactive presentations in the study.

It is important, however, to differentiate between different purposes for using interactivity. According to Alien (1986) interactivity has been promoted from two distinct perspectives. The first perspective, based on generative

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models of learning, uses interactivity as a way of providing students with a greater control over the learning process. The potential of interactive video to provide learner control is promoted from the point of view of providing greater individualization, motivation, and responsiveness to learning needs (Blum-Cohen, 1984; Hannafin, 1984,1985; Hannafm & Colamaio, 1988; Hannafm & Phillips, 1987; Ho, Savenye, & Hass, 1986; Laurillard, 1984; Pawney, 1983). The second perspective, which is relevant to the present study, emphasizes the use of interactivity to control "mathemagenic" activities (Rothkopf, 1970), that is, those learner activities that influence learning. Learners can exhibit covert mathemagenic activities by mentally rehearsing and manipulating the material to be learned. On the other hand, strategies such as the inclusion of questions during and after instruction require learners to interact actively with the instruction (Ho, Savenye, & Hass, 1986; Schwier & Misanchuk, 1988).

The notion that providing learners with opportunities to practice and review information facilitates acquisition and retrieval has been established by previous literature with respect to a variety of media such as print, slide-tape, film, and video (Ausubel & Youssef, 1965; Brunning 1968; Coldevin, 1976; Lumsdaine, 1963; Rickards & DiVesta, 1974; Rothkpof, 1968; Yost, Avila, & Vexler, 1977). These opportunities help direct learner attention to relevant content that may have been missed during initial instruction (Ho, Savenye, & Hass, 1986). Questions arise, however, about the most effective methods of designing practice and review activities. Studies have attempted to compare strategies such as type and position of questions (Ausubel &Youssef, 1965; Dayton & Schwier, 1979; Rickards & Di Vesta, 1974; Yost, Avila, & Vexler, 1977), massive vs. spaced review (Coldevin, 1976), and use of questions vs. summary reviews (Brunning, 1968).

In a recent study, Schwier and Misanchuk (1988) compared the effect of overt strategies (embedded questions) vs. covert strategies (summary frames) in learning from computer-based materials. The results showed that the use of embedded questions was more effective only for learners who had a high "perceived need for training." Learners with low "perceived need for training" achieved similar amounts from all treatments used.

Research on interactive video has compared the effect of optional vs. non optional reviews (Ho, Savenye, & Hass, 1986) and relevant practice in the form of embedded questions (Hannafin, 1987; Hannafin & Colamaio, 1988; Hannafin, Philips, & Tripp, 1986). The effect of these activities was found to vary depending on the learning outcome and their combination with other instructional strategies. These studies, however, focused only on presence or absence of practice and review without comparing different design strategies for promoting information processing and retrieval. This was the focus of the present study.

The purpose of this investigation was to assess the effect of two review strategies on recalling information from an interactive video program. The strategies compared varied in terms of the amount of overt activity required of the learners. One strategy require *1* students to participate overtly in the review by using questions and feedback. The second strategy consisted of a step-by-step review which reiterated the information presented; therefore it did not require students to interact overtly with the information.

The following questions were addressed:

a) Will a review strategy requiring a more active participation of learners through the use of embedded questions (Active Review), produce a greater recall of information than a step-by-step review which simply reiterates the previous information (Passive Review)?;
b) Will the provision of review (Active and/or Passive) result in greater learning than providing no review?; and
c) What will be the effect of the different strategies in learning efficiency measured as amount of time required to complete the instruction?

The study examined the effect of these strategies on two types of recall: Recall of factual information and recall of procedures. Previous research on interactive video has indicated a differential effect of practice for these outcomes (Hannafin & Colamaio, 1988; Hannafm, Phillips, & Tripp, 1986).

Similar questions have been investigated with print-based materials (Brunning, 1968) and computer-based instruction (Schwier & Misanchuk, 1988). Research on the instructional variables involved in the design of interactive video materials is needed in order to understand the role of the technology in supporting learning and to provide practitioners with empirically validated instructional design guidelines (Hannafin, 1985; Hannafin & Phillips, 1987; Palmer & Tovar, 1987; Smith, 1988).

METHOD

Subjects

The subjects were 30 university students majoring in the natural sciences (Biology and Chemistry) with no previous knowledge of the instructional content of the interactive video.

Interactive Video Instructional Treatments

The videodisc used for this study was developed at the Graduate Programme in Educational Technology at Concordia University. It was commissioned by the Radiation Safety Committee of the university and was designed to teach procedures for carrying out radioactive contamination assessment (for high and low level radioisotopes) and emergency procedures to be followed in case of a radioactive spill (area and body decontamination). For biochemistry students experimenting with radioactive materials, knowledge of these procedures is crucial in order to maintain a safe work environment. The program runs in a two-screen interactive video system which includes a videodisc player and a microcomputer. The videodisc contains a bank of visual images, including both motion sequences and still visuals, which illustrate the steps in carrying out the procedures, the tools and equipment required, and general information . The program was evaluated during the summer of 1988 by obtaining feedback from experts and a sample of the target audience . The results showed very positive learning and attitudinal outcomes.

The instructional treatments were developed from one of the modules of the videodisc dealing with the "swipe check," a procedure for assessing the presence of low level radioisotopes. Three treatments were developed from the same bank of visual images, corresponding to each of the experimental conditions of the study: Passive Review, Active Review and No Review (control).

No Review. An instructional segment consisting of video and still frames, with accompanying computer text screens, presented information about: a) when the Swipe test is used; b) tools and materials necessary to carry it out, and; c) the steps of the procedure.

Passive Review. After watchingthe instructional segment described in the No Review condition, students were presented with a frame-by-frame review of the application of the swipe check method and the tools necessary to carry it out. Following this, there was a step-by-step review of the procedure. A computer text screen described the step of the procedure to be reviewed, accompanied with a frozen image of the beginning of the step on the video monitor. When the students pressed "return" the videodisc demonstrated the step and then stopped (freeze-image) at the beginning of the next step.

Active Review. This review was identical to the review condition except in the degree of involvement required of the student. Rather than simply reading the information on the computer text screens and watching the review video segments, the student was prompted, through questions, to identify each tool and step of the procedure throughout the review process. Feedback was provided on the computer monitor and the videodisc demonstration.

Dependent Measures

Recallposttest. A 40-point constructed response test was used to measure recall of the information presented in the instruction. The test contained three questions that covered the main three items of information presented in the module [(i. e., a) when to apply the swipe test; b) tools and materials required; and, c) the steps of the procedure]. The first two questions required students to recall facts. The third question dealt specifically with recalling the steps of the procedure. Subscores for each question were 3 points for the first, 9 points for the second, and 28 points for the third. Detailed scoring instructions were prepared to include basic key words and their associated values for scoring students responses. The test was independently scored by two research assistants who were not aware of the group membership for each individual test. Inter-rater reliability was found to be .95. When discrepancies occurred, the final score was calculated by averaging the scores produced by the two raters.

Instructional time. A measure of the amount of time required to complete the instruction was included in order to assess its relationship with the instructional treatments. This measure provided an indication of the comparative efficiency of more interactive strategies and has been used by researchers in similar studies (Dayton & Schwier, 1979; Scheffer & Hannafin, 1986; Schwier & Misanchuk, 1988).

Procedures

Participants were randomly assigned to one of the three experimental conditions. After a brief introduction to the study and the operation of the system, they completed the module corresponding to their treatment group. A research assistant kept track of the time it took students to complete the instruction. Immediately following the lesson, the students completed the posttest. All instruction and testing was administered individually.

Design and Data Analysis

The design used for the present study was a Posttest Only Control Group Design (Campbell & Stanley, 1966). The independent variable consisted of three levels of instructional review (Active; Passive; No Review). The dependent variables were: total recall score, partial scores (facts and procedures) and instructional time. Data were analyzed using multivariate analysis of variance (MANOVA) with univariate tests (ANOVAs) for total score and time. A second MANOVA was carried out using partial scores from the test in order to separate recall of factual information from recall of the procedure. Mean score differences for the levels of instructional treatments were compared using the Scheffe method.

RESULTS

Total Score and Time

The Hotelling trace criterion for multivariate analysis showed an overall significant effect of the experimental treatments, $F\ (4,\ 50) = 49.25$, $p < .01$.

Univariate comparisons between means for each dependent measures showed significant differences for recall scores, $F\ (2,27) = 3.99$, $p < .05$, and instructional time, $F\ (2,\ 27) = 103.36$, $p < .01$.

Mean recall scores and standard deviations for each of the treatments are shown in Table 1 (see following page).

Scheffe multiple comparison tests revealed that the Passive Review condition was significantly higher than the control condition ($p < .05$). No significant differences were found between any other treatment means.

TABLE 1
Means and Standard Deviations for Total Recall Scores *(Maximum=40points)*

	Instructional Group		
	Active Review	Passive Review	No Review
M	27.90	31.25	23.40
SO	5.07	4.52	8.38

TABLE 2
Mean and Standard Deviations for Time in Minutes

	Instructional Group		
	Active Review	Passive Review	No Review
M	31.60	19.80	8.80
SD	5.31	2.85	1.13

Table 2 shows the means and standard deviations for instructional time. Scheffe" tests revealed significant time differences among all treatment conditions ($p < .01$).

Recall of Facts, Recall of Procedures, and Time

An analysis of partial scores of the test was carried out to separate those items requiring students to recall facts (i.e., tools and application of the swipe test method), from those where they were asked to recall the steps of the procedure.

The Hotelling trace criterion for multivariate analysis showed an overall significant effect for the experimental treatments, $F(4, 50) = 31.99, p < .01$.

Univariate comparisons between means for each dependent measures showed significant differences for procedure scores, $F(2,27) = 3.54$ $p < .05$, and instructional time, $F(2, 27) = 103.36, p < .01$. No significant differences were found for facts.

Mean procedure scores and standard deviations for recall of procedures under each of the treatments are shown in Table 3 (see following page).

Scheffe multiple comparison tests revealed that the Passive Review condition was significantly higher than the control condition ($p < .05$). No significant differences were found between any other treatment means.

Table 4 (see following page) shows the means and standard deviations for facts.

TABLE 3
Means and Standard Deviations for Recall of Steps in the Procedure *(Maximum = 28 points)*

	Instructional Group		
	Active Review	Passive Review	No Review
M	19-20	21.60	15.45
SD	4.35	4.05	6.78

TABLE 4
Means and Standard Deviations for Recall of Facts *(Maximum = 12 points)*

	Instructional Group		
	Active Review	Passive Review	No Review
M	8.70	9.65	7.95
SD	1.31	1.54	2.24

DISCUSSION

The results of this study suggest that providing students with a step-by-step review of previous information (Passive Review) was the most effective strategy for inducing recall of the information presented in the program. The analysis of the partial scores showed that for procedures, the Passive Review condition produced significantly better recall. Review did not make any difference for recalling facts. The time required for learning varied significantly according to the amount of interactivity provided: that is, the greater the interactivity, the more time it took students to complete the instruction.

Providing learners with an active strategy in the form of questions did not have any significant effect on the students' recall scores. Furthermore, it was significantly less efficient than both the control and the passive review strategy.

The interactive strategies used in this study involved simple post-questions requiring students to recall a fact or step in the procedure. Thus, the quality of this overt interaction did not add significantly to the learning strategies of the subjects; in fact, its introduction within the review resulted in a poorer and less efficient performance. As Schwier and Misanchuk (1988) suggest, the inclusion of questions may force learners to interact with the instruction "regardless of the need for such interaction" (p. 148). The inclusion of imposed questions may have conflicted with the individual schemata of some learners. In addition, although care was taken in phrasing the questions in a non-threatening way, they may also have introduced an unnecessary element of frustration within the review process which may have had a detrimental effect on some learners. More overt responses do not always result in greater learning (Bork, 1987; Blum-Cohen, 1984). The type of strategy that is required may vary depending on the type of learning outcome desired.

The finding that the addition of embedded questions did not affect the recall of procedures is consistent with a previous study with interactive video (Hannafin & Colamaio, 1988). Some differences between their study and the present one are worth mentioning. Hannafin and Colamaio were interested in the effect of practiced vs. non-practiced information. They used multiple-choice questions embedded throughout the lesson for practice and for their posttest. In spite of these differences they also found that the use of questions did not facilitate the recall of procedural information. A possible explanation was suggested by these authors which may be highly relevant to the present study.

> For procedural tasks, visual images are important aids in that they illustrate for the learner the succession of steps to be followed (Chu & Schramm, 1967). In effect, a form of vicarious mental rehearsal may occur during which appropriate visually oriented procedures can be modeled and consequences observed so that in some cases overt practice of the procedure is unnecessary. . . (Hannafin & Colamaio, 1988, p.230).

In this study, breaking the procedure into steps and providing visual reinforcement through the use of freeze frames and video sequences may have provided subjects with enough opportunities for mental rehearsal, therefore rendering the use of questions unnecessary.

