The Effects of Structural Communication, Learning Approach, and Computer-Assisted Learning on Ensuring Understanding

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ABSTRACT

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In the research reported here, two independent variables were arranged in a 2 X 3 factorial design. The first variable, learning approach, consisted of (1) deep approach and (2) surface approach. The second variable, delivery mode, consisted of (1) print study unit with computer-assisted learning (CAL) structural communication discussion, (2) print study unit with print structural communication discussion, and (3) print study unit with no structural communication discussion. The findings of this research indicated a significant difference in favour of subjects classified as deep approach learners in terms of the level of understanding achieved in the absence of structural communication. CAL structural communication was found to be more effective than not using structural communication in terms of the level of understanding achieved. As well, CAL structural communication was found to be more efficient in terms of the time required to learn than print structural communication. No significant differences were found between subjects classified as deep approach learners and subjects classified as surface approach learners using structural communication as a delivery mode. The results of this research support the use of structural communication as a method for designing CAL.

DEDICATION

To Carmen and Alexandra. Without your support and encouragement, this work would not have been completed. Thank-you.

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TABLE OF CONTENTS

TABLE OF CONTENTS (cont'd)

List of Tables

List of Tables (cont'd)

List of Figures

CHAPTER ONE

INTRODUCTION

With the invention of the printing press in the fifteenth century, the nature of education was changed completely. The reality of multiple copies quickly replaced handwritten manuscripts and enabled educators to circulate information to large numbers of people. The only revolution prior to this with a comparable influence on education occurred when the first word was written. Information that, until then, could be conveyed only verbally finally had permanence.

The written word and the printing press are the foundation of our education system. These developments allowed modern society to create an education system that served the masses. Since then, one would expect not only refinement but also further innovation in education.

Those who judge, however, suggest that the present system of education has not changed dramatically since mass education was first introduced more than 100 years ago. The traditional organization of schools into classes and assigned teachers remains unaltered. Teachers continue to teach material suited to the majority of students in a class: the others either do not comprehend the material or are unable to reach their full potential. As a result, many critics question whether current educational methods have reached the limits of their capacity. Hallworth and

Brebner (1980) suggest that "little further improvement in the effectiveness of the schools is possible, despite the best efforts of all professionals involved" (pp. 2).

Criticism alone, however, is not sufficient to instigate change in education. This is evidenced by Hodgson's (1968) criticism which, despite the progress of technology and innovative research in education over the past fifteen years, is still valid:

> Education today is dominated by examination systems which, whatever people may claim to the contrary, emphasize the conservation of knowledge through the transmission of 'subjects' from the teachers to the pupils. (pp. 2)

He argues that the education system is inefficient because it places emphasis on information and information processing without due attention to the need for communication through understanding. The education system emphasizes rote learning through memory, smothers exploration by conditioning learning, and assesses people as if they were human data banks capable of regurgitating information on demand. As well, he claims it ignores the systemic and structural nature of knowledge by assuming human learning to be a linear progression of knowledge acquisition, and it confuses the quality of education with a plethora of innovative schools and schooling, media, and other technological gadgetry in the guise of quality education.

Implementation of technology in education has produced only superficial change within the education system. The introduction of television and programmed learning, for example, was hailed as something capable of revolutionizing modern education; yet, implementation and present utilization are far below what was expected more than twenty years ago. For the most part, then, the education system remains unchanged. Recently, however, a new revolution has appeared: microelectronics. Its influence on education may be more drastic and more influential than anything since the printing press.

At the centre of this new revolution is the microcomputer. Unlike other developments, the development of the microcomputer has mushroomed in just a few years. Few educational institutions in the western world remain unaffected by its pervasive influence. William Gosling (1978) eloquently summed up the influence of microelectronics when he said "we find ourselves on the threshold now of something more significant and more far-reaching in its consequences than perhaps anything that has happened to our race since our long dead ancestors took fire into their service " (pp. 11).

Although microcomputers will potentially alter education, their success depends emphatically on courseware development. Though an extensive amount of courseware has been published in an attempt to meet the demands of a growing number of microcomputer users, the majority of this courseware is of poor quality: either it is not pedagogically sound, or it is inappropriate for specific curriculum needs. Attempts to obtain quality courseware are easily frustrated for these reasons. Braun (1981) warns that this is a most serious impediment to computer-assisted learning (CAL) development, and it could be the greatest dampening influence on further adoption of microcomputers in education. He says that the majority of people developing and marketing courseware are doing so to take advantage of the large potential market, but they "know nothing of pedagogy; consequently, they generate material that is educationally useless" (pp. 228). Hallworth and Brebner (1980) are similarly critical. They suggest that quality courseware will have to be developed locally because "there are no programs available for microcomputers which both represent state of the art CAL and provide a substantial segment of a school course" (pp. 190).

Improving microcomputer courseware requires attention not only to pedagogy and specific curriculum areas, but also to the utilization of the full potential of the computer to promote learning. A large proportion of CAL courseware designed to-date has used the computer primarily to structure learning to ensure all users achieve the same objectives in the same way. Maddison (1983) warns against the "monolithic" approach of developing CAL based solely on the principles of programmed learning. "Of the thousands of educational computer programmes available for use on microcomputers," he says, "a substantial proportion is devoted to what are in effect not much more than revamped versions of the 1950s type of linear programmes in printed form" (pp. 39). Although the computer is capable of efficiently controlling learning in this manner, its greatest potential is yet to be fully realized -- the potential of computers to adapt to individual differences in learners.

This adaptive approach is not new. Pask (1961) foresaw this potential well before CAL was developed to its current level. He argued then that it is the teaching machines which should be adapting to the students, not the reverse. Others are now realizing the value of programming computers to adapt to students. Describing computer-based instruction (CBI), McCann (1981) suggests:

> A good CBI program takes the greatest advantage of the student's particular strengths and minimizes the effect of his weaknesses. Yet, up to the present time, no instructional methodology has been sophisticated enough to enable us at once to acquire and use enough information about the learner to provide such ideally individualized instruction (pp. 139).

Designing a computer program like this is truly arduous. However, Edmonds (1980) points out that a trend away from designing structured, computer-controlled programs is beginning. He claims that this trend "would seem to be towards a more unstructured approach, at least in the sense of giving the student freedom to 'drive' the computer" (pp. 100).

Past development, based on programmed learning techniques, is clearly falling out of favour. In its place is a turn toward unstructured design. Leith (1983) maintains that because "the promised revolution in computer-assisted learning (which was confidently predicted to take place in the 1960s) may be at hand .... it may be considered feasible to develop the variety of teaching-learning strategies required to cater for the full range of individual differences in learning" (pp. 20). Obviously, this has many implications for educational technologists. The purpose of this research is to explore these implications.

Problem Statement

Two important concerns are evident from the above discussion. First, it is clear that much needs to be done to improve the pedagogical effectiveness of microcomputer courseware. Courseware needs to be developed that emphasizes effective learning and ensures a high level of understanding in learners. Linked with this is a second concern regarding the potential for developing courseware that adapts to the lerning approach of learners utilizing the full capability of the microcomputer. It is these two concerns that prompted the author to initiate the research described in the following pages.

The purpose of this research was to design an experiment that would test microcomputer courseware that was not only pedagogically sound and adaptable to individual differences in learners, but also was able to promote a high level of understanding in learners. The method of structural communication was chosen as a likely method to accomplish this.

The literature review which follows is divided into three sections. The first section reviews the relevant literature related to levels of understanding and approaches to learning. The second reviews the literature related to the instructional method of structural communication. The final section is devoted to a literature review of computer-assisted learning (CAL), with special emphasis on microcomputer CAL.