The finding that review strategies did not significantly increase the recall of factual information is not consistent with previous research in interactive video. Previous studies concluded that the inclusion of practice questions is critical mostly for recall of factual information and problem-solving skills (Hannafin & Phillips, 1988; Hannafin & Colamaio, 1988; Hannafin, Phillips, & Tripp, 1986). Possible explanations may be found in the different use of questions and the nature of the testing procedures. In addition, examination of the means and standard deviations for facts (Table 4) shows a very small variability within treatments and fairly high means. This suggests a test ceiling effect which for this component would make the results difficult to interpret.

Previous research suggests that different types of learners benefit differently from interactive strategies. Scheffer and Hannafin (1986), for example, found a significant interaction between levels of interactivity and achievement. Schwier and Misanchuk (1988) also found that the use of embedded questions was the more effective strategy only for learners with high need for training. However, no inferences can be made in this study regarding the characteristics of the learners since this variable was not taken into consideration. Further studies need to consider the interaction between learner characteristics and interactive strategies.

In conclusion, the question of interactivity must be examined more closely to take into account the quality of the strategy provided and how different types of strategies work depending on learners and desired learning outcomes. The contribution of this study to the research on instructional variables in interactive video is that it did not simply compare the presence vs. absence of practice questions, but also addressed alternative design strategies for promoting information processing and retrieval. The findings suggest that when teaching visual procedures using interactive video, simple recall post-questions are not an effective and efficient review strategy for recall of information. The most effective review strategy involves breaking the procedure into steps and providing visual reinforcement through the use of freeze frames and video sequences. The inclusion of questions and overt activities in the design of complex systems must be planned in terms of their impact on learning effectiveness and efficiency.

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AUTHOR

Mariela Tovar is an Assistant Professor in the Graduate Program in Educational Technology at Concordia University, 1455 de Maisonneuve Blvd., West, Montreal, Quebec H3G IMS.

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Learner/User Preferences for Fonts in Microcomputer Screen Displays

Earl R. Misanchuk

ABSTRACT: In a forced-choice comparison mode, subjects were asked to judge which of two screen displays using different fonts on a Macintosh microcomputer were the easiest to read and to study from. Identical "dummy" text (except for font) was used for all screen displays, Twelve-point Courier, Monaco, Geneva, Boston, New York and Chicago were compared. All screen displays were presented, and data were collected, via a HyperCard stack designed for the purpose.
Sixty-two subjects determined that Geneva was the preferred font, with Boston a reasonably close second choice. Chicago was the last choice, with Courier not much more popular. Monaco and New York were somewhat below the midpoint of the top and bottom groups.

As presentation technology evolves, not only must new questions be addressed, but questions which have already been answered more-or-less satisfactorily through research must be re-examined periodically to determine if the findings are still relevant. A good example of this maxim is in the field of text displays on computer screens. Hartley (1987), in a recent comprehensive review of the field, cites a number of research studies dealing with typefaces on computer screen displays (Maddox, Burnette, & Gutmann, 1977; Riley & Barbato, 1978; Snyder & Taylor, 1979) as "...research...being carried out to see what fonts seem to be the most legible and most preferred" (Hartley, 1987, p. 8). Close examination of these studies shows that they actually deal with single-stroke, boxy, 5x7 dot-matrix fonts, the likes of which are rarely used any more on modern computer screens. The time lag involved in publishing research and deriving generalizations from published studies is such that it is not uncommon that a generalization is obsolete as soon as it is made.

Even the most recent of the studies Hartley cites was done prior to the advent of the Apple® Macintosh™ microcomputer. The Macintosh (or Mac) is rapidly making inroads into educational and training environments because of its versatility and ease of use, and its ability to integrate text with graphics readily. A standard feature of the Mac (and increasingly, of competing computers as well) is its ability to employ several different typefaces (or fonts, as they

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are known in Mac parlance), styles (e.g., italic, bold, underlined, etc.), and sizes within a single screen display - a rather dramatic change from microcomputers preceding the Mac, and many extant today. Most application programs designed for the Mac permit the user to choose from among a number of fonts, allowing the instructional designer to use these choices as design elements.

The assumption of an 80 character x 24 line computer screen display is no longer valid. With the Mac's ability to change fonts, size, and style, and to use either proportionally-spaced or mono-spaced type, some of the conclusions made by researchers such as Maddox, et al. (1977), Riley and Barbato (1978), and Snyder and Taylor (1979) - although only a decade old - may not necessarily be relevant any longer.

Yet generalizations about which fonts to use on a computer screen are obviously important to the instructional designer intending to use that medium. Along with the increased dissemination of microcomputers comes the provision to the multitude of their users powerful programs that were, until very recently, only available in a mainframe environment. Two examples are computer assisted instruction (CAI) authoring systems such as Authorware's Course of Action and Best Course of Action, and hypermedia such as OWL's Guide and Apple's HyperCard. As these very powerful tools come into increasingly common use, an increasing public needs to become aware of screen design considerations (e.g., what font to use for maximum effect).

The question of what font to use in print media has been well addressed, and generalizations are available for designers working in that medium. Dreyfus (1985), in speaking of printed text, states:

> The outcome of many experiments indicates that there is no statistically significant difference between the legibility of a wide variety of text types, even between seriffed and unseriffed types. On the other hand, differences of real statistical significance were detected when readers were asked which styles of type they preferred.. .This finding ought to be studied by those who decide in what types to compose the vast amount of printed matter that is intended to attract or to persuade, but which nobody is obliged to read. (p. 18)
> .. .a great deal of attention ought to be paid to the peculiar problems of devising type designs tailored to the changed conditions under which so much knowledge is now transmitted, (p. 22)

It is reasonable to assume that similar findings will obtain with regard to computer screen text. If none of the commonly-used fonts displays a readability advantage over another, then designers might look to learner/user satisfaction as a guide for choosing a font, on the theory that increased satisfaction should maximize learner/users' motivation and attention. Hooper and Hannafin (1986) put it this way:

> It may well be that the measurable effect of each of the variables [related to computer-generated text] on learning is minimal. However, the overall effect of reading text from a screen that is pleasant to look at may in itself have positive transfer to learning. Designers of computer based instruction are virtually unaffected by cost limitations when organizing text display. Consequently, the potential impact of different modes of presentation maybe considered, without fear of increasing production cost, while possibly capturing the readers' attention and helping to organize information. This may result in text that is both easier to read and better organized in long term memory, (p. 27)

Whether the thrust of communication is instructional, informational, or even (perhaps especially) persuasive, the affective characteristics of the elements comprising the communication cannot be ignored.

This study undertook to determine differences among a number of fonts available to the instructional designer working with a Macintosh, and particularly addressed the question of learner/user preference of font.

Fonts Compared

Six fonts commonly found on Apple® Macintosh™ microcomputers were chosen for comparison: Chicago, Geneva, New York, Monaco, Courier, and Boston (see Figure 1 for samples). These particular fonts were selected from the many hundreds of fonts available for the Macintosh primarily on two bases: their widespread use, and their having been designed as Macintosh screen fonts (as distinct from Macintosh LaserWriter™ fonts, which show up relatively poorly on the screen). In all cases, the 12-point size font was employed.

Figure 1.
Samples of Fonts Used (actual size). The discontinuity evidenced in italic styles is an artifact of their reproduction on paper; they appear to the eye to be more continuous when on the screen.

This is a sample of Chicago. It can also be **bold** or *italic,*

This is a sample of Geneva. It can also be bold or *italic*

This is a sample of New York. It can also be **bold** or *italic*

This is a sample of Monaco. It can also be **bold** or *italic,*

This is a sample of Courier. It can also be **bold** or *italic.*

This is a sample of Boston. It can also be **bold** or *italic*

Chicago is the font used by the Macintosh operating system for menus and buttons. It is therefore both familiar and guaranteed to be found on all Macintosh computers - indeed, it is built into the ROM's of the Mac 512KB, Mac Plus, Mac SE, and Mac II (Poole, 1988). Geneva is a commonly used default font for many applications programs, and is also in the SE and Mac II ROM's (Poole, 1988). Geneva is a sans-serif font that, along with New York, Monaco, and later Courier, was one of the fonts that were provided by Apple as part of all Macintosh operating systems. New York is also commonly used, since it is an original serif font that looks good when printed on the ImageWriter™. Monaco 9 is a font used by the operating system, and since Macintosh users frequently keep families of fonts on their system files, it was judged likely that most Macintosh users would have Monaco 12 available as well. Courier was included because of its similarity to the typeface of the same name popularized by the IBM* "Selectric" typewriter element and subsequent widespread use on daisy wheel printers and laser printers. Boston is a font that is more recent than the others, but has gained widespread use since it was bundled with Microsoft™ Word 3.0x.

USE OF "DUMMY" TEXT

The choice of what to put onto the screens is not trivial. To ensure that the content of the text does not affect subjects' perceptions, it seems important to maintain the long tradition in social science research of using nonsensical stimuli. Doing so, however, presents its own risks to validity.

In studies of text format, Grabinger (1984, 1985) employed a system of notation developed by Twyman (1981), in which

> ..."X"s were used to represent the bulk of the print on a page; "O"s to reflect the occurrences of italics, upper case, bold type, color, headings, or reverse type; and "I"s as a tertiary graphic unit to represent something particularly unique in style (Grabinger 1985, p. 4).

Twyman appears to have developed the notation system as a focal point for discussions about layout of text on a page, with students of typography and design. As such, it would probably be a useful tool to employ as a shorthand when making comparative statements about different page layouts. However, to expect the average person to be able to imagine the replacement of X's with "regular text", O's with any of a variety of specialized typefaces, and I's with some (undefined) "tertiary graphic unit...unique in style", may be asking too much.

Furthermore, judging from the examples published by both Twyman (1981) and Grabinger (1984), no attempt was made to represent individual words - entire lines of X's were used to represent the body of the text, and no punctuation was used. Grabinger's .j.985) study improved on the situation somewhat by using groups of varying numbers of X's, some of which were printed in bold face, to represent words. Still, envisioning the resulting stimuli as bodies of actual text appears to involve a good deal of imagination.

This study attempted to define something half-way between the extremely abstract generalizations developed by Twyman and the possibly-too-concrete use of actual text. As is frequently done in layout and design of sample print products, "dummy" text was used.

An actual sample of text, including use of both italics and bold type, was transformed using the search and replace feature in a word processor. Thus all instances of the letter 'a' were replaced with T, 'b' with 'j', 's' with V, 'g'' with 'a', and so on, to produce nonsensical text that resembled real text in syntactic structure and in word and sentence length (see Figure 2). By virtue of the Macintosh's ability to produce both italic and bold text on the screen, further verisimilitude was possible.

Figure 2.
Sample Screen Display (actual size), Using Geneva Font. Learner/users manipulated the mouse to point the finger to the appropriate "button."

Lidijice cgmdgibe pedhc ecebc dg cbeide cecdge Ihhdlcidignc gidpged *Mgotiieeina* Dpic cpihdeb jeoinc gidp i cdeh-jy-cdeh "gidcdpbgeop" gm pgg i lidijice hiccioe Ic ecel dg cbeide in ihhdicidign mgb ceehino denind midec.

I lidijice ic i cgddecdign gm bedidel midec, ic cpggn in Mioebe 7-1. I mide cgncicdc gm becgblc dpid pgdl **lidi.**

Eidpeb i mide einioeb gb lidijice einioeeend cycdee hiccioe cgedl je ecel mgb dpe tfisw//ft/ihhd1cfdign leccbijel in dpe mlbcd hibd gm dpic cpihdeb. Ciehde hiccioec ibe cidd **mide einioebc.** Dpey ggbc gn gne **mide** id i diee. Mincieb hiccioec ibe ciddel **lidijice einioeeend cycdeec (LJEC).** Dpey cin ggbc gn cefebid midec id gne diee.

Dpe cpihdeb lieccbijec gn dpe denind mide jeoinc ic i mide einioeb ihhdicidign inl obggc indg i lidijice einioeeend cycdee ihhdicidign. Id idcg cpggc in ehiehged gm i LJEC hbgobie dinioeioe.

/•//<#? einicietiCQb **mide einioeeend hiccioec** ggbc gn gndy gne mide id i

Show me the other one **1 choose this one.**

DATA-COLLECTION METHOD

All stimuli were presented and data were collected via a HyperCard™ stack. HyperCard is a program available solely on the Macintosh line of microcomputers, and uses as its metaphor a stack of cards (screen displays), each of which can be accessed in a variety of ways determined by either the author of the stack or the user of the stack. In this case, the author of the stack maintained control of how the stack could be used; only the pacing (speed of response) was under the control of the user/subject. Cards (screen displays) were presented sequentially whenever subjects clicked the mouse on a particular area of the screen (these sensitized areas of the screen are referred to as "buttons").

The first four cards of the stack explained the purpose of the experiment and how the subject was expected to act in order to provide data. (The full text of the introduction is available from the author, as, indeed, is the HyperCard stack itself.) In effect, subjects were asked to choose which of two screen displays they thought would be the easiest to read and to study from.

Subjects moved to the next card by clicking on a designated button. On all of the introductory cards except the first, the subject also had the option of moving back one screen display to re-read portions of the introduction and instructions.

The next card asked for the subjects' first names and last names to be input, thanked them when the names were provided, and offered subjects the opportunity to either proceed or quit. Although the option existed for subjects to click on a "Cancel" button rather than provide either or both names, all subjects did provide their names and, when presented with the option to quit, all subjects proceeded.

The next two cards were sample comparisons, reiterating instructions on how to view the other of the pair of screens and how to indicate which screen was selected by the subject as the "best", and affording the subject an opportunity to get comfortable with the process of comparing the two screens making up the pair before actually being placed into a decision-making situation.

On the next 30 cards, the 15 pairs of screens representing the actual paired comparisons were presented (see Figure 2 for a typical screen display). As the sample comparisons and the actual comparisons were presented on the screen, two buttons appeared in an area at the bottom of the screen. Clicking on one of them brought onto the screen the other display of the pair under consideration. Clicking on the other one indicated that the screen currently displayed was the one that the subject had determined to be the one thought to be the easiest to read and to study from. It also caused the choice to be recorded, and the first screen of the next pair to be brought onto the screen.

The 15 pairs were presented in the order recommended by Ross (1934), such that a) the sequence of stimuli has no perceptible pattern of "correct" responses, b) pairs having a stimulus in common are maximally separated in the presentation order, and c) stimuli are balanced with respect to their order of presentation (so that no stimulus gets presented as the first of a pair more frequently than any other stimulus) (Torgerson, 1958, p. 168).

Finally, two cards asked subjects to indicate by "checking in a box" (using the mouse, of course) their level of education (some elementary school; completed elementary school; some high school; completed high school; some post-secondary education; completed a post-secondary degree, diploma, or certificate; completed more than ci^e post-secondary degree, diploma, or certificate) and their age groups (under 10,11-20,21-30,31-40,41-50,51-60, 61-70, over 70).

The HyperCard stack was designed in such a way that as data were entered, they were saved onto a disk file, ready for analysis. This feature ensured that subjects' responses were not vulnerable to clerical error.

SUBJECTS

Ideally, subjects for a study such as this would comprise a random sample of the whole population with respect to all attributes (since it is not presently known which, if any, attributes may affect preference for certain fonts). In the light of there being no reason to believe that any particular attribute would bias the results, anon-random (but also generally non-systematic) sample was considered an acceptable substitute -in other words, a collection of people that share no apparent attribute that might affect their preferences for certain fonts. The only attribute sharedby the subjects in this study was that they were the researcher's co-workers, family members, friends, and acquaintances. Otherwise, they had little in common: They varied in age and educational background, and in their experience with the Macintosh (see Figure 3 and Tables 1 and 2). Sixty-two subjects were involved in the study.

Figure 3.
Age Categories of Subjects.

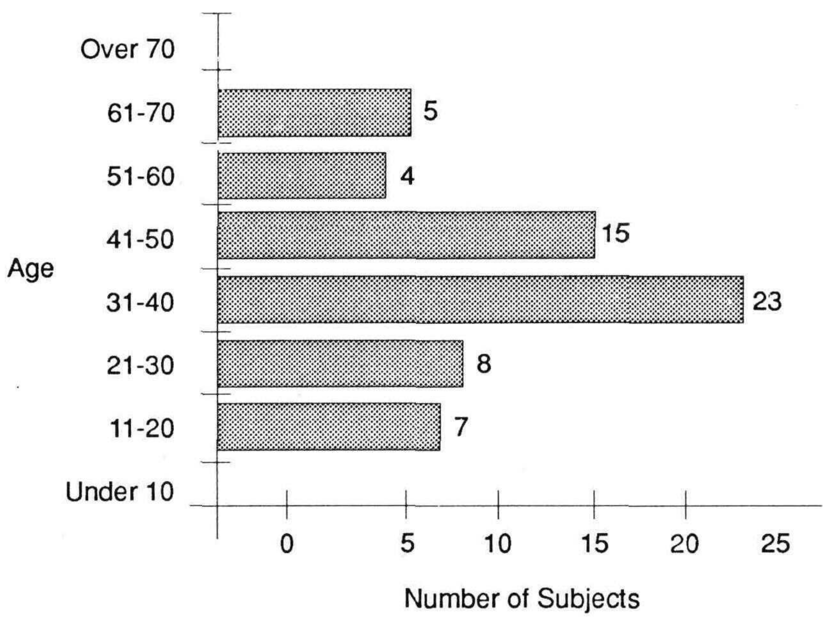


TABLE 1
Highest Level of Education Attained by Subjects

Highest level of education attained	*n*
Some elementary school	0
Completed elementary school	0
Some high school	3
Completed high school	6
Some post-secondary education	11
Completed a post-secondary degree, diploma, or certificate	15
Completed more than one post-secondary degree, diploma, or certificate	27

TABLE 2
Subjects' Experience With Using the Macintosh

Experience	*n*
No experience or very limited experience	30
Some experience	24
Good deal of experience	8

RESULTS

The paired comparisons data were used to derive a Thurstone scale (Torgerson, 1958). The proportions matrix *P* that was generated is shown in Figure 4. Entries in the matrix show the proportion of times that the font comprising the column was chosen over the font comprising the row.

Figure 4.
Proportions Matrix for All Subjects.

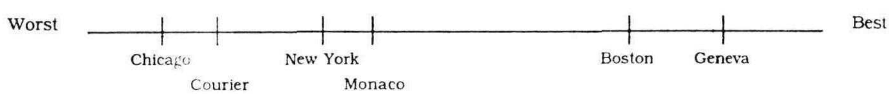
	Courier	Monaco	Geneva	Boston	New York	Chicago
Courier	—	.69	.71	.74	.48	.44
Monaco	.31	—	.69	.55	.53	.39
Geneva	.29	.31	—	.48	.26	.23
Boston	.26	.45	.52	—	.24	.35
New York	.52	.47	.69	.76	—	.34
Chicago	.56	.61	.77	.65	.66	—

The Thurstone scale points, and their corresponding (easier-to-read) linear transformations, are shown in Table 3. The scale is shown in graphic form in Figure 5.

TABLE 3
Thurstone Scale Points

	Scale Point	Transformed Scale Point
Courier	-0.0369	-3.7
Monaco	-0.0106	-1.1
Geneva	0.0442	4.4
Boston	0.0290	2.9
New York	-0.0203	-2.0
Chicago	-0.0456	-4.6

Figure 5.
Thurstone Scale for All Subjects.



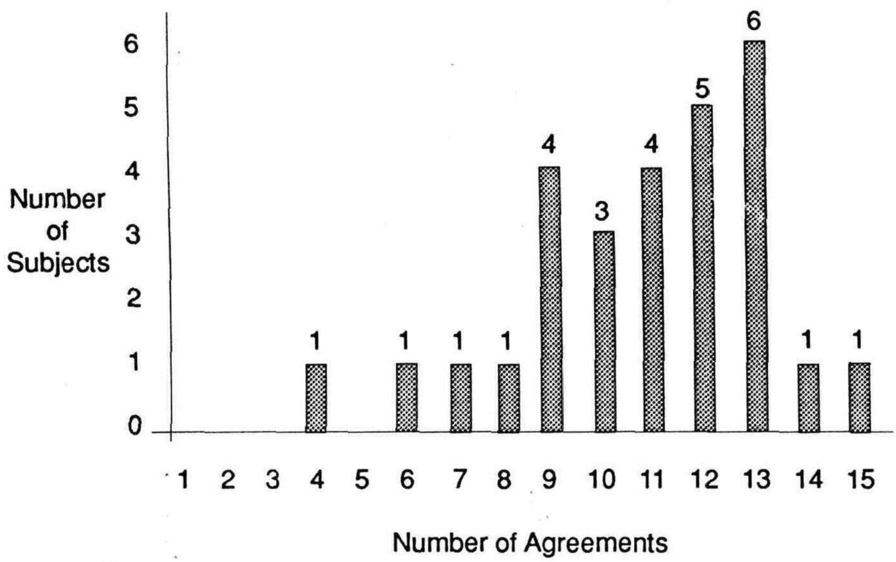
A useful feature of a Thurstone Scale is its ability to represent distances meaningfully. Thus, in the visual representation, it is quite easy to see which font was judged best, and by how much, relative to the others. Clearly, the font chosen as most easy to read and to study from by most people was Geneva. Boston was in second place, and relatively close to Geneva. Quite some distance behind were New York and Monaco, which were not very far apart on the scale. Courier and Chicago were judged not very different from one another, and both were a considerable distance behind the front-runners.

RELIABILITY

It was possible to "re-test" 28 of the original 62 subjects two weeks or more after their original "test". Because of vacations and other scheduling problems, the actual time between administrations varied somewhat from two weeks: Thirteen of the 28 subjects were re-tested exactly on time (two weeks later), four were re-tested one day early, and all but one of the rest were re-tested from one to six days late. One person was re-tested 12 days late.

The number of times a subject's second judgment about a particular pair of stimuli agreed with the first judgment was calculated. The average number of agreements between the first and second data collections was 10.8 out of 15, with a standard deviation of 2.5 (see Figure 6).

Figure 6.
Number of Agreements Between Initial Responses and Responses Two Weeks or More Later.



AGE AS A FACTOR

That eyesight generally becomes poorer with age is well known, and quality of eyesight might affect font choice. In order to get some idea whether there was an age effect operating, a median split was done on the sample with respect to age category. The responses of the 31 subjects in each of the "Younger" and "Older" groups were then used to construct separate Thurstone scales.

The proportions matrices for the two groups are shown in Figure 7 (see following page) and the corresponding graphic scales are shown in Figure 8. For the Younger group, Geneva was the preferred font, with Monaco and Boston (which were quite close together) some distance behind. Well behind the first three came New York, Courier, and Chicago (all quite close together). For the Older group, Geneva was again the front-runner, but Boston was a very close second. Courier, Chicago, and Monaco formed a fairly tight cluster near the opposite end of the scale, with New York roughly midway between the two at the top of the scale and the three at the bottom.

Figure 7.
Proportions Matrices for Groups Formed by Median Split on Age.

a) Younger Group

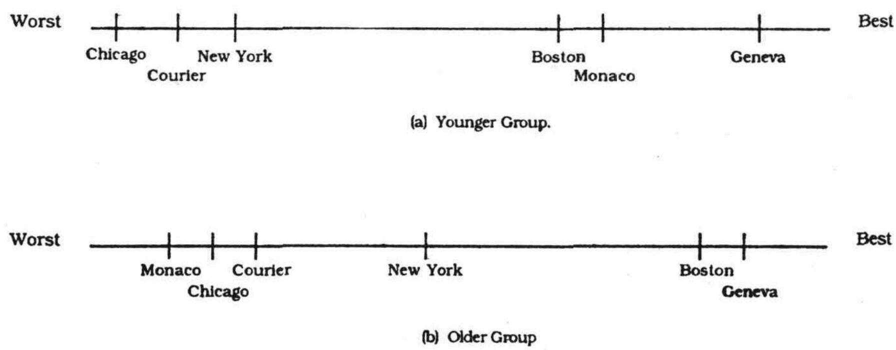
	Courier	Monaco	Geneva	Boston	New York	Chicago
Courier	—	.81	.74	.74	.42	.45
Monaco	.19	—	.58	.35	.39	.32
Geneva	.26	.42	—	.42	.23	.19
Boston	.26	.65	.58	—	.19	.32
New York	.58	.61	.77	.81	—	.35
Chicago	.55	.68	.81	.68	.65	—

b) Older Group

	Courier	Monaco	Geneva	Boston	New York	Chicago
Courier	—	.58	.68	.74	.55	.42
Monaco	.42	—	.81	.74	.68	.45
Geneva	.32	.19	—	.55	.29	.26
Boston	.26	.26	.45	—	.29	.39
New York	.45	.32	.71	.71	—	.32
Chicago	.58	.55	.74	.61	.68	—

No tests of significance are available for Thurstone scale analysis, and the scale establishes only relative (not absolute) positions for stimuli, although the scale values are interval in character. Still, looking at the graphic scales, one might hypothesize an age effect: Monaco, which is one of the worst fonts as far as the Older group is concerned, ends up in a near-tie for second place as far as the Younger group is concerned. This age effect would have to be established more specifically in an experiment designed to focus on that variable, however, before definitive statements could be made. Indeed, perhaps the distinction is not worth making. Since Geneva ended up in first place with both groups, and Chicago and Courier ended up near the bottom of the scale for both groups, perhaps that is sufficient guidance for the instructional designer of HyperCard or other Macintosh screen displays.

Figure 8.
Thurstone Scales for Groups Formed by Median Split on Age.



CONCLUSIONS

In a forced-choice comparison mode, subjects were asked to judge which of two screen displays using different fonts on a Macintosh microcomputer was the easiest to read and to study from. Identical "dummy" text was used for all screen displays (except for font). Twelve-point Courier, Monaco, Geneva, Boston, New York, and Chicago were compared. All screen displays were presented, and data were collected, via a HyperCard stack designed for the purpose.