CHAPTER TWO

LITERATURE REVIEW

Levels of Understanding and Approaches to Learning

Understanding in Education. Many definitions exist for the term understanding as it relates to the learning process. Understanding involves the internalization of knowledge in such a way that the knowledge becomes personalized -- owned by the individual. It means more than the mere knowledge of facts and the recognition of concepts. To understand one must be able to structure and extend knowledge meaningfully and thus be able to explain the relationships between new and old knowledge. Consider, for example, a comparison between word recognition and word meaning. There are many words which can be recognized when reading text -- that is, they can be pronounced correctly. However, unless the meaning of the word is understood, and unless the word can be used in written or spoken language, it is only recognizable, not understood. Understanding in learning is similar. Learners may have knowledge of a concept, for example the concept of refraction, but they do not fully understand refraction unless they can relate it to many other concepts and explain the relationships to these other concepts -- concepts like material density, fluids and solids, reflection, light energy, and so forth. Thus, understanding cannot be isolated from other related concepts. Understanding a concept also implies an understanding of the relationships among the main concepts and other related concepts within a knowledge structure.

Research in Learning and Understanding. Recognizing that improving understanding in learning is a necessary goal of educational technologists is not sufficient without a theoretical foundation and resulting methodology to justify change. Research in the learning process has produced some new understandings of the nature of human learning and perhaps is pointing the way to the development of a different kind of education system. Although there are no magic formulae for ensuring understanding in learning, as defined above, some researchers have developed approaches which may help to solve this educational problem. Although each approach considers understanding from different perspectives, there is considerable similarity in many of the descriptions.

From her research, Laurillard (in press) concluded that problem-solving tasks improve understanding. She suggests that problems should be developed to help students "weave the factual knowledge they have into their own conceptual organization -- by enabling them to elaborate the relationships between concepts and to give some structure to the information they have" (Chap. 7, pp. 1). To her, understanding is a synthetic process of constructive recombination of concepts and information, initiated by posing challenging problems for students to solve -- problems which require the student to think about the subject matter and not simply apply a 'bookwork' solution to a bookwork problem.

The Education Research Group of the Institute for the Comparative Study of History, Philosophy and the Sciences (1967), under the direction of J.G. Bennett, saw understanding as a product of communication. They suggested that communicating understanding required "a means whereby the recipient of a message can reproduce, or at least simulate, the action by which the author of the message reached his own understanding of its content" (pp. 188). By producing successive challenges to which recipients would respond to demonstrate understanding, they found that both the author and the recipient could verify their respective understandings of the content or modify these relative to the response from the recipient and the feedback from the author. This communication process need not be restricted to a verbal exchange, but could be in writing or via computer. The important aspect for communicating understanding is the requirement for creating some form of structured dialogue that "ensures unambiguous expression of the author's intention and the recipients' response " (Education Research Group, 1967, pp. 189).

From their research, Bennett and his colleagues developed a method for improving understanding in individualized or group instruction which they named structural communication. This was described by Hodgson (1975) as guided dialogue wherein "the 'pre' factors in judgement, conception and disposition are worked on and loosened up by a process of reciprocal action in which aspects of the message are explored, contradicted, negotiated and correlated between the people concerned" (pp. 139).

Later, Pask's (1976b) research on learning and understanding produced a communication-based theory called conversation theory.

Here, learning occurs through relationships of topics within a knowledge structure, where agreements on concept meaning between the participants in the learning process lead to understanding by the learner. He describes understanding as an active process where the learner must 'do' something to demonstrate understanding. "Not only must the student be able to describe the concept (which may reflect only rote or temporary learning), he must also be able to use the underlying relationships by operating on appropriate apparatus to demonstrate understanding" (pp. 14). In conversation theory also, understanding is a synthetic process that depends on the ability to reconstruct a concept by applying cognitive operations to topics which are already understood by the learner.

As a result of his work in conversation theory, Pask (1976a) found he could describe learners and the outcome of learning by identifying two mutually exclusive learning strategies (holist and serialist) and two learning styles (comprehension and operation learning).

> The holist has many goals and working topics under his aim topic; the serialist has one goal and working topic, which may be the aim topic .... Evidence suggests that the holist is assimilating information from many topics in order to learn the 'aim' topic, while the serialist moves on to another topic only when he is completely certain about the one he is currently studying (pp. 130).

Learners who are predisposed to act like holists are described as comprehension learners, and those predisposed to act like serialists are described as operation learners.

> Comprehension learners readily pick up an overall picture of the subject matter .... These individuals are able to build descriptions of topics and to describe the relation between

> topics .... Operation learners pick up rules, methods and details, but are often unaware of how or why they fit together. They have, at most, a sparse mental picture of the material and their recall of the way they originally learned is guided by arbitrary number schemes or accidental features of the presentations (ibid, pp. 133).

Although the learning strategy classifications are mutually exclusive, Pask found that the learning style classfications are not. Learners may operate as comprehension or operation learners in degrees or may adopt one or the other style depending on the kind of subject matter being learned. Because these learners were capable of demonstrating both learning styles, Pask designated them as versatile learners.

Marton and Svensson (1982) approached learning and understanding in a similar structurally-based, systemic manner. Their focus is on the ability of learners to conceptualize content by understanding inter-relationships among concepts. They suggest that there are fundamentally different ways in which this may be done. Two types of understanding or learning dichotomies are described: holistic/atomistic, described previously by Svensson (1977), and deep/surface, described previously by Marton (1974). Holistic learners organize "the content in some main parts and their relation into a structured whole", whereas atomistic learners structure content as an "aggregation of more specific parts" (Marton and Svensson, 1982, pp. 9). A learner using a surface approach "approaches the text as a set of linguistic units to be understood and remembered", or is using a deep approach if he "intends to go beyond the text and get to know what the text is about" (ibid., pp.

10).

In comparing the approaches of Svensson and Pask with his own approach, Marton (1982) describes Svensson's as an organizational approach, Pask's as a procedural approach, and Marton's as a referential approach. Svensson's holist/atomistic categories focus on how content is related by the learner, Pask's comprehension/operation categories focus on what learners do when they learn, and Marton's deep/surface categories focus on the object of attention of the learner.

Although each of the approaches to learning discussed above differs in terms of specific perspective, they all provide a framework for understanding the process of human learning which sets them apart from other approaches to learning. A common conception in all these approaches is the way that structure and organization of knowledge is viewed. Each emphasizes the need to structure and organize knowledge systemically to bring about improved understanding.

Systemic Representation of Knowledge . When behaviorist learning theory was applied to individualized instruction, programmed instruction resulted. Here, knowledge was treated as a sequential amalgamation of concepts, procedures, etc. defined by behaviorial objectives. However, to develop pedagogical methods based on the theory of learning previously discussed requires a model of knowledge which is not compartmentalized as it is in programmed instruction, but is systemic in nature.

Systems theory deals with systems and their relationships to other supra-systems or subsystems. A major premise is that no part of a system can be studied in isolation from its relationship to any other part without changing it in some way. Thus, systems analysis concerns itself not only with analyzing system components, but also with analyzing the inter-relationships among all components within and without the system. By applying systems analysis to knowledge, a different perspective of its structure and organization can result.

If knowledge is analyzed as a system, it must include concepts, procedures, rules, relations, and the like, organized in a network of inter-connecting relationships. To understand a concept or procedure entails understanding other related concepts or procedures, but not necessarily in a linear or sequential manner. This is not a new idea. Relational network (Mitchell, 1982), entailment structure (Pask, 1976), concept map (Egan, 1976), and features/ideas map (Hodgson, 1975) have been used to describe the organization of knowledge into a discrete system.