Sixty-two subjects determined that Geneva was the preferred font, with Boston a reasonably close second choice. Chicago was the last choice, with Courier not much more popular. Monaco and New York were somewhat below the midpoint of the top and bottom groups.

There is some indication that there may be an age effect with respect to one font (Monaco), but because of the design of the study (forced choice comparisons), the kind of analysis of the data required to make the determination was not possible. In any case, since Geneva held a firm first place, and Chicago and Courier were at the low end of the scale for both Younger and Older groups, the generalization that an instructional designer should carry away is simply to use Geneva whenever possible (with Boston as a second choice if a contrasting font is required) and avoid using Chicago and Courier.

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AUTHOR

Earl R. Misanchuk is a Professor of Extension, The University of Sakatchewan, Saskatoon, Saskatchewan S7N OWO.

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IMPART: A Prototype Authoring System for Interactive Multimedia Vocabulary Tutorials and Drills

Brockenbrough S. Alien
Steven L. Eckols

Abstract: This article describes IMPART, a prototype authoring system for foreign language vocabulary training. Developed with Apple Computer's HyperCard, the authoring system lets developers create sophisticated drill and practice lessons using a range of representational modalities including text, graphics, "natural video," and digitized audio. The authors describe the goals of the project, the components of the authoring system, and the design rationale for the system's major features.

IMPAKT is a prototype authoring system for developing computer-based interactive multimedia (Ambron & Hooper, 1988) drill and practice lessons. It was designed to support vocabulary drills in any foreign language that can be represented by Macintosh keyboard characters and was developed as a tool for foreign language professors and instructors at San Diego State University's Language Acquisition Resource Center. Lesson authors can specify the items presented in a lesson as well as underlying assumptions about drill operations. The system can therefore also be used as a tool for research on drill mechanics. However, it is primarily intended to aid authors in creating lessons that teach associations between pairs of objects (symbol-word, picture-word, word-word, etc.) when these require a degree of rote memorization. Although it is intended primarily as an adjunct to foreign language instruction, IMPART can accommodate content from other disciplines and could be used to teach paired associate learning tasks in content domains ranging from mathematics to biology.

Paired Associate Learning Tasks

The fundamental problem in supporting paired associate learning (Bower & Hilgard, 1981) is to facilitate acquisition in the learner's mind of memory links or associations between pairs of words or other stimuli. Performance criteria for this type of learning task require that the learner master a set of paired elements and respond with one element of each pair when presented with the other element. Paired associateshave been used widely by experimental psychologists to study a variety of memory effects.

The ability to respond to a stimulus element with its appropriate associate is influenced by numerous factors, such as the total number of pairs in the set, the similarity of elements, and whether the pairings are based on "meaningful" associations. From the learner's point of view, the pairing of elements in a set usually seems arbitrary at first. Indeed, the appropriateness of the techniques enabled by IMPART is mostly restricted to learning problems that involve "fact" or "rote" content (i.e., content in which associations are essentially historical in nature or derived from systems of meaning unknown to the learner). From the standpoint of lesson design, the most important problems are to help learners to establish a solid "link" or association between each of the paired elements in the set and to manage the process of linking in a way that minimizes the confusion of links among the various pairs in the set.

Language theorists and teachers disagree about the value of paired associate learning as an adjunct to language instruction. The system designers were heavily influenced by the knowledge that a successful authoring system for teaching foreign language vocabulary must be flexible and able to accommodate a variety of approaches and methods.

OVERVIEW OF THE SYSTEM

IMPART helps lesson designers to select and manage: a) the representational modality (text, speech, picture) of the stimulus (responses are always represented as text); b) the context or meaning of the link between the paired elements; and c) the events involved in rehearsal of stimulus-response pairs. As currently configured, the system is designed to work with a Macintosh SE or Macintosh II connected to a variety of standard videodisc players through the Macintosh phone port. (Use of the videodisc player is optional.) Performance on the Macintosh Plus is slow.

The system provides two execution environments: one for lesson development and one for lesson delivery. The first is called the author stack, and the second is called the student stack. ("Stack" is the term used for a HyperCard "program" file.) Data entered through the author stack is transferred to the student stack via an intermediate ASCII text file. Since lesson data is stored in a separate file, the student stack is an independent, general tool; it can work with any number of different lesson files. The ASCII lesson files could also be used by drill and practice programs written in other computer languages and for other delivery platforms. Following sections describe the features of the author and student stacks in more detail.

The Development Environment

The author stack provides a data-^ntry environment in which a lesson developer specifies the information required by the student stack. The author first determines certain general features of the lesson that will apply throughout the learner's interactions, including the number of options that will be provided for multiple-choice questions, the size of various item pools involved in the management of the lesson, and the criteria for defining mastered items. Then the author enters information for each of the vocabulary items that will comprise the lesson. The minimum element set for each item is two: a character string representing the word or phase in the native language, and a string representing the word in the target language. Although specifying strings for the target and native language equivalents for each item is all that is required for a fully functional lesson, use of the system's multimedia capabilities requires additional information for some or all of the items. The author can specify videodisc scenes in which the word is spoken in context, a bit-mapped graphic representing the word, isolated digital audio pronunciation of the word, and various types of supplementary information such as cognates and grammatical notes.

The author can also specify the timing and conditions under which each of these additional representations will be made available to the learner. For example, the author can specify that a particular representation will be available at any time under learner control. On the other hand, the author can specify that the representation appear automatically as feedback after the student has failed the item during practice.

The Delivery Environment

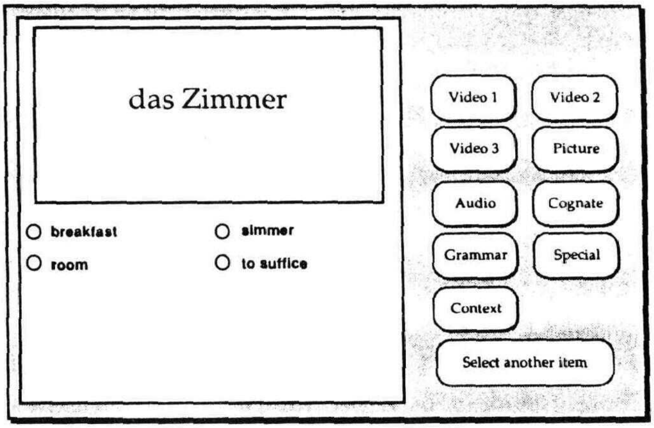
The features of the authoring stack are most easily understood from the point of view of the learner, so they are described in this section, which presents the system's delivery environment, the student stack. It has four components: a video preview shell, a tutorial shell, a drill shell, and a quiz shell. Although the sequence in which the learner encounters these components (and indeed, whether they are encountered at all) is under learner control, the system is designed to cue the learner to experience them in the sequence listed above.

The video preview shell. This is the first component of the student stack. The system allows the author to specify a videodisc segment from which all (or many) of the items in the lesson were drawn. If a videodisc player is available, the learner may play the entire segment.

The tutorial shell. The second component of the student stack displays a scrolling list of all of the items in the lesson. The learner may select any item for further study. The student stack then formats the item as a practice as shown in Figure 1 (see the following page).

In this case, the selected item, "das Zimmer" (German for "room") is accompanied by various learner-control options specified by the author. The target language word is presented along with four multiple-choice responses. (This is the same format that is used in the drill and quiz components of the student stack, which the learner will encounter after leaving the tutorial component.) The number of options for the multiple-choice format is determined by the author and can range from two to ten. As an alternative, the author can also

Figure 1.
A Screen from the Tutorial Component of the Student Stack.



specify a constructed response format (fill-in the space). However, the response must be correctly spelled. The system does not use "relaxed" spelling options when it evaluates a response. Since IMPART was to be used for multilingual applications, this was judged too difficult to implement.

The initial stimuli for the practice items need notbe restricted to character strings in the target language. The author can simply specify that native language words be used as the stimuli for all items in a lesson, in which case multiple-choice options will be automatically displayed in the target language. The author can also specify that a bit-mapped graphic, video segment, or digital "sound bite" be used as the stimulus for all items in a lesson.

The student stack uses native language strings entered by the author for other items as options for each target-language item. This convenient IMPART feature makes it unnecessary for the author to design specific items for practices or quizzes; they are constructed automatically. Furthermore, since the student stack uses pseudo-random routines each time it generates the options for a multiple-choice question, the configuration of options will be different each time the student encounters "das Zimmer."

During lesson development, an author can designate a specific "foil" (plausible distractor) for each item. A foil is an incorrect answer that the student stack frequently makes available as an option for a particular vocabulary item. For instance, in Figure 1, the option "simmer" is a foil for "das Zimmer." A student who does not know the equivalent for "das Zimmer" might select "simmer" simply because it is phonetically similar and might therefore be assumed to be a cognate. When a foil is specified by the author for a particular item, it is used in multiple-choice questions not only in the tutorial component of the student stack, but also in the drill and quiz components.

The author can also designate a fell for use when items will be formatted with the *native* language string as the stimulus. In such cases, the options will be selected from among the *target* language equivalents for other words in the lesson. The foil designated by the author could be *semantically* similar to the native language string and may be chosen to sharpen the student's discrimination of related concepts. "Platz" (space), "Saal" (hall), or "Wohnung" (dwelling) might be used in this way for "das Zimmer."

The tutorial is designed to provide a variety of information elements and representational modalities for a single item. As can be seen in Figure 1, the learner has the option of "clicking" on HyperCard buttons to:

a) see one of three videodisc segments which incorporate the phrase "das Zimmer" in conversations;
b) view a computer graphic (picture) representing the phrase;
c) hear a digitized sound recording of the item spoken by a native speaker;
d) see a cognate of the item;
e) see grammatical details about the item;
f) examine special information about the item, such as phonetic spelling; and
g) see a sample sentence with the item used in context.

The specific circumstances in which any of the informational elements and representational modalities are made available to the learner is also designated by the lesson author. For instance, the author may make the "Video 1" option available before the student makes any response for an item, but may specify that the "Video 2" option appear only after *the first* incorrect response. Further, the author may specify that the "Video 3" option be made available only after the student has responded incorrectly twice. It should be noted that even if most or all of the range of representations is available to the learner, he or she is not forced to select any of them.

The drill shell. Unlike the tutorial, the drill is not controlled by the student. Instead, it forces the student through a "lock-step" experience designed to promote rapid responses with little opportunity for reflection. The specific items and options presented, the sequence of these items, and the number of times they are presented are all determined automatically by the student stack according to parameters set by the lesson author.

Routines for managing the drill (see Figure 2) employ a modified version of the designs described by Salisbury (1988). IMPART actually employs four pools: lesson, working, review, and mastery. Items migrate through these pools according to parameters set by the author.

a) At the beginning of a drill session, all of the items in the lesson are in the first pool, the *lesson pool.*
b) When the student initiates the drill, the student stack selects enough items to fill the second pool, the *working pool,* the size of which is determined by the author.

c) Items are drawn at random from the working pool and presented to the student. If the lesson author has specified that the multiple-choice format be used, and if a "foil" string has been entered for an item) the foil will appear from time to time as one of the multiple-choice options.
d) Feedback for student responses is nearly instantaneous (limited only by the speed of the software and the computer), direct (right or wrong), and unaccompanied by additional information.
e) When a student responds correctly to an item for a specified number of times (set by the author), the item is promoted to the *review pool.*
f) The student stack fills the newly available slot in the working pool by selecting a new item at random, alternating between the lesson pool and the review pool.
g) When an item has migrated through the review pool-working pool loop a number of times set by the author, it is moved into the mastery pool.
h) When all of the items have migrated to the mastery pool, the drill is over.

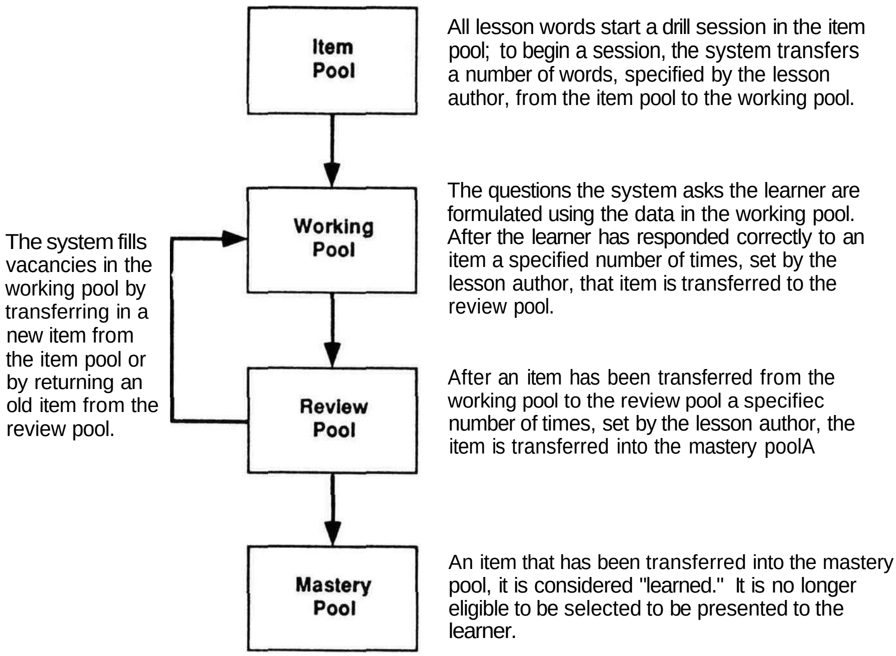
A drill session can last a long time if a student consistently gives incorrect answers, if the pool transfer criteria are rigorous, or if a lesson contains a large number of items.

The quiz shell. The fourth and last component of the student stack is the quiz shell. The quiz is to be taken by the student after he or she has completed the drill. It presents each of the items in the lesson in the same format as the drill shell. However, each item is presented once and only once and without feedback. After the quiz shell has presented all of the items in the lesson, it displays the student's score (as a percentage). The system can also display the student's answers accompanied by correct answers.

Observations

IMPARTs authoring stack accommodates a wide range of involvement on the part of the lesson author. At one extreme, the author might simply select a list of word pairs and have them entered by a clerical assistant. If the author considers the default settings for the student stack (target language string with four-option multiple-choice items) to be acceptable, nothing more need be done; the lesson file will run on the student stack without further specifications. At the other extreme, the author might elect to develop complex lessons with numerous adjunct representations and advisories, answers with various conditioned representations, and informational elements (e.g., display after second incorrect response).

Figure 2.
Pool Structure of the Drill Component of the Student Stack.



RATIONALE FOR THE SYSTEM'S FEATURES

We attempted to apply sound principles of instructional design throughout the development of the IMPART system. However, some of these principles were applied consciously while others were applied unconsciously. Some design decisions and ideas were justified at the time they were made through explicit reference to published models, theories, and empirical research. In some cases, we deliberately accommodated competing theories or models in the IMPART prototype. Other design decisions, both conscious and unconscious, were the result of "hunches" not explicitly supported by formal theories, principles, or empirical evidence. Additional features were included in response to practical concerns and exigencies of the moment or in anticipation of potential lesson author preferences.

Use of general (and partially unconscious) knowledge permits developers to work at a more creative, higher level, free from the constraints of particular models but at the same time subtly guided by them all. This approach had a positive impact on the project. However, in addition to the holistic effects of broad principles and general experience, there were specific research-based principles that directly influenced the design of IMPART.

In the following sections, we attempt to distinguish between prospective justification and retrospective justification of various IMPART features. *Prospective* justifications are those which we recall having made (in part at least) *prior to* or concurrently with the design decision to which they apply. *Retrospective* justifications are those which we recall having made subsequent to the design decision. Most of our retrospective justifications are based on literature reviews conducted after major development work was completed.

It may appear self-serving to offer retrospective justification for IMPART's features, but it is not unrealistic. After all, how many development projects are really planned from the start based explicitly and exclusively on a specific model or theory? In our opinion, many (if not most) instructional development decisions are based on the general training and experience of the developers. Hopefully this includes exposure to a range of theories and principles.

Why IMPART is Structured As It Is

The four shells that constitute the student stack were not directly derived from any formal design model, but in retrospect they reflect Gagne's (1970) "Nine Events of Instruction." (Several of the events are omitted however; Gagne"'s model does not require inclusion of all nine events.) The video preview serves to engage the learner, gain his or her attention (Event 1) and remind him or her of the items to be presented in the lesson (Event 3). Key vocabulary items may have already been presented in another instructional setting. To the extent that they have been, the video preview may also stimulate recall of prerequisite learning (Event 3). The tutorial shell presents the stimulus material (Event 4). The drill shell elicits performance (Event 6) and provides feedback about performance (Event 7). Finally, the quiz shell assesses performance (Event 8).

Why IMPART Provides for a Range of Learner Control Options

Every CAI designer must confront the issue of learner control. Although we were familiar with the general literature on learner control as it has evolved over the last 10 years, our deliberations were not derived directly from specific literature-based prescriptions. What follows is therefore in the nature of a retrospective justification.

Bonner (1988) argues that instructional products are often overly prescriptive. Brown (1986) claims that learner control over instruction is motivating. On the other side of the issue, Jonassen (1986, p. 287) cites a series of studies that show that "the case for learner control of instruction, which requires self-determination, autonomy, and responsibility, simply has not been empirically supported."

Hannafin (1984) proposes a continuum in which, at one extreme ("learner control"), sequence is determined completely by the learner; at the other extreme ("lesson control"), sequence is determined solely by the delivery system. He argues that selection of a location on the continuum should be determined by the characteristics of both learners and the material to be presented. Required learning outcomes are obviously another important consideration.

IMPART provides for degrees of learner control all along the Hannafin continuum. However, the author stack permits authors to specify many learner control options in the tutorial shell of the student stack; learner control is drastically constrained in the other components of the student stack.

The decision to select any one of the four basic components (preview, tutorial, drill, quiz) is, of course, left to the student. IMPART allows lesson authors to adjust the amount of learner control for each item in the tutorial. The author can vary the number of available representations from one element (presentation of only one stimulus - usually the word string) to several representations which may or may not be eventually selected for exploration by the student. The drill shell sacrifices learner control to the need for automaticity training, but it does adapt the presentation of items to the student's response patterns. The quiz shell, of course, totally eliminates learner control.

Why IMPART Uses a Pool Structure for the Drill

Whenever technology is considered as a means for addressing learning problems, designers should consider whether non-technological solutions might be just as effective. In the case of computer-based drills, the title of David Salisbury's article "When is a Computer Better than Flashcards?" (1988) is right to the point. It directly influenced the design of IMPART as did other work by Salisbury cited in this article.

Klein and Salisbury (1987) have demonstrated that flashcards can produce learning results that match those achieved through sophisticated computer-based drills. However, Klein and Salisbury note that the learners in their study demonstrated well developed learning strategies and suggest that learners with less well developed strategies can benefit from computer-based drills. The four-pool drill structure in the IMPART system was planned with this in mind.

Edwards and Siegal (1985), argue that simple drill and practice programs are flawed at two extremes. If the number of items is large, the learner is likely to forget missed items before he or she has a chance to answer them again. If the number of items presented is small, the learner will not be required to remember a missed item for any extended period, and long-term retention will suffer.

The four-pool structure used to manage the IMPART drill component addresses both of these issues. Items that are presented to the learner are drawn from a relatively small working pool, regardless of the total number of items that make up the lesson. However, the size of the working pool (which is specified by the author) need not be so small that an item will be fresh in the learner's mind when it is next encountered. The use of the review pool from which working pool vacancies are filled ensures that "learned" items are intermittently re-presented to the student to verify that they really were 'learned" and to promote long-term retention.

An important goal of foreign language vocabulary instruction is to promote automaticity in processing the meaning of words. Anderson (1980) describes automaticity as the state in which a practiced process requires little, if any, attention. Automaticity is an important factor in language learning because one cannot be fluent in a second language if much attention has to be focused on remembering commonly used words. According to Salisbury, Richards, and Klein (1985), effective automaticity training has three stages: a) accurate practice, b) accurate and fast practice, and c) accurate, fast, and "burdened" practice, in which the learner must divide attention between the drill exercise and some competing activity. The drill component of the student stack provides an environment in which learners can experience the first two of these three stages.

Why IMPART Provides for a Wide Range of Representational Modalities

The wide range of representational modalities available in IMPART might seem to run counter to views held by authors such as Clark (1983) who argue that the various "media" used to deliver instructional messages have no differential impact on learning outcomes. Clark's review of the literature offers a number of rival hypotheses to explain studies over the last two decades that purport to demonstrate the superiority of one "medium" over others as vehicles for delivering instruction. In our view, however, Clark's arguments are based on a definition of media as hardware/delivery systems. It was "media" in the sense of communications modalities - basic systems that humans use for encoding information - such as speech, text, and pictorial codes that we wanted to exploit.

From the point of view of the lesson author, the choice of modalities depends partly on the intended learning outcomes. Should the criterion be based on the ability to spell words - as might be the case if instruction is to support acquisition of writing skills? Or is assessment of mastery to be based on ability to select a response to a text stimulus - as might be the case if instruction is to support reading? Stimuli consisting of spoken words might be used to support instruction in comprehension of conversation whereas (arguably) pictorial stimuli might be more appropriate as a means for promoting speaking skills.

One of the considerations that prompted support for so many representational modalities was that prospective users of the system (foreign language faculty) hold different opinions about the best way to teach vocabulary. Some argue that native language words should never be used as stimuli and that pictures or motion video segments should instead be employed to stimulate recall of words in the target language. Other faculty are less adamant and themselves use a range of representations when they teach, including native-language equivalents. The system was designed to let lesson developers use the representations that they think are most effective.

Why IMPART Supports Both Multiple-Choice Response and Constructed Response Formats

Interference is a major obstacle to successful mastery of drill content. Salisbury, Richards, and Klein (1985) have suggested an operational definition of interference especially appropriate to computer-based drills: confusion between two stimulus-response situations. It might be concluded that situations likely to contribute to such confusion should be avoided. However, the essence of paired associate learning is that the student be able to distinguish an element from a field of candidates and match it with the presented stimulus. This is true whether the format is fill-in (in which case the element must be distinguished from all candidate elements stored in the student's memory) or multiple choice (in which case the element must only be distinguished from among the other options).

Should items be formatted to require response through multiple-choice options or through a constructed response ("fill in the blank")? We decided to make both formats available, in part because we had not researched the issue at the time of the decision.

IMPART automatically selects items from the working pool for presentation as multiple-choice options. In other words, it forces the student to distinguish the correct element from *n* listed elements where *n* (as set by the author) can range from 2 to 10. Thus, the author determines the degree of potential interference that will accompany each item. The reason for constructing items in this way is primarily practical: It eliminates the need for the lesson author to construct individual practice items and it permits students to respond instantly, without the problems associated with keyboard input.

We were also concerned that the use of constructed-response items would slow the drill sessions and reduce the number of items that could be practiced, especially for students with poor keyboard skills. Spelling errors further complicate the problem. It is fairly easy to build tolerance for minor spelling errors into CAI response evaluation routines. However, this is more difficult if the overall goal is to build an authoring system that can accommodate multiple languages governed by different rules for spelling and accents. In addition, it was also assumed that the processing required to do relaxed evaluations of responses might slow the system to the point where its performance would be unacceptable. This problem was judged too difficult to solve with available resources.

In the end (also as a matter of practicality), to accommodate the concerns of certain foreign language faculty who felt strongly about the matter, the system was designed to support both multiple-choice and fill-in responses. For fill-in questions, the system requires an exact response. In other words, IMPART considers a "nearly" correct answer, which differs from the correct response by as little as a single keystroke, to be incorrect.

A subsequent review of the literature suggested the issue is not settled. For example, Gay (1980) found that constructed response items resulted in equal or greater retention than did multiple-choice items, but Duchastel and Nungester (1982) found that constructed-response items do not necessarily lead to better retention that multiple-choice.

Why IMPART Uses Multiple-Choice "Foils"

Random presentation of multiple-choice options has a serious drawback. The reliability of multiple-choice tests is negatively influenced by a lack of plausible distractors. (In fact, much of the work of professional test item writers consists of inspecting item analysis data.) In IMPART, it is quite likely, therefore, that any given presentation of an item in multiple-choice format will contain options that can be easily discarded by the student as being very unlikely (on the basis of disagreement in tense or gender, for example). Furthermore, as items migrate to the mastery pool, the student works with a smaller and smaller set of items. To some extent this problem can be solved by specifying a larger number of options. However, we believe the use of foils is likely to improve the reliability of the system's quizzes and tutorials.

CONCLUSION

Like any tool, an authoring system adapts general principles to specific conditions and desired outcomes. If possible, the principles underlying an authoring system should be based on validated research findings. When designers are confronted by ambiguous or conflicting theoretical prescriptions relating to tool design, they should consider constructing (and testing) alternative prototypes based on contrasting capabilities. Another possibility (represented by IMPART) is to build a single prototype that operationalizes the conflicting prescriptions as alternative and contrasting capabilities of an integrated system.

Incorporating contrasting capabilities into prototypes offers two advantages. The first is that, in the absence of clear and unambiguous theoretical prescriptions, such prototypes can help to accommodate the personal preferences, hunches, and "styles" of lesson authors. The second advantage is that, properly conceived, a prototype with contrasting capabilities can support a series of related experimental treatments aimed at resolving the very ambiguities that underlie the design.

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AUTHORS

Brockenbrough S. Alien is an Associate Professor of Educational Technology at San Diego State University, San Diego, California 92182-0311, where he teaches graduate courses in interactive video and instructional design.

Steven L. Eckols is an Instructor, Department of Educational Technology, San Diego State University where he teaches courses in educational computing and message design for interactive training systems.