The systemic nature of knowledge has implications for controlling transmission of information and subsequent understanding. Hodgson (1968) described two different methods for doing this. He compared knowledge that can be broken down into independent linear sub-sets to knowledge that, because of its systemic properties, cannot be sub-divided without losing some essential features of its structure. Aquisition of knowledge in the first instance can be accomplished by convergent control as in "programmed learning on the linear principle of minimal learning steps and constant reinforcement" (pp. 103). Knowledge that must be transmitted as an integral whole can only be acquired through coalescent control -- control required when "principles must be grasped and the mutual relevance of groups of facts must be recognized" (ibid., pp. 104). Coalescent control does not lead to a terminal state as does convergent control; it leads to a coalescence of knowledge into a higher order of understanding. Coalescent control seeks to transform information and knowledge into understanding.

Representing knowledge as a system and using coalescent control to ensure understanding within this system have obvious implications for the design of instruction. Instruction designed from this perspective must take into account not only individual differences, but also the presentation and control of knowledge as a system to develop a high level of understanding in learners.

Implications for Instructional Design. In a homogenous class, a conscientious teacher can ensure comprehension or deep learning. However, classes are seldom homogenous, and teachers, no matter how conscientious, are seldom able to devote enough time and energy to ensure all students learn at a deep level. More often, a classroom consists of a group of students whose approaches to learning and whose abilities to understand are quite different. Some will be able to understand a given topic easily, while others may find it extremely difficult. Individualized instruction has been, and continues to be, an appropriate alternative. However, designing a lesson that ensures understanding of subject matter (deep or steps and constant reinforcement" (pp. 103). Knowledge that must be transmitted as an integral whole can only be acquired through coalescent control -- control required when "principles must be grasped and the mutual relevance of groups of facts must be recognized" (ibid., pp. 104). Coalescent control does not lead to a terminal state as does convergent control; it leads to a coalescence of knowledge into a higher order of understanding. Coalescent control seeks to transform information and knowledge into understanding.

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Individualized instruction, as implied previously, is not new to education. At one time, it was a novel approach. For many years, instructional designers have been developing materials for use by individual learners. The majority of this material has been designed according to the behaviorist principles established for programmed instruction. Critics of this method have suggested that this notion of individualized instruction is precarious. To be individualized, instruction must take account not only of the rate at which students learn, but also of the way students learn. Egan (1976) maintains that "typical linear programs make little allowance for individual differences and styles of learning, and branching programs allow only slightly more" (pp. 9).

The challenge with which educational technologists are faced is to develop a method of delivering individualized instruction that ensures understanding of subject matter. Obviously, knowledge aquisition, a prerequisite to understanding, cannot be ignored. However, to ensure understanding, the method must allow for individual differences in learners, must give them an opportunity to interact with the program, and must engage them in a kind of thinking which goes beyond the traditional linear or branching approach of behavioral programmed learning. Structural communication, introduced earlier, is a method with the potential to do this.

Structural Communication

Definition . The development of structural communication by J.G. Bennett and his colleagues was inspired by the failure of current linear or branching programming methods to ensure understanding. The central objectives of structural communication as the Education Research Group (1967) saw them were threefold: to evoke understanding, but to convey facts as a by-product of understanding; to teach students to think and judge independently; and to teach students to look for the broader relevance of what they are taught.

"Programmed instruction in all its forms is based on the principle that learning by small or large steps is a carefully designed sequence with frequent verification and encouragement" (ibid, pp. 267). Compared to linear or branching programmed instruction, which is a conditioning process, structural communication is a deconditioning process. Egan (1974) has the following extensive description for structural communication:

> Structural communication individualizes learning; controls the students' progress through the program; faces him with challenges to which he must compose responses; and provides reinforcing or corrective feedback on the responses. But it does much else besides: it engages the student in high-level synthetic thinking while he learns; it engages him in learning by simulating at an appropriate level the activity of scholars, rather than simply drip feeding him the results of scholars' work; it allows the student considerable freedom in composing responses to the challenges -- typically over a million possible responses may be made to each problem; it individualizes not only in the trivial sense of allowing each student to work at his own pace, but also in the more important sense of permitting a variety of strategies in composing responses; it conducts a 'discussion' with the student based precisely on his particular responses to the problems; it focuses both on the relevant content and its structures to

ensure understanding and the ability to use the knowledge flexibly and creatively. (pp. 38)

The didactic component of structural communication is the study unit. Each study unit is organized into six sections: the intention, presentation, investigation, response matrix, discussion, and viewpoints.

The intention serves as an introduction to the content of the study unit. It relates the content to the curriculum and informs the student about any prerequisite knowledge required for the unit. In other words, it serves as an advance organizer.

The presentation is the section that presents information to the student. It could be prepared text, a chapter in a book, an article or group of articles, a multimedia presentation, a laboratory experiment, or a real experience such as a field trip.

The investigation, response matrix, and discussion sections form the heart of a structural communication study unit. It is these sections that make structural communication the unique method it is. The investigation poses challenges to the student by presenting four problems, each of which investigates a different aspect of the study unit theme.

The student responds to each of the posed problems by using the response matrix. Typically, the response matrix consists of ten to thirty items. Individual items may be facts, ideas, symbols, concepts, etc. arranged randomly in the matrix. Each item is worded so it cannot be obviously identified with any one problem area. Collectively, the items map the subject matter of the theme. The student chooses responses to each problem from the response matrix. The choices made determine which particular feedback the student is given in the discussion section. Feedback in the form of written comments initiates a dialogue with the student. The feedback is not simply reward or help comments: it comments on the items chosen by students as their response, and on the items not chosen, to lead the student to a better understanding of the theme. Based on discussion comments, students may be sent back to the investigation to make a further response, which is reacted to in the discussion section again.

The final section, the viewpoints, is intended to expand or discuss the study unit material from the author's unique perspective. It may serve to expose biases in the material or to suggest other sources of information or alternative points of view.

The pedagogical approach of challenging investigation, response, and discussion in the study unit was specifically aimed at guiding students toward a better understanding of the subject matter. The inventors of structural communication based this aspect of the method on their research that investigated the intellectual activity of learners. From this research, they developed a model of intellectual activity which, in part, forms the theoretical basis of structural communication.

<u>A Model of Intellectual Activity</u>. The Education Research Group (1967) developed this model of intellectual activity while investigating ways to encourage students to think creatively and

synthetically. The model distinguished four qualitatively distinct levels.

The four levels can be described by referring to the intellectual activity that occurs during reading. At the lowest level, automatic, the learner is below the threshold of awareness. It is characterized by reading without knowing what is read -- mechanically going through the motions. At the next level, sensitive, the learner is in a nonreflective awake condition. He can read text and be aware of its meaning. The learner operating at the third level, conscious, is in a reflective state -- able to think about what is being read. The highest level of intellectual activity, creative, is characterized by spontaneity and unexpectedness of thought. The learner discovers new insights into what is being read without any obvious stimulus from the text.

Mental operations are such that learners can move from one level to another during a learning activity. A transition, for example, from an automatic to a sensitive level of operation would be marked by the sudden realization that not only the sound of the words is taken in, but also the meaning of the words is understood. Bennett and his colleagues also found that unless learners were attentive to the learning process and unless they were consciously striving to understand at a higher level, they tended to lower their level of intellectual activity gradually. They described the Law of Mental Declension as the state where the mind tends "to operate at the minimum intensity that demands made upon it permit" (Education Research Group, 1967, pp. 233). Given this natural tendency, together with a lack of sufficient motivation or challenge, learners will function at a lower level of mental operation. Because understanding can only be accomplished at the conscious level, learners must be challenged to overcome the tendency to follow the Law of Mental Declension. Structural communication was designed to do just this.

Structural Communication Research . Since its development in 1965 by J.G. Bennett and A.M. Hodgson, structural communication has been used in a variety of educational settings and across a variety of curriculum areas. The most extensive research using structural communication was accomplished by their Education Research Group.