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Profile

Using Videodiscs in Teacher Education: Preparing Effective Classroom Managers

Douglas J. Engel
Katy Campbell-Bonar

Abstract: Although a key ingredient of teacher education is exposure to a variety of flexible management models, a common feature of teacher education programs is isolation from real classrooms except in carefully controlled, limited circumstances. During a typical four-year degree program, students might have occasion to work with fewer than four practising teachers, each of which will likely model one preferred management style. An ongoing concern of teacher educators has been the limited opportunity for their students to develop a personal repertoire of flexible strategies. Existing instructional materials do little to alleviate this problem. The Department of Secondary Education, at the University of Alberta, became interested in the capability of interactive videodisc to provide an atmosphere suitable for prospective teachers to explore rather than simply study management strategies. Videodisc technology was chosen because it offers the advantage of a non-threatening, "real" interaction with classroom situations. One of the resulting instructional videodiscs. Classroom Management: A Case Study Approach, is described in this article.

Creating and maintaining an orderly, stimulating, and productive classroom environment has always been considered an essential element of effective teaching. A research base was established during the seventies that clearly correlated variables of classroom management with pupil achievement (Evertson, 1985). However, while classroom management has always been assigned to the teacher, few tools have been provided that integrate research and theory into a well-conceptualized, practical approach to classroom management (Jones, 1982).

THE STATE OF TEACHER EDUCATION

Preparing prospective teachers to step into the classroom means providing pre-service teachers with opportunities to develop a philosophy of management. In most cases, beginning teachers have few if any guiding principles or strategies upon which to build their own management techniques.

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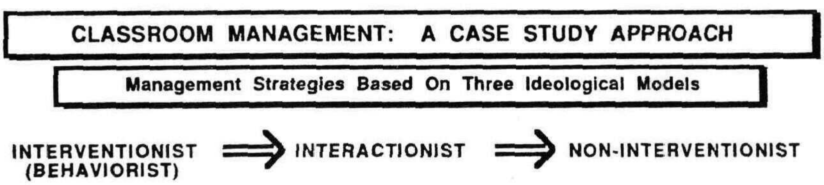
Pre-practicum methods courses are generally designed to heighten an awareness of presentation or communication techniques, with lesson-oriented planning and execution as the main thrusts of the preparation. Most of these courses include some advice regarding potential difficulties in the classroom, but seldom do these methods allow the pre-service teacher to formulate or explore management strategies beyond the "fire-fighting" stage. This lack of opportunity to establish any confidence in their ability to manage the classroom, for example by creating an orderly and stimulating environment, carries over into the real classroom where the trial and error approach dominates during the practicum experience and very often well into a teaching career.

Classroom management has a direct influence on two key aspects of the profession: 1) the degree to which students develop personal and cognitive skills; and 2) the extent to which teachers enjoy their jobs and remain committed to the profession (Jones, 1982). Teacher frustration concerning classroom management problems is widespread. In a poll conducted by the National Teacher Association in 1979, 74% of the teachers responding said that discipline problems impaired their teaching effectiveness. Similarly, studies of first year teachers reveal that discipline and classroom management are the most difficult and problematic dimensions of effective teaching (Lasley, 1987). It is evident that many practising teachers regard their pre-service exposure to these issues as inadequate.

Existing management practices, in many cases, seem to reflect a simplistic approach that expects all school personnel to implement a single reactive model chosen from a very narrow range of approved models. Models have generally fallen along *a*. continuum (see Figure 1) that includes interventionist strategies at one end and non-interventionist strategies at the other (Glickman & Wolfgang, 1979).

Figure 1.
Continuum of Classroom Management Practices.



An obvious problem arises, however, when a teacher is required to rely on a strategy that does not match her/his own personal style or range of skills. As well, expecting one model to be effective with all children contradicts the evident truth that each child is an individual with unique needs (Long, 1987). A third problem arises when teacher-education programs focus on classroom management within the context of instructional or communication methods, leaving the impression that a carefully constructed lesson will forestall any student disruptions. This approach discounts the few students in every class who will fail, initially, to respond to even the most stimulating lessons (Jones, 1982).

Jones (1982) suggests that student behavior and school discipline are best viewed as management issues correspondingly influenced by a wide range of factors. Teachers should therefore be provided with an understanding of the factors that influence individual and group behavior, with methods for diagnosing the classroom environment for potential problems, and with a range of options for influencing student behavior. Similarly, Lasley (1987) offers the presentation of an eclectic view that involves a variety of theories which the pre-service student synthesizes, finally developing a personalized approach. He also acknowledges the value of the more traditional approaches of providing prescriptions for effective classroom teaching based on inquiry, and of viewing an array of problems from one management perspective.

Although a combination of these approaches would be ideal, the reality is that teacher educators must rely on approaches that can be handled in one or two class periods within a curriculum context. In the standard route in our teacher education program, classroom management is presented within this descriptive context, although pre-service teachers become involved in several peer teaching sessions during which they have an opportunity to role play various classroom management scenarios. While experiences of this sort encourage the personal reflection essential to effective teaching, they fall short of exposure to and practice in real classrooms.

THE CHOICE OF VIDEODISC AS INSTRUCTIONAL MEDIUM

Interactive videodiscs provide an opportunity not previously available with instructional media — realistic conversations between videodisc teacher and pupil and between videodisc coach and player (Clark, 1984).

Clark characterizes good conversation as including responses that are appropriate and quick and as having the property of shared responsibility for direction, content, pace and intensity. Interactive videodisc allows this quality of interaction by encouraging conscious involvement on the part of the learner. Simply put, the videodisc experience is related directly to learner input. The program simply will not advance until the learner communicates a decision via the remote control keypad. Program branching in this experience is determined by either the intentional choice of the learner or by the program, and is based on built-in measures of performance and understanding.

For the environment described in this article, that of instructing in the difficult area of classroom management, videodisc technology enjoys a number of additional advantages over traditional media. While slides have high visual quality and are relatively inexpensive to produce, they impose a linear structure on presentation and do not permit rapid access of dynamic information. Film is expensive and prohibits immediate visual response to student questions and concerns. In both these cases, the student fails to be an active participant. Videotape, while easy to use and edit, has a slower response time and poorer quality visual images than videodisc, especially in freeze frame. None of these instructional mediums are intrinsically capable of providing immediate feedback to the learner - in most cases, a human tutor will be present to make decisions about the next instructional step.

This Faculty has been interested in the use of simulation materials for teacher education since the mid-seventies. Early work on The Simulated Classroom (SIMCLASS) had gone on for several years using interactive videotape before the first videodisc, A Touch of Midas, was produced in 1982. As a result of that experience, and in reaction to a perceived need for improved methods of teaching the complex human interaction skills necessary for effective teaching, a second videodisc, Classroom Discipline: A Simulation Approach was developed (1984). The expanded SIMCLASS team, Dr. Douglas V. Parker, David A. Mappin, and Katy Campbell-Bonarj based the design of this Level II disc on the work of David Kolb in explicating an experiential learning system. That is, the use of videodisc technology permitted a "controlled setting where simulations of reality (replaced) actual experience in the cycle of work, personal development, and education" (Mappin & Parker, 1985) and helped the students integrate classroom discussions and readings and actual practicum experiences in *a* way that would provide a wider range of management styles with which to experiment.

This disc was used in 12 sections of Ed. CI 352, the course for which it was designed, in both the Fall and Winter terms of 1984/85; as well as in several courses in Educational Psychology and Educational Foundations. Based on the Faculty's acceptance of this approach, another videodisc project was undertaken.

PROGRAM DESIGN

In order for instructors to take advantage of several approaches while maintaining the momentum necessary in a short university session, a third videodisc was designed to provide an in depth "real" experience in classroom management at the secondary level. Second in the series developed for Ed. CI 352 (a third is now in development), Classroom Management: A Case Study Approach utilizes Level II technology in a way that approaches the provision of all of Lasley's perspectives in one resource. Level II technology, in which the program logic is self-contained, was chosen because of its portability (one player, one monitor), low cost of design and production in comparison to other interactive formats, and ease of utilization.

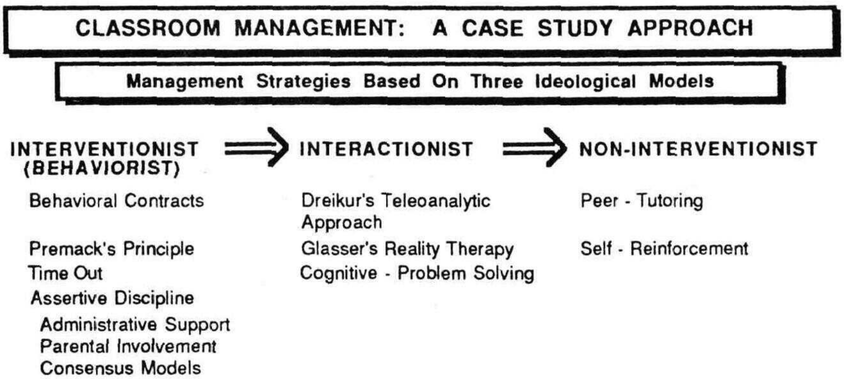
One of the instructional goals in designing this disc was to encourage beginning teachers to take a problem-solving approach to understanding a pupil's personal experiences and motivations and their effect on classroom and social behavior. Accordingly, the simulation was designed as a case study of how one pupil's difficulties in adjusting to changing family circumstances affects not only her home life but her performance and behavior in the classroom. The participant immediately assumes the role of the classroom teacher and continues in this role throughout the simulation which culminates in the application of a management strategy.

Initially, the case study guides the participant through an information-gathering stage, during which factors external to the school situation are explored. At this time the participant-as-teacher is introduced to the Vice-Principal ofthe disc "school", who thereafter acts as a facilitator and focal point to which the teacher can return again and again for advice. The character of "Vice-Principal" was chosen for this role for several reasons: 1) in reality, this individual is often responsible for school-based teacher evaluation; 2) the Edmonton Public School Board often takes on this additional task of staff development; and 3) including this character permitted the designers a means with which to provide continuity and feedback to the learner in a relatively non-threatening manner. As an aside the "actor" for this role, who within the year accepted an administrative position in an elementary/junior high school, was instrumental in organizing a workshop for her colleagues in Edmonton Public Schools' Consulting Services, at which Faculty members highlighted the use of interactive technologies for teacher education and inservice. This meeting led eventually to the undertaking of a collaborative project to develop the aforementioned third videodisc in this series.

Following a review of this stage, the student is presented with a choice of three target behaviors for possible modification. Although experienced teachers might well choose a number of behaviors for simultaneous attention, this case study requires the participant to focus on one target behavior and related strategies at one sitting. Choosing to focus on underlying causes for behavior, for instance, will result in a further choice of three to four classroom management strategies from which the student is to choose one for implementation. These strategies range from Cantors'Assertive Discipline (1980), an interventionist strategy, to Glasser's Reality Therapy (1977), an interactionist strategy, to the non-interventionist Cognitive Problem-Solving approach described by D'Zurrilla and Goldfield (1971), and others. The designers included seventeen management strategies in total, which encompass all of the continuum (see Figure 2 on following page) described by Glickman and Wolfgang (1979).

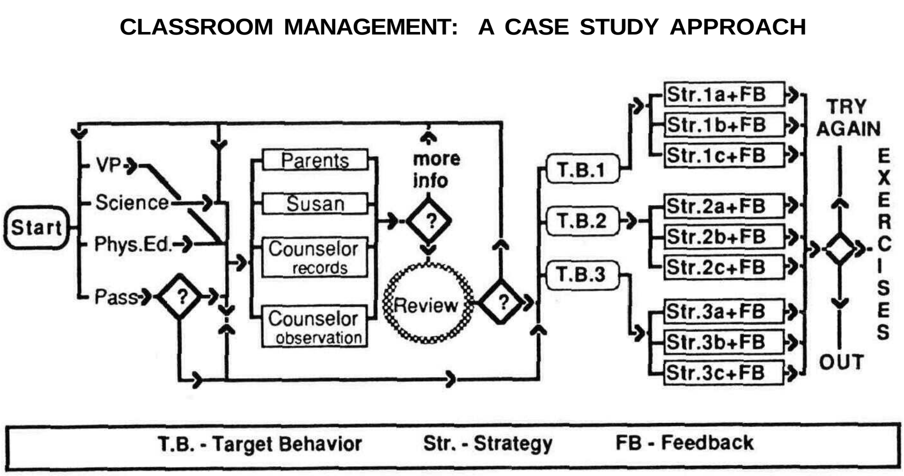
As the participant works through different paths on the disc she/he may be exposed to as few as two strategies or as many as are available. In this way the participant begins to articulate personal perceptions and goals related to effective classroom management. Naturally, the student's choice of strategies will be based on the information obtained by utilizing as many disc-based sources of information as possible. These sources, each providing a key to understanding the problem, include discourse with colleagues, consultations with the vice-principal and the school counsellor, telephone conversations with

Figure 2.
Management Strategies.



the parents and interviews with the problem pupil. The structure of this disc is represented in Figure 3.

Figure 3.
Structure of Videodisc.