At the University level, structural communication was used to even out students' prerequisite knowledge as they enter their first year courses and in course lectures during their studies. Because students entering university do not have the same prerequisite knowledge and experience, structural communication was found useful "to tackle both the diagnosis of student potential and the leveling up of basic studies, in the same operation" (Education Research Group, 1967, pp. 203). As well, structural communication was used to help students digest lectures by providing follow-up material that students used to expand their understanding of the lecture or to deliver the lecture itself, where the lecture became a structural communication study unit.

At the secondary school level, structural communication was used to help special or scholarship students "develop a sense of method and direction" (ibid, pp. 204) in their studies, for tutorials and discussions; for private study and revision of students' work, for homework exercises, and for special problems in understanding where students needed to be guided carefully toward comprehending specific areas in the curriculum.

Others have demonstrated additional uses of structural communication for simulation, assessment, and discussion. Egan (1972a, 1972b, 1974) used simulation units in Social Studies and used assessment units at the University level to diagnose potential learning problems of incoming students as well as to measure the ability of students to structure knowledge. In his work at Cornell University, Egan (1972b) found that structural communication used in the development of discussion units challenged synthetic intellectual activity and gave teachers an opportunity to get students to interrelate ideas, facts, etc. systemically which they would not have been normally able to do.. Here, structural communication was used to guide and initiate discussion about a topic as opposed to the actual delivery of the subject material. Adams, Gagg and Marsden (1971) also used structural communication for promoting classroom discussion. They found it indispensable for enabling teachers to adopt a "child centred" as opposed to a "subject centred" pedagogical approach (pp. 27).

Research using structural communication for training has had equally good success at improving understanding. Using structural communication for leadership training in the U.S. Navy, Zeitlin and Goldberg (1970) reported structural communication "can be ... a 'promising' approach to stimulating students to interact with students" (pp. S9).

Similarly, writing about Hodgson and Dill's (1970a, 1970b, 1971) experiment using structural communication for computer-guided correspondence seminars for managers, Hodgson (1971) suggested "this type of approach, with a more sophisticated technology, could be a precursor of computer managed correspondence courses in a variety of teaching areas suitable for the case method approach" (pp. 88).

In experiments designed to improve training advisor skills in analysis, problem identification, and presentation of arguments, Blake (1971) found structural communication "developed sensitivity to certain specific areas of concern. There is also a limited but outstandingly important capacity for self evaluation, originality and independent judgement" (pp. 79).

At the Structural Communication Systems Ltd., Hodgson (1972) researched the use of structural communication for leadership training in the U.S. Navy, personnel management training, technolpgical systems training for management, and social education of teenagers. From this research, Hodgson concludes:

> structural communication ... appears to be a valuable heuristic aid to the design of new forms of practical exercise which sustain quality whilst not driving up the costs of production beyond a viable limit within the current economic climate (pp. 86)

The use of structural communication as a method for developing computer-assisted learning (CAL) has not been well documented. Preliminary research using the Systemaster teaching machine (Education Research Group, 1967; Hodgson, 1967; Arbon, 1967), a simple response processing device, showed great promise for future CAL development. However, Hodgson's (1968) predictions for the development of computer-based structural communication have not materialized. Either there is a lack of research or results have not been published. Whatever the reason, little documentation exists for CAL applications of structural communication. The use of structural communication as a method for designing CAL is discussed in the next section.

Computer-Assisted Learning

Computers in Education. The development of computers and computer technology is relatively new. In less than forty years, computer technology has evolved more rapidly than any other technology yet devised by man. Computers have continued to become more efficient, sophisticated, and widely available; at the same time, they have become less expensive and easier to use. Major advances in transistor technology initially and in micro-electronics technology more recently have made this possible.

Compared to the development of computers and computer technology, educational computing is in its infancy. Educational computing connotes many things. Computers have been used in education as a topic of learning: learning about computers; as an aid in instructional or learning management: computer-managed instruction (CMI) or computer-managed learning (CML); as an aid in educational administration: for timetabling, registration, reporting, etc.; or as a means of delivering instruction or promoting learning: computer-assisted instruction (CAI) or computer-assisted learning (CAL).

For the purpose of this research, the author was concerned primarily with computers as tools to promote learning or to deliver instruction. The terms CAL and CAI have been used to describe essentially the same thing. In the United States, the term CAI is commonly used; in Great Britain CAL is more common; in Canada both terms are used. However, the term CAI has an implicit focus on instruction, whereas the term CAL has an implicit focus on learning. The term CAL has been chosen over the term CAI because of the author's conceptualization of learning and instruction, even though in practice both terms represent the same thing. Learning is viewed as an outcome of instruction and instruction as an input to learning. When computers are used in the instructional/learning process, the focus should be on the outcome -- learning. Therefore, to avoid confusion, the term CAL is used throughout the following discussion. Bear in mind that the term CAI can be substituted without altering the approach.

The intention here is not to describe the development of the computer and CAL comprehensively over the past few decades. Others have done this elsewhere (cf. Suppes and Macken, 1978; Hallworth and Brebner, 1980; Hunka, 1981; Maddison, 1983). The purpose of this introduction is to establish a foundation only on which to base a discussion of CAL.

Historical Development . CAL has been used in education and training for more than thirty years. Most notable of these developments are the IBM 1500 system by Stanford University, the PLATO (Programmed Logic for Automated Teaching Operations) system by the University of Illinois, and the TICCIT (Time-shared Interactive Computer Controlled Information Television) system by the MITRE Corporation in conjunction with the University of Texas. All these systems have made lasting contributions to the development of CAL in education, however, the cost reductions as a result of the "microelectronic revolution" have made it possible in the last decade for computers and, to a lesser extent, CAL to infiltrate the educational system as a whole. The number of educational institutions purchasing microcomputers and attempting to utilize them for educational delivery is increasing rapidly.

The development of the microcomputer began with the introduction of the Altair 8800, a hobby computer kit, in January 1975. Since then, many commercially produced turnkey systems have been introduced. So rapid has this development been that within a period of less than five years many of the original systems introduced have been replaced with newer, improved models. For example, the microcomputer purchased by the author in 1981 was out-of-date only a year later when an updated model was released. Today, hundreds of thousands of microcomputers have been purchased by schools, homes, and businesses, and indications are that further expansion in the microcomputer industry is inevitable.

With this massive proliferation of the microcomputer into our society, including the educational system, the effect on instructional delivery will be far-reaching. Of particular interest is the effect these changes will have on CAL and CAL delivery systems. Before considering these influences, however, it is important to consider the variety of CAL programs that presently exist within educational settings.

Categories of CAL . The term CAL now includes a variety of delivery modes. Courseware can usually be described as one or a combination of several categories: drill and practice, tutorial, revelatory, simulation, and game. Individual categories, or a combination of them, form a CAL program. CAL programs differ in the way they are used in a learning situation. Programs designed primarily as a supplement to traditional classroom instruction are referred to as "adjunct" CAL, and programs designed to replace traditional classroom instruction are "primary" CAL (Chambers and Sprecher, 1980, pp. 332).

In addition to varieties, CAL programs vary in complexity. Programs developed using one of the common high-level programming languages (eg. BASIC, PASCAL, APL, etc.) with limited hardware requirements are usually quite simple. On the other hand, programs developed using a complex authoring language (eg. COURSEWRITER, TUTOR, PILOT, CAN, NATAL-74, etc.) can be quite complex: they often include interactive graphics, on-line authoring aids, or use of external hardware, such as videorecorders, videodiscs, and/or audiorecorders.

Unfortunately, the majority of programs presently available have been designed with little regard for their eventual use in the classroom. Regardless of the type or complexity of CAL, it is the manner in which CAL is used in a learning environment that should be the major influence on program design. Consequently, microcomputer CAL development has a long way to go to equal the sophistication of hardware development. Only then will CAL be accepted by the skeptics as a valuable instructional delivery system.