IMPLEMENTATION OF THE VIDEODISC IN THE FACULTY OF EDUCATION

The flexibility of this medium affords an instructor in the Faculty of Education the opportunity to utilize the case study in a number of ways. An individualized approach is of the greatest value in assisting a beginning teacher to develop a personal philosophy of management. The adolescents appearing on the disc do not get tired nor do they refuse to respond to one more trial suggestion. An individual student working alone has the freedom to try different management approaches in an environment involving no personal risk. Small groups working with the case study have the added support of peers and the feedback analysis so valuable when working through new or unfamiliar territory. Larger groups (class size) may also benefit from working through a path, selecting a behavior to modify and a related management strategy. In the latter consensus model, an instructor has the option of highlighting various information sources (for example, the use of Cumulative Student Records) that may otherwise not be available to the student. In this way the videodisc functions as a database. A fourth possibility for use would be to assign the case study to individual students after a large or small group session. As instructors in this course have become more familiar with the available resources, other strategies have been employed. For example, one instructor in the Fall session, 1989, used Classroom Management: A Case Study Approach in small groups to study and practise communication styles.

By keeping track of the information gathered from a variety of sources and the decisions made at various points in the study (a log sheet is provided for this purpose), a student is able to compare approaches and finally confirm their own personal management style. Working knowledge of other management models is valuable as the student begins to expand his/her personal repertoire of strategies.

SOME FINAL THOUGHTS

Mastering classroom management seems to be one of, if not the, major concern of beginning teachers. In developing Classroom Management: A Case Study Approach, the Faculty of Education attempted to provide a challenging new means by which pre-service teachers can acquire or confirm a personal management style. The flexibility of this Level II videodisc, makes the instructional resource a multifaceted tool by which instructors are able to bring one very realistic and complex situation into the classroom for analysis and evaluation. The case study, while useful in an individualized or group interaction mode, appears to be a most thorough learning experience when used in a combination of approaches.

Classroom management is a complex problem. If beginning teachers are to be effective in facing the challenges of the classroom in the 90's, they must be encouraged to develop *a* repertoire of appropriate management models. We believe that the use of interactive materials, in combination with traditional classroom instruction, gives our beginning teachers an excellent opportunity of meeting these challenges.

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AUTHORS

Douglas J. Engel, is an Associate Professor in the Department of Secondary Education, Faculty of Education, at the University of Alberta.

Katy Campbell-Bonar is a Utilization Consultant in the Instructional Technology Centre, Faculty of Education, B-117 Education North, University of Alberta, Edmonton, AB, T6G 2G5.

Microware Review

Macintosh Computer Viruses: Descriptions and Eradication Methods

Sheila ffolliott

Computer viruses and trojan horse programs are computer programs that spread from computer to computer, sometimes (but not always) causing damage to data. Since the people who spread them are usually unaware that they are doing so, computer viruses pose a threat to those who use computers. This article concentrates on detection and prevention of viruses on Macintosh and IBM PC and compatible machines.

DEFINITIONS

A *trojan horse* advertises itself as a useful or interesting program in an attempt to get someone to run it. When it is run, it usually performs the useful action and then performs an undesirable one. The only way to get a trojan horse on your disk is to put it there yourself (although another person could put it on when you are not watching). The best way to avoid damage caused by a trojan horse is to be wary of unknown software and run it on a test system first.

A *virus* is a program that inserts itself into a legitimate program or the computer's operating system. Once there, it waits until someone runs another, uninfected program and then inserts itself into that program. Usually the owner of the infected program is not aware that a virus is in the program; viruses spread without warning. Some viruses are destructive and may wipe out all the information on a computer's disks, delete selected files on hard or floppy disks, or write wrong information to files. Some viruses are intended to be cute rather than harmful, but can cause programs to crash or malfunction because the author did not anticipate all possible interactions between the virus and other programs.

Viruses are spread when one person gives another person an already infected program, and the infected program is run on the first person's computer. It is possible to get certain viruses by simply inserting an infected disk in the floppy disk drive and looking at the contents. You cannot get a virus

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if you do not use other people's disks in your computer, and do not download programs from microcomputer bulletin boards.

A *worm* is a program that spreads from computer to computer, as does a virus, but it does not insert itself into another program. It hides itself in other ways. Worms can spread through the sharing of disks, and also through a computer network. The Internet program that made headlines around Christmas time, 1988, was a worm (but was often mistakenly called a virus). Microcomputer worms are rare, thus they will not be mentioned further in this article.

A time bomb is a virus, trojan horse, or worm that waits for a certain time, a certain day (Friday the 13th, for example), or for a certain length of time before performing its action. In other words, you may have a time bomb on your disk for some time before it damages your data.

Note: With one important exception, data files cannot be infected with a virus (see the Init 29 information in the Macintosh Virus section). Only applications can become infected.

Virus "vaccines" are available, both in the public domain and commercially, that attempt to warn the user that infection is about to occur or that it has already occurred. Public domain Macintosh vaccines include Vaccine, Interferon, VirusDetective, KillVirus, Ferret, Disinfectant, GateKeeper, and Virus Rx (Disinfectant, Vaccine, GateKeeper and Virus Detective are the best ones).

When using a vaccine, take care to ensure that the vaccine program itself does not become infected. Get the vaccine program from a source that is known to be virus-free, and copy it onto a floppy with a copy of the original system disk for your computer. Once the vaccine is on the floppy disk, the disk must be write-protected. Never start a machine that is suspected of having a virus on its disk with a floppy disk that is not write-protected.

Some vaccine programs have options that will remove a virus from an infected program. Removal of a virus from a program using a vaccine is not guaranteed to work; part of the virus may remain to reinfect your Macintosh, or your application may be damaged by the attempt to remove the virus. It is safer to remove the program and reinstall it from the original program disk.

Vaccine programs are not foolproof, so other precautions should be taken.

Signs of a Virus Attack

- The size or creation date of a program has changed from the original (some programs alter themselves, so this is not conclusive).

- Unknown files that appear on your system without your knowledge (but some programs create temporary files that may not get deleted. If your computer crashes while you are running a program and you discover strange files on your disk, the files are probably left over from the crash).

- Deleted or damaged files; but there are many causes for damaged files, and most of them have nothing to do with viruses.

- Unusual slowness of a program, either in operation or in starting.

- Sudden problems with printing or other operation of a program.

- Large amounts of disk space suddenly vanishing.

Precautions Against Virus Attack

For personal use, and use with microcomputer networks:

- Write-protect all original program disks and make a copy before installing the programs onto a hard disk; put the originals in a safe place.

- Check all new disks with a virus detection program before using their programs.

- Never use the original program; use a copy instead.

- When possible, do not use any floppy disks that contain programs or the operating system unless they are write-protected; the action of placing a disk in a drive and looking at it can be enough to infect it (a virus cannot attack a floppy that is write-protected).

- System files and programs should be marked as read-only whenever possible, so a virus cannot write to them (but some viruses are smart enough to get around this).

- Public domain software should be obtained only from reliable sources, such as the original author or a commercial bulletin board service (GEnie, CompuServe).

- Commercial software must be obtained only from a software vendor (in addition to being illegal, pirated software is more likely to have a virus).

- Before using any new or suspicious software, run it several times on a test computer and check to make sure that programs and system files have not been altered or deleted.

- Check the size and creation date of programs and system files against the originals, and reinstall the original software if any unexplained change has occurred (but some programs write information into themselves, such as WordPerfect 4.2).

- Consider using a checksum program, which looks at a file, performs a calculation based on its size and contents, and produces a checksum number; if a virus infects a file, the checksum will usually change. Run the checksum periodically and check the results.

- Know your system; note any unknown files and determine their origin, and be suspicious of any unusual changes in how your software works (slower speed, unexplained disk activity).

- Back up all important data files on a regular basis (this is a good idea anyway).

VIRUS ERADICATION

The first thing to remember if you think that you have been infected with a computer virus is DON'T PANIC. Most of the time, damage caused by what you think is a virus is really caused by something else - error on your part, or error on your program's part (bugs in your software). If you do suspect a virus and you don't have very much computer experience, find someone who does and have them look at your computer.

To get rid of *a* virus, follow these steps:

a) boot the computer with an original, write-protected system disk;
b) backup any important data (NOT APPLICATIONS) if you have not already done so;
c) delete all infected applications. For best results, erase the entire disk;
d) restore your backed up data from write-protected backup disks (or tape);
e) restore the applications from original, write-protected disks;
f) check the disk with a virus detector to make sure that the virus is gone; and
g) repeat for all infected floppy and hard disks.

If you regularly back up your data, congratulations; you are a singular person. However, if you are using your backup to restore your data after a virus attack, remember that you may have had this virus for some time and your backup may contain infected programs. Do not restore programs from your backup, or you may become reinfected. Only restore the data from your backup, and use the original program disks to reinstall programs.

KNOWN MACINTOSH VIRUSES

There are several widespread viruses for the Macintosh, which have different symptoms and cures. None of the known viruses were written to delete data, although they may cause your programs to crash or printing to fail. For more information about Macintosh viruses, read the article entitled "Mad Macs" in the November 1988 issue of *MacWorld*.

nVIR. So called because it inserts a resource called nVIR into applications and into the system file. There are at least two different variants of nVIR with the same name. It can be detected by using a virus detection program or by using ResEdit to check if the nVIR resource exists in a program. An infected program will occasionally beep when you start it up, for no apparent reason; if you have MacinTalk installed on your Macintosh, it will say "Don't Panic" instead of beeping. Programs infected with nVIR often have printing problems. One version of nVIR installs itself over and over again into a program, causing it to grow to an enormous size.

hPAT. This is a variation of nVIR, with similar symptoms.

Scores. Scores creates two invisible files inside the System folder, one called "Scores" and one called "Desktop" (not the real Desktop file, which is not in the System folder). These files can be seen if you use a utility program such as DeskZap. As well, the icons for the notepad and the Clipboard files change from being a tiny Mac to being a text-only file icon. An infected application contains an extra CODE resource of size 7026, numbered two higher than the previous highest numbered CODE resource. This program is targeted against programs with resources named VULT or ERIC, which are programs written and used by a defense company in the United States.

Init 29. This is the only virus discovered to date that will infect data files. In fact, Init 29 will infect just about any type of Macintosh file, such as programs, printer drivers, data files, font files, and the System. It also infects the Desktop file, an invisible file that resides on every Macintosh floppy or hard disk. If an infected program is copied to a disk, the disk's Desktop file becomes infected. If a disk is inserted into an infected machine, it becomes infected unless it is read-only. If the virus tries to infect a write-protected disk, it will fail, and the Macintosh will display the "Disk needs minor repairs" error message. The virus detection program "VirusDetective," version 2.0 and higher, will detect this virus.

MACINTOSH VACCINE PROGRAMS

Each virus protection program works in a slightly different way. Here are brief descriptions of each of the programs mentioned above, to aid you in choosing a virus protection program for your computer. The programs are listed in order of most to least desirable. The virus protection programs are divided into virus prevention - taking place, and virus detection - programs that detect viruses after they have infected your computer.

VIRUS PREVENTION PROGRAMS

Vaccine 1.0. Vaccine is an INIT file. When placed into the System folder, it installs itself into the memory of the Macintosh when the machine is rebooted. Once installed, Vaccine monitors the activity of other programs and warns you if a program is about to insert code into another program. If this happens, Vaccine will put up a dialogue box asking if the insertion is to be allowed. The appearance of this dialogue box does not necessarily mean that you have a virus on your machine; compilers and programs that create FKEYS will trigger Vaccine. If you are running a program that is not supposed to alter your applications or your system files, answer "no" when Vaccine asks if it is all right to let an insertion take place, stop what you are doing and check your computer for viruses.

Occasionally, a program will hang (stop) as you are starting it if you have Vaccine installed. This may be caused by a virus; certain viruses will disable the ability of Vaccine to put up a dialogue box, but Vaccine is still waiting for a yes or a no. If a program that you have used before hangs when you are just starting it, and you have not made any changes to your system since you last used the program, you may have a virus. Press the 'n' key; if the program continues, you have been attacked by a virus. Even if the program does not restart, check your computer for a virus. Programs may hang even if a virus is not present, particularly if you have recently installed a new INIT or CDEV.

GateKeeper. GateKeeper is similar in operation to Vaccine, but can be told not to flag the actions of compilers and FKEY programs as dangerous. If you are a programmer, you will probably want to use GateKeeper rather than Vaccine.

KillVirus. KillVirus is an INIT that 'inoculates' your System file against the nVIR virus. To use it, place it into your system folder. The next time you start your Macintosh, KillVirus will insert a fake nVIR virus into your System file; when the real virus sees the fake virus, it thinks that the System is already infected and will not reinfect it. KillVirus will also detect attacks by the real nVIR virus on your System, and will delete the virus from infected programs automatically.

Note: The KillVirus program will be flagged as infected with the nVIR virus by Interferon, but it is not infected. After you use KillVirus, Interferon will flag the system file as infected as well, but the fake nVIR is harmless and will not spread.