Adaptive CAL . Regrettably, little research has been done on "adaptable" CAL using microcomputers. Research, primarily in Artificial Intelligence (AI), has demonstrated some of the possibilities for adaptable CAL (cf., eg. Carbonell, 1970; Pask, 1972; Koffman & Blount, 1973), but this has been accomplished using computers with large memory capacities. The larger memory requirement for programs of this nature is no doubt a limiting factor for microcomputers. However, technological advances in hardware and the increasing availability of microcomputer AI languages (eg. LISP is now available on microcomputers) may allow for development of adaptable microcomputer CAL in the near future. As Sleeman and Brown (1982) suggest, the advent of inexpensive microcomputers will provide ample opportunity for development of CAL within the field of Intelligent Tutoring Systems (ITS).

Given the opportunity, instructional designers of CAL courseware should adopt program designs which, although not specifically in the realm of ITS, adapt to individual differences in learners. Complex systems such as those mentioned in AI may not be possible at this time; however, instructional methods do exist that closely approximate an adaptable approach. Structural communication, described earlier, is one method which may improve the current inadequateness of microcomputer courseware to adapt to individual differences in learners.

Structural Communication as Adaptive CAL. In a previous section, the use of structural communication as a method for improving understanding by challenging learners to understand at a higher level, thus enabling them to gain more from the subject matter under study was discussed. In the introductory discussion, the author emphasized the paucity of microcomputer courseware that takes account of individual differences in learners -- that is, adopts an adaptable approach to CAL design. Combining the instructional method of structural communication with an adaptable CAL design may provide a new approach for the development of microcomputer courseware. This has not been accomplished in the past. A review of the literature supports this claim: structural communication has not been used as a basis for the design of CAL courseware.

As well, the potential for using structural communication to adapt to individual differences in learners has not been investigated. Baccanale (1981) did attempt to demonstrate the effectiveness of structural communication with holist and serialist learners. She found structural communication to be more effective for improving understanding than not using structural communication. However, she was unable to find enough serialists in her student population to determine if there is a difference between the understanding achieved by holist learners and the understanding achieved by serialist learners. Since previous research has demonstrated that holist learners should understand at a higher level than serialist learners and that structural communication is a method for improving understanding, this suggests that structural communication may be a method that adapts to serialist learners, enabling them to reach as high a level of understanding as holist learners.

Conclusion

Two major concerns were outlined in the introduction to this discussion. The first suggested that too often educators emphasize knowledge aquisition over understanding of subject matter. The second suggested that current microcomputer courseware is severely lacking in terms of educational quality and/or specific curriculum coverage. In the discussion of these concerns, I have attempted to review the related research in search of a means for improving this situation.

Four significant points have imerged from this discussion. First, research into classification of learning approach suggests that the level of understanding is affected by the learner's approach to learning. Second, structural communication seems to be a good method for improving understanding. Third, it is clear that the potential of microcomputers to adapt to individual differences in learners has not been developed to the extent that it could be. Finally, evidence seems to indicate structural communication could be a useful method for designing adaptive microcomputer CAL.

The first three of these points are supported by research. The final point was the focus for designing the research described in this paper. This research was designed to investigate the potential value of structural communication used as a design method for adaptive CAL. The main objective was to utilize structural communication as a method for CAL design with the intent that this would assist in the development of microcomputer courseware that adapts to the learning approaches of learners by ensuring achievement of a high level of understanding independent of learning approach.

CHAPTER THREE

METHOD

Research Questions

The purpose of the experimental study was to investigate the use of structural communication as an instructional method for designing adaptable microcomputer CAL. Based on previous research on learning and on the lack of specific research utilizing structural communication as a design method for CAL, the following questions were posed:

1. Will learners using structural communication have an improved level of understanding compared to learners not using structural communication?
2. Does learning approach affect the level of understanding of learners who do not use structural communication? How will this compare to learners who use structural communication?
3. Is structural communication a method that adapts to the learning approach of learners, enabling achievement of an equally high level of understanding independent of learning approach?
4. Will CAL, using structural communication as a design method, be more effective than non-CAL structural communication?

Sample

The sample consisted of 79 subjects enrolled in Management 340 at Concordia University in Montreal, Quebec. Subjects were English speaking males and females enrolled in a Bachelor of Commerce degree program. Subjects participated in the study as part of their regular classwork in Management 340.

Design

Two experimental variables were arranged in a 2 X 3 factorial design. The first variable, learning approach, consisted of (1) deep approach and (2) surface approach. The second variable, delivery mode, consisted of (1) print study unit with computer-assisted structural communication discussion, (2) print study unit with print structural communication discussion, and (3) print study unit with no structural communication discussion. Dependent variables measured were coherence index, number of response trials, and the time taken to complete the study unit.

Instrumentation

Learning approach was assessed using the Wertheimer questionnaire (Entwistle, 1981). This questionnaire classifies learners as deep approach or surface approach learners. Two independent markers assessed each completed questionnaire, rating each subject as deep approach or surface approach. Of the 79 questionnaires assessed by the markers, 4 were found to be debatable assessments by the two markers. For these 4 subjects, the author determined the ratings.

Level of understanding was assessed by the structural communication study unit. Each response trial was evaluated using a coherence index based on the index originally used by Hodgson and Dill (1970a, 1970b, 1971). This coherence index was based on specific responses made within the response matrix of the structural communication study unit. Individual items in the response matrix were assigned values related to the significance of those items to the problem. The sum, expressed as a percentage, of all values in the response matrix for any one response trial determined the coherence index. The coherence index values described by Hodgson and Dill (1970b) "fall in a range of +100 to -100, where 100 represents what the authors consider to be total coherence or logic in the items selected, 50 is a reasonably good score, 0 indicates some confusion in understanding the problem, and -100 represents total failure to comprehend or 'see through' the problem" (pp. 109).

Statement of Hypotheses

The experimental design was created in an effort to answer the research questions posed earlier. The following hypotheses were predicted from this design:

1. The mean coherence index score for subjects using structural communication will be greater than the mean coherence index score for subjects not using structural communication.
2. For subjects using structural communication, there will be no difference in the mean coherence index score for subjects classified as deep approach learners compared to subjects classified as surface approach learners.
3. The mean coherence index score for subjects classified as deep approach learners will be greater than the mean coherence index score for subjects classified as surface approach learners for those subjects not using structural communication.

4. The mean number of response trials for subjects classified as deep approach learners will be less than the mean number of response trials for subjects classified as surface approach learners.
5. The mean coherence index score for subjects using CAL structural communication will be greater than either the mean coherence index score for subjects using print structural communication or the mean coherence index score for subjects not using structural communication.
6. The mean time for completion for subjects using CAL structural communication will be less than the mean time for completion for subjects using print structural communication.

Materials

Three structural communication study units were developed for the study: a print version with print structural communication discussion, a computer version with interactive CAL structural communication discussion, and a print version with no structural communication discussion.

The print version (see Appendix A) was adapted from a unit designed by Hodgson and Dill (1970a, 1970b, 1971). It was re-designed to include six sections of a structural communication study unit -- the intention, presentation, investigation, response matrix, discussion, and viewpoints.

The CAL structural ocmmunication study unit consisted of all the print sections of the print study unit except for the discussion. Subjects in the CAL group entered responses at the computer terminal. The CAL program analyzed each response trial, generated appropriate comments for subjects to read, and gave subjects feedback regarding the coherence index score achieved. Subjects were then given the option of entering an additional response trial or of continuing with the next problem.

The print version with no structural communication discussion consisted of all the print sections of the print study unit except for the discussion. In addition, a different version of the intention was written which did not contain any reference to the use of structural communication as an instructional method (see Appendix A).

CHAPTER 4

PROCEDURES

Administering the Wertheimer Questionnaire

Approximately one month prior to running the study, the Wertheimer questionnaire (Appendix B) was administered to all subjects. Due to constraints on available classtime, it was impossible to administer the questionnaire in class. The questionnaire was assigned as a homework assignment. Subjects were given the questionnaire at the end of their Wednesday class and were required to submit it at their next class period the following Monday. Subjects were told not to look at the questions until they had read the Wertheimer article and not to refer back to the article once they had begun to answer the questionnaire.

Sampling Procedures

Subjects were assigned to treatment groups by cluster random sampling. Class schedules made it impossible to use non-intact groups; however, the assignment of students to class sections was assumed to be random. This was supported by the fact that all three sections were taught by the same professor and all classes were offered in the afternoon on the same days; the first class beginning at 1:15 PM, the second class at 2:45 PM, and the final class at 4:15 PM.

Administering the Study

Once subjects were assigned to treatment groups, the experiment was run during normal classtimes on the same day for the control group and the print structural communication group. Due to the limited number of computer terminals available, the computer group was divided into two smaller groups. The first group completed the CAL program during the class period before their normal classtime while the second group completed the CAL program during regular classtime.

The intention, presentation, and investigation sections of the study units were distributed to all subjects five days before the study was run. In addition, each subject was given written instructions describing how the study unit would be used and how to respond to each of the five problems (see Appendix A). Subjects were directed to read these materials and come prepared to respond to the problems in class.

The remaining sections of the study unit were distributed at the beginning of the class on the day the experiment was run. Before the experiment began, the researcher verbally reviewed the instructions for completing the study unit, described the use of the coherence index for evaluating responses, then asked if there were any questions. When all questions were answered, each group was told it had as much time as needed to complete the unit. The groups were then asked to begin. The starting time was recorded for the control group and the print structural communication group. The computer program kept track of the time for the CAL group. As each subject completed the unit, the time of completion was recorded on the response form. Each subject was given an opinion questionnaire to complete when they submitted their response form (see Appendix C). Subjects in the computer group were given an opinion questionnaire when they completed the program.

CHAPTER 5

RESULTS AND DISCUSSION

Analysis of variance was chosen to test the six hypotheses of the study. For all analyses, the independent variables were learning approach (deep versus surface) and delivery mode (print study unit with print structural communication discussion, print study unit with CAL structural communication discussion, and print study unit with no structural communication discussion).

Hypothesis 1

To test the first hypothesis, five analyses of variance were conducted using the coherence index score as the dependent variable. Since problems 2 through 5 were the only problems designed to have interactive structural communication discussion for the print and computer groups and this hypothesis was concerned only with the effect of structural communication on coherence index value, only the analyses using the coherence index scores for these problems were considered to be relevant for this hypothesis. Each group responded to problem 1 in the same way -- both were allowed to make one response trial only and received no interactive discussion based on their responses.

Table 1 through Table 4 show the results of the individual analyses of variance for problems 2, 3, 4, and 5, respectively. Table 5 shows the analysis of variance using the mean of the coherence index scores for problems 2 through 5 as the dependent variable.

The results of the analyses of variance for problems 3, 4 and 5 showed no significant difference for delivery mode, learning approach or interaction. For problem 2, however, there was a significant main effect for delivery mode (F (2,78) = 4.18, p = .019). The results of a subsequent Scheffe test are summarized in Table 6. An examination of the means in Table 6 indicates a significant difference in favour of the computer group over the control group, but no significant difference between the computer group and the print group or the print group and the control group. These results partially confirm hypothesis 1. Subjects using CAL structural communication achieved a higher coherence index score on average than subjects not using structural communication. Although subjects using print structural communication achieved a higher coherence index score than subjects not using structural communication as well, the difference was not large enough to be significant.

The analysis of variance using the mean of the coherence index scores for problems 2 through 5 are summarized in Table 5. These results indicate a significant main effect for delivery mode (F (2,78) = 3.44, p = .037). Table 7 shows the results of the Scheffe test conducted using the delivery mode means. A significant difference in favour of the computer group over the control group is indicated, but no significant difference was found between the computer group and the print group or the print group and the control group. Although these results lend support to confirming

Table 1

Analysis of Variance

Coherence Index Score -- Problem 2

Source	SS	df	MS	F	p
MAIN EFFECTS	5496.389	3	1832.130	4.08	.010
Mode	3753.834	2	1876.917	4.18	.019
Approach	2041.785	1	2041.785	4.54	.036
2-WAY INTERACTION	218.049	2	109.025	.24	.785
Mode X Approach	218.049	2	109.025	.24	.785
EXPLAINED	5714.438	5	1142.888	2.54	.035
RESIDUAL	32813.739	73	449.503		
TOTAL	38528.177	78	493.951		

$N = 79$

Table 2

Analysis of Variance

Coherence Index Score -- Problem 3

Source	SS	df	MS	F	p
MAIN EFFECTS	239.961	3	79.987	.18	.918
Mode	215.236	2	107.618	.23	.799
Approach	17.084	1	17.084	.04	.851
2-WAY INTERACTION	2262.985	2	1131.493	2.36	.101
Mode X Approach	2262.985	2	1131.493	2.36	.101
EXPLAINED	2502.947	5	500.589	1.05	.398
RESIDUAL	34947.484	73	478.733		
TOTAL	37450.430	78	480.134		

N = 79

Table 3

Analysis of Variance

Coherence Index Score -- Problem 4

Source	SS	df	MS	*F*	*p*
MAIN EFFECTS	1763.724	3	587.908	1.38	.256
Mode	1468.262	2	734.131	1.72	.186
Approach	329.650	1	329.650	.77	.382
2-WAY INTERACTION	1822.592	2	911.296	2.14	.125
Mode X Approach	1822.592	2	911.296	2.14	.125
EXPLAINED	3586.317	5	717.263	1.68	.150
RESIDUAL	31133.683	73	426.489		
TOTAL	34720.000	78	445.128		

N = 79

Table 4

Analysis of Variance

Coherence Index Score -- Problem 5

Source	SS	df	MS	F	p
MAIN EFFECTS	2241.119	3	747.040	1.12	.346
Mode	2237.563	2	1118.782	1.68	.193
Approach	.608	1	.608	.00	.976
2-WAY INTERACTION	514.165	2	257.082	.39	.681
Mode X Approach	514.165	2	257.082	.39	.681
EXPLAINED	2755.284	5	551.057	.83	.534
RESIDUAL	48592.083	73	665.645		
TOTAL	51347.367	78	658.300		

N = 79

Table 5

Analysis of Variance

Mean of Coherence Index Scores

for Problems 2, 3, 4 and 5

Source	SS	df	MS	F	p
MAIN EFFECTS	1390.226	3	463.409	2.61	.058
Mode	1220.740	2	610.370	3.44	.037
Approach	224.917	1	224.917	1.28	.264
2-WAY INTERACTION	768.535	2	384.268	2.16	.122
Mode X Approach	768.535	2	384.268	2.16	.122
EXPLAINED	2158.762	5	431.752	2.43	.043
RESIDUAL	12960.169	73	177.537		
TOTAL	15118.930	78	193.832		