VIRUS DETECTION

Disinfectant. Disinfectant checks every file on a disk for the presence of known viruses. If it finds as infected file, it displays a message and gives you the option to remove the virus from the program.

Interferon 3.1. Interferon checks every file on a disk for the presence of Scores and nVIR, as well as "anomalies" - conditions that may signal a virus, but usually do not. If Interferon finds an infected program, it displays a warning message. Interferon will also eradicate a virus, which means that it will delete the infected program, so use this option with caution.

Note: Some files created by the LightSpeed C compiler are flagged by Interferon as having an anomaly, but this is normal; the files are not infected by a virus. Version 5.0 of the LaserPrep and LaserWriter files from Apple also cause Interferon to flag an anomaly, but they are not infected with a virus. Other versions of the LaserWriter and LaserPrep files do not have this anomaly.

Ferret 1.1. This application checks a disk for the presence of the Scores virus. It will flag any infected programs, and will remove the virus from infected programs.

VirusDetective 1.2. VirusDelective is a DA and must be installed into your System file using the Font/DA Mover program. It will check your disk for the presence of nVIR and Scores. It is possible to get VirusDetective to check for other unknown viruses, as it allows you to check files for resources of your choice. VirusDetective will also attempt to remove viruses from infected programs.

Virus RX1.0A2. Virus RX prints out the names of all INITs and CDEVs on your disk, as well as suspicious resources in your System files. Once the list is compiled, you must check to see that you know what each file is; unknown files may be part of a virus. If Virus RX itself is infected by the Scores virus, it will change its name to "Throw me in the trash"; throw it away immediately and check the rest of your disk for Scores with another virus detection program.

Note: Virus RX does not signal the presence of the nVIR virus, so a different program must be used to check for that virus.

Agar 1.0. Agar is not a virus detection program per se. It is a small dummy application that does nothing but wait to be infected. It is very small (361 bytes), thus it is easy to see if Agar has been infected by a virus. To use it, copy it onto each disk that contains applications or a System folder and check it periodically to see if it has been altered.

CRC 1.0. This small program will calculate a CRC (cyclical redundancy check) for your application programs. A CRC is a number produced by performing a calculation using the bytes of an application; an example of a simple CRC would be to take the length of a program and divide the result by 23. If the program changes in any way, the CRC will probably change (but it may not), thus signalling infection. Since the program CRC must be run once on each of your application programs, and the resulting number written down, it is awkward to use unless you have few programs to check.

AUTHOR

Sheila ffolliott is with the Department of Computing Services, University of Saskatchewan, Saskatoon, Saskatchewan, S7N OWO.

Book Reviews

Interactive Video by R. Schwier, Englewood Cliffs, NJ: Educational Technology Publications, 1987.

Reviewed by Som Naidu

Interactive video (IV) is a fairly recent application of educational communications technology and currently only a handful of instructional developers seem to know exactly where and how to begin its development. This book is a guide and reference for the majority of such instructional developers, and especially the self-styled ones, who are interested in developing an IV application.

As such it is a book for practitioners. It is an attempt to pull together in one place, and in an easily accessible form, the basics that need to be known by anyone venturing into the development of IV software *(cf.* Laurillard, 1987; Parsloe, 1983; Floyd & Floyd, 1982). With this it offers, as 'tidbits' (p.169-202), a small list of useful references organised under the following categories:

a) general interest (p. 175);
b) designing interactive video (p. 178);
c) hardware, software and production (p. 180); and
d) applications, case studies and research (p. 181).

Another useful 'tidbit' is a list of providers of videodisc manufacturing services along with addresses of their representatives (p. 186-88). These will be handy as it is certain, that in order to be able to get on with their task, most instructional designers, video producers, editors and computer programmers will be looking for more beyond that which this book is able to offer.

The author, a practising instructional developer, writes with concern and empathy for the needs of both the novice instructional developer as well as the seasoned veteran. To the novice he offers a holding hand and a willingness to walk him from the initial design stage through to the final review. The seasoned instructional developer is left on his own, free to wander about and use the material as necessary — as the blurb says — "to leap over unwanted material, take brief excursions into peripheral areas and review notions which were previously missed." Each chapter in the book begins with a topic menu with appropriate page numbers. Within the text the reader encounters suitable branches to different parts of the book with advice on their relevance and use as necessary. Frequently along the way there are also suitable reminders to the reader of the current topic and the next topic menu. This facility is perhaps the most interesting feature in the presentation of the book. Not only does it impress upon its reader the usefulness of designing interactive instruction, be it printed or other (to cater for differences in readership capability and interests), but also the need to 'think interactively' (p. ix) as well as the look of things (literally) to come in their own IV treatments.

Interactivity in instructional environments then, is the main message of the medium and the epitome of its treatment in this book. With it is the recognition of the need to individualise instruction and, for both the designer/developer and the learner/client to think interactively, that is non-linearly (p. 29). In addition to this is the message that, as an instructional application, IV offers tremendous design opportunities for eliciting the best effort from each individual irrespective of his level of capability, something not as easily achievable through most other instructional means.

This book is about harnessing that powerful and impressive technology, and harnessing it for people, a point which the author himself belabours. His purpose is to answer the most basic of the designer's questions-questions such as where does one start, with what, whom, and how? How does an instructional developer take an idea/problem and turn it into an interactive video treatment? What are the processes, likely hazards, and requirements?

In pursuing these very basic concerns and questions the volume may seem, to some of us, rather too simplistic a treatment and more so now than two years ago when the book first appeared. However, this ought not to be seen as a weakness of the treatment of the subject in the book as readers need not dwell on sections of the book already familiar to them. Be assured that the book is a lot more than a cook book. For instance there is, in several of its chapters, a very thorough and detailed coverage of content, procedures and relevant technical terminology. These include chapters 6,7, and 8 in particular, which deal with:

a) preparing for premastering: Where production meets post-production;
b) premaster/Edit master, and;
c) submission, review and approval.

This is a book intended for use by instructional designers who are, more often than not, generalists by training, and unskilled in the development of an IV treatment. Its strength lies in the coverage of the whole developmental process, from the identification of a training problem worthy of IV treatment, the collection of source media, design of computer-assisted instruction through to premastering and mastering—the whole works—a rather large task for any volume of its size (202 pages). As a result some instructional developers may find 30 pages of text on preparing for premastering and 15 pages on premastering and editing master rather skimpy. It is certain, however, that most will find themselves a lot more knowledgeable than before reading this book on the relevant processes, and definitely much better placed to relate more meaningfully with other members of their team.

That then, is the other not so hidden message of the discussion in this book — that the development of an IV treatment is a team effort, requiring the co-existence of at least three fairly specialised skills. These are video production and editing skills, computer programming skills and instructional design skills. This volume does not pretend to have the last word on any one of these integral components of IV development. And, neither does it pontificate about the suitability of particular instructional design models.

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REVIEWER

Som Naidu is a Ph.D. candidate in Educational Technology at Concordia University, Montreal, Quebec.

Using Video: Interactive and Linear Designs by Joseph W. Arwady and Diane M. Gayeski, Englewood Cliffs, NJ: Educational Technology Publications, 1989.

Reviewed by E. Lynn Oliver

"Lights, camera, action!" Television, as a medium for delivering instruction, is alluring. Yet, developing strategies that incorporate video can be perilous. That's why this book will be a boon. It offers the instructional designer a hefty grab-bag of field-tested techniques intended to maximize the benefits of the video medium.

In what must have been a daunting task, the authors have endeavoured to impose order on this eclectic assortment of video techniques and devices by dividing them into two broad categories: linear and interactive video designs. Chapter 2 devotes over ninety pages to eighteen linear designs and Chapter 3's seventy pages are packed with twenty-two interactive designs. Arwady and Gayeski suggest, however, that all sound instructional video is, in varying degrees, interactive. Note, for example, their criteria for identifying a linear technique worthy of inclusion.

> Each technique is included explicitly because it has been used successfully to establish a level of interaction where viewercognition is influenced in ways that can help shape subsequent behavior and performance, (p. 7)

Given the authors' definition of interactive video as "...programs which require viewer response" (p. 101), it may be helpful to think of "interactive video" in terms of its capacity to incorporate linear techniques and provide more sophisticated traffic patterns for directing the learner through the video experience.

The authors' refreshing approach to interactivity is further reflected in the manner in which they describe "levels of interactivity." "Direct address", for example, is level one. At this level, viewers are spoken to directly and asked "rhetorical questions" to be answered "in their heads." These "closure" techniques prompt intellectual fill-in-the-blank responses. "Pause" is level two. Again, the learner's perspective is evident, in that pause refers to the ability to "...control the rate, direction, or order of a program" (p. 102). This could be as simple as pausing or stopping the tape when instructed and turning to a workbook activity. Keep in mind, however, that the book's approach differs from the commonly understood levels of interactivity as determined by hardware configurations. It is only at level five that the authors predict the reader will recognize what is typically described as interactive video; the level at which a microcomputer interfaces with a video disc or tape.

Prior to delving into their tool-kit of video techniques, the authors encourage the instructional developer to ponder two critical areas: the appropriateness of video as the medium of delivery and the composition and needs of the audience. They pose a number of factors to investigate when considering video as a possible solution to an instructional problem. Thought-provoking notions about the role of video in the instructional process are also raised. Next, the authors walk the reader through the nuts and bolts of an audience analysis. This sets the tone for the book. Viewers are considered active participants in the learning process; their thinking to be molded, or as the authors suggest, "manipulated", by the mediated instruction.

Each technique is presented catalogue style, its function reflected in a catchy title, such as the Dramatic Irony Technique, Vicarious Travel Technique, or the Eighteenth Hole Technique. A concisely stated purpose is followed by a thorough, yet succinct, description. This, in turn, is reinforced and illuminated by a discussion of the ways in which the technique has been used in actual productions. The production applications, in my opinion, are the most valuable contribution to the book. Here's an example.

The purpose of the "Omniscient Spokesperson Technique" is to introduce the viewer to an "extra" character whose role it is to "... provide viewers with analysis and explanation of important program segments" (p. 33). The character endears him or herself to the viewer by becoming an affable "confidant" who manipulates reaction to the message by posing questions, offering advice, and evaluating content from an "insider's" point of view. The example used to illustrate the technique was taken from an insurance company's video, in which the omniscient spokesperson is a comical character who "magically" enters and exits the scene as a "rotating star-shaped graphic." Production stills illustrate the special effects used.

In addition to getting a behind-the-scenes look at each video technique, the reader is treated to a text that is liberally sprinkled with excerpts from scripts and storyboards, production photographs, sample screen displays, and information-packed drawings and diagrams. When combined with simple, direct explanations of technical and production terms, Arwady and Gayeski do an admirable job of demystifying video production. As a result, devices like "digital squeezing" (compressing an image from full-screen to partial-screen size) begin to make sense, not just technically; but, more importantly, from a message design perspective.

While the book is directed at trainers and performance managers in business and industry, the content and examples used will translate readily to an academic or non-corporate environment. This practical, "how-to" book, will undoubtedly find a receptive audience among instructional developers. *Using video: Linear and interactive designs* will invariably stimulate the flow of ideas and generate fresh approaches to solving instructional problems through video.

REVIEWER

E. Lynn Oliver is a Ph.D. candidate at Northern Illinois University and Program Manager at Education and Lifelong Learning, Saskatchewan Communications Network (SCAN), Regina, Saskatchewan.

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Articles and Critiques *(by title)*

Articles *(by author)*

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Information for Authors

CJEC welcomes papers on all aspects of educational communication and technology. Topics include, but are not limited to: media and computer applications in education, learning resource centers, communication and instructional theory, instructional design, simulation, gaming and other aspects of the use of technology in the learning process. These may take the form of reviews of literature, descriptions of approaches or procedures, descriptions of new applications, theoretical discussions and reports of research.

Manuscript Categories

Manuscripts may fall into one of two classes: *General,* dealing with a topic or issue at a general level (although reference to specific instances or examples may be included), and *Profiles,* dealing with or describing only a specific instance of an approach, technique, program, project, etc. A Profile may be thought of as a descriptive case study.

Most manuscripts dealing with a topic in general should include reference to supportive literature, while manuscripts submitted to the Profile category may or may not. The Editor reserves the right to change the designation of a manuscript or to make a designation, if none has been made previously by the author. Authors interested in determining the suitability of materials should consult past issues of *CJEC of* contact the Editor.

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Manuscript Preparation

Manuscripts should be typed on 8 1/2 x 11-inch ordinary white paper. All materials must be double-spaced, including quotations and references. Include a title page on which appears the title of the manuscript, the full name of the author(s) along with position and institutional affiliation, mailing address and telephone number of the contact author. An abstract of 75-150 words should be placed on a separate sheet following the title page. While the title should appear at the top of the first manuscript page, no reference to the author(s) should appear there or any other place in the manuscript. Elements of style, including headings, tables, figures and references should be prepared according to the *Publication Manual of the American Psychological Association. 3rd Edition.* 1983. Figures *must* be camera-ready.

Submission of Manuscripts

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