N = 79

Table 6

Scheffe Test of the Mean Coherence Index

Scores by Delivery Mode -- Problem 2

	GROUP		
	Control	Print	Computer
MEANS	22.48	31.56	38.78
		9.08	16.30*
			7.22

*Significant at the .05 level, critical s' = 14.63

Table 7

Scheffe Test of the Mean of

Coherence Index Scores for

Problems 2, 3, 4 and 5

	GROUP		
	Control	Print	Computer
MEANS	28.37	31.82	37.70
		3.45	9.33*
			5.88

*Significant at the .05 level, critical s' = 9.19

hypothesis 1 also, the nonsignificant difference between the print group and the control group was not expected. Subjects using CAL structural communication achieved a higher coherence index score on average than subjects not using structural communication; however, subjects using print structural communication did not achieve a significantly higher coherence index score on average than subjects not using structural communication. Two possibilities exist for explaining this nonsignificant difference. First, subjects using print structural communication may have been negatively influenced by the format of the print material. To read discussion comments, subjects first had to determine from the discussion guide which lettered comments were appropriate for the responses they made, then they had to turn to the page containing the comments and read them. After subjects read the appropriate comments, they could choose to make, or not to make, another response trial based on the comments they read. The physical inconvenience of flipping pages may have reduced the desire to make another response to improve their score. A second explanation could be due to the small average number of response trials made by the print group (see Table 11). Since the print group made only an average of 1.75 response trials compared to 1 response trial per problem for the control group, this may not have been enough to improve the scores of subjects in this group significantly. Although subjects in the computer group did not make any more response trials on average (1.37 trials) than those in the print group or in the control group, they did have the advantage of receiving feedback regarding the value of their coherence index for each trial. This feedback may have given subjects in the computer group an added advantage for determing the most appropriate time to make another response to improve their score. Their decision to make another response could have been based on not only the discussion comments, but also on the knowledge of the coherence index value.

Hypothesis 2

Tables 1, 2, 3, and 4 summarize the results of the analyses of variance for problems 2, 3, 4, and 5, respectively, using the coherence index value attained for each problem as the dependent variable. Table 5 summarizes the results of the analysis of variance using the mean of the coherence index values for problems 2, 3, 4, and 5 as the dependent variable. No significant difference in coherence index score between subjects classified as deep approach learners and subjects classified as surface approach learners is indicated for problems 3, 4, and 5 or for the mean of the coherence index values for problems 2, 3, 4, and 5. However, a significant main effect ($\underline{F}(1,78) = 4.54$, $\underline{p} = .036$) in favour of subjects classified as deep approach learners is indicated for problem 2.

The results for problems 3, 4, and 5, and the overall mean coherence index support the hypothesis that using structural communication negates any influence learning approach may have on achievement of a high level of understanding. The results for problem 2, however, do not support this hypothesis. As problem 2 was the first problem in the study unit to utilize structural communication discussion, this significant difference may have been due to the fact that subjects were not yet familiar enough with the structural communication process and thus the influence of learning approach had more effect than any effect structural communication would have had.

Hypothesis 3

As mentioned in the discussion for the first hypothesis, all the structural communication study units were designed in such a way as to have only structural communication discussion for problems 2, 3, 4, and 5. For all groups, subjects could make a single response trial for problem 1 only, and they received no discussion comments related specifically to the responses. However, subjects in the print group and the computer group were able to read a general discussion of problem 1 after they made their single response trial.

The results of the analysis of variance for problem 1 outlined in Table 8 indicate a significant main effect for learning approach ($F(1,78) = 4.33$, $p = .041$) in favour of the deep approach. These results support the third hypothesis. Subjects not using structural communication and classified as deep approach learners achieved a higher mean coherence index score than subjects not using structural communication and classified as surface approach learners. Table 9 shows the means and standard deviations of the coherence index scores for each problem by group and learning approach.

Hypothesis 4

The results of the analysis of variance using the mean number

Table 8

Analysis of Variance

Coherence Index Score -- Problem 1

Source	SS	df	MS	F	p
MAIN EFFECTS	2488.762	3	829.587	2.02	.118
Mode	783.068	2	391.534	.95	.390
Approach	1776.138	1	1776.138	4.33	.041
2-WAY INTERACTION	744.716	2	372.358	.91	.408
Mode X Approach	744.716	2	372.358	.91	.408
EXPLAINED	3233.478	5	646.696	1.58	.178
RESIDUAL	29950.269	73	410.278		
TOTAL	33183.747	78	425.433		

N = 79

Table 9

Mean Coherence Index Score by Group

Deep and Surface learning Approach

		Problem											
		1		2		3		4		5		M[a]	
Group	n	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
CAL													
Deep	10	-26.7	33.8	42.4	24.7	24.1	20.4	37.4	23.6	36.1	17.7	35.0	9.9
Surface	17	-45.2	12.3	36.7	20.0	38.4	25.3	39.5	24.1	42.7	28.1	39.3	16.4
PRINT													
Deep	11	-31.3	19.5	39.7	25.0	38.8	24.4	39.0	20.0	36.3	30.2	38.5	15.9
Surface	16	-37.6	15.8	25.9	23.3	26.5	22.3	21.3	21.7	35.3	31.9	27.3	14.9
CONTROL													
Deep	11	-40.1	19.8	28.9	18.1	28.2	16.8	32.7	17.8	30.7	20.3	30.1	9.1
Surface	14	-44.3	21.1	17.4	15.8	29.6	18.9	36.4	14.2	24.5	18.8	27.0	9.2

Note. Maximum score = 100, Minimum score = -100.

[a]Scores in this column are the means of the coherence index scores for problems 2, 3, 4, and 5.

Table 10

Analysis of Variance

Mean Number of Response Trials

Source	SS	df	MS	F	p
MAIN EFFECTS	7.334	3	2.445	15.41	.001
Mode	7.281	2	3.641	22.96	.001
Approach	.026	1	.026	.17	.686
2-WAY INTERACTION	.820	2	.410	2.59	.082
Mode X Approach	.820	2	.410	2.59	.082
EXPLAINED	8.154	5	1.631	10.29	.001
RESIDUAL	11.575	73	.159		
TOTAL	19.729	78	.253		

N = 79

Table 11

Scheffe Test of the Mean Number of Response Trials by Group

	GROUP		
	Control	Print	Computer
MEANS	1.00	1.75	1.37
		.75*	.37*
			.38*

*Significant at the .01 level, critical s' = .32

of response trials for problems 2 through 5 as the dependent measure are summarized in Table 10. No significant difference for main effect of learning approach was indicated; however, a significant main effect for delivery mode ($F(2,78) = 22.96$, $p = .001$) was found. Although the Scheffe test indicated a significant difference among all three groups (see Table 11), the mean number of response trials for all groups was too low to draw any conclusions.

Hypothesis 5

The results of the analysis of variance using the mean of the coherence index values for problems 2 through 5 as the dipendent measure summarized in Table 5 indicate a significant main effect for delivery mode ($F(2,78) = 3.44$, $p = .037$). A subsequent Scheffe test (see Table 7) showed the computer group ($M = 37.7$) as superior in terms of mean coherence index score to the control group ($M = 28.4$), but not superior to the print group ($M = 31.8$). These results support the contention that subjects using CAL structural communication achieve a higher level of understanding than subjects not using structural communication, however, they do not support using CAL structural communication over print structural communication.

Hypothesis 6

Table 12 outlines the results of the analysis of variance using the time for completion as the dependent measure. A significant main effect was found for delivery mode ($F(2,78) = 99.54$, $p = .001$). The Scheffe test results summarized in Table

Table 12

Analysis of Variance

Mean Time for Completion

Source	SS	df	MS	F	p
MAIN EFFECTS	10150.965	3	3383.655	66.51	.001
Mode	10128.079	2	5064.040	99.54	.001
Approach	4.087	1	4.087	.08	.778
2-WAY INTERACTION	34.222	2	17.111	.34	.715
Mode X Approach	34,222	2	17.111	.34	.715
EXPLAINED	10185.187	5	2037.037	40.04	.001
RESIDUAL	3713.902	73	50.875		
TOTAL	13899.089	78	178.193		

N = 79

Table 13

Scheffe Test of the Mean Time

for Completion by Group

	GROUP		
	Control	Print	Computer
MEANS	22.08	50.04	36.85
		27.96*	14.77*
			13.19*

*Significant at the .01 level, critical s' = 5.76

13 indicate a significant difference among all three groups. The control group completed the study unit in the least time ($\underline{M}$ = 22.1 minutes), the computer group in the second least time ($\underline{M}$ = 36.9 minutes), and the print group in the longest time ($\underline{M}$ = 50.0 minutes). Although the control group completed the study unit more quickly than the computer group, the mean coherence index scores were lower than for the computer group. These results support the sixth hypothesis. The mean time for completion for subjects using CAL structural communication is less than the mean time for completion for subjects using print structural communication.

CHAPTER 6

GENERAL DISCUSSION

The primary purpose for conducting the research outlined in this paper was to determine the effect of structural communication as a design method for CAL. As well, previous research demonstrating that learning approach affects the level of understanding achieved by learners prompted the author to determine whether structural communication used as a design method for developing CAL would produce CAL material that adapts to the learning approach of learners. These questions, and the specific questions posed earlier in this paper, are partially answered by the results outlined in the previous chapter.

The use of structural communication as a design method for developing effective CAL is supported by this research. Subjects using CAL structural communication achieved a higher level of understanding than subjects not using structural communication. Unfortunately, the results of this research do not support the use of print structural communication over not using structural communication. These results are surprising compared to previous research results demonstrating the usefulness of print structural communication. A possible explanation for this may be found in the format of the print study unit and in the length of time spent on completing this unit. Although the mean time for completion of the print study unit was 50.04 minutes and although all subjects finished the unit before the end of classtime, subjects may have felt they were pressed for time and thus were reluctant to make additional response trials. If this study unit is used for future investigations, it would be advisable either to reduce the number of problems to which subjects respond or to have ample time available so subjects would not feel pressured.

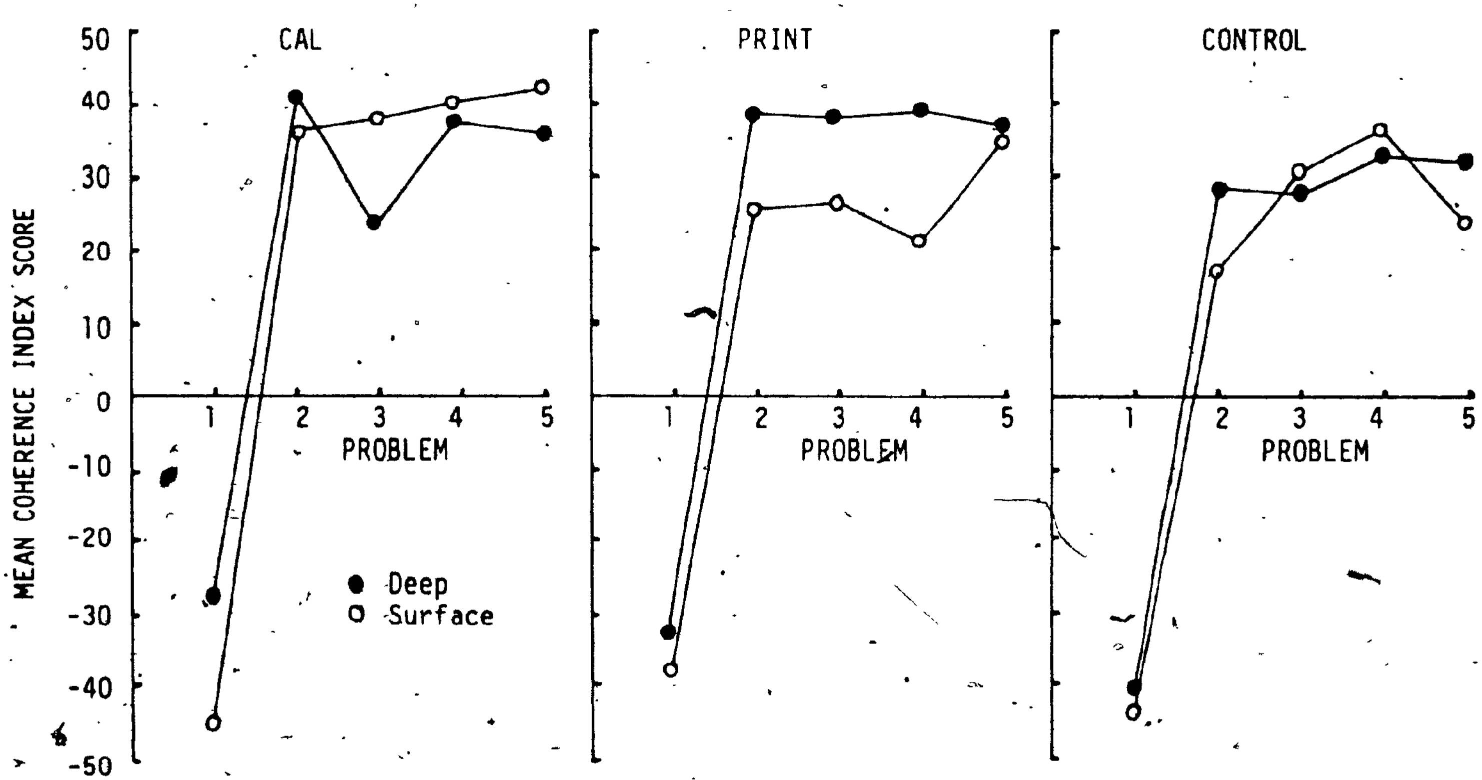
Previous research on the effects of learning approach on achievement is also supported by the findings of this research. Learners classified as deep approach learners achieved a higher level of understanding than learners classified as surface approach lerners. As suspected, the content of this structural communication study unit was more easily understood by learners classified as deep approach. However, the results are not as clear cut as they may at first appear. Although a significant difference was found between learners classified as deep approach and learners classified as surface approach in terms of level of understanding achieved on problem 1, there seems to be more variation than would be expected within the control group. Figure 1 illustrates graphically the coherence index scores by group and learning approach.

The influence of CAL structural communication for adapting to the learning approach of learners is also supported by this research. Subjects achieved equally high levels of understanding independent of learning approach However, the author had predicted that this equality of level of understanding would be due to a difference in the number of response trials made by subjects classified as

Figure 1

Mean Coherence Index Scores by Group

Deep and Surface Learning Approach



deep approach compared to subjects classified as surface approach. Unfortunately, too few response trials were made by either learning approach group to determine if the number of response trials is a significant factor. However, the number of response trials may still be a factor in determining the adaptability of structural communication to learning approach.

Although no significant difference was found for subjects classified as surface approach compared to subjects classified as deep approach, a larger number of response trials may have shown a difference. Encouraging subjects to make more response trials might be accomplished by increasing the difficulty of the content. If subjects did not perform well on a first trial, this might motivate them to make additional trials. Alternatively, the CAL program could include a "present high score" like many arcade games. The challenge of beating a high score might motivate learners to make additional response trials to increase their score. Further research to determine the relationship between number of response trials and learning approach in terms of the level of understanding achieved is justified.

Previous research on the effectiveness of CAL versus other non-CAL delivery modes has had mixed results in terms of the efficiency of learning. The research reported here adds support in favour of using CAL as a delivery mode. Learners using CAL structural communication achieved a higher level of understanding than learners who did not use CAL structural communication. As well, CAL structural communication was found to be more efficient in terms of the time required to reach this high level of understanding. The use of CAL structural communication should enable learners to achieve a high level of understanding independent of learning approach in less time than when using other methods.

Conclusion

The implications of this research for future developments of CAL microcomputer courseware are important. Currently available courseware has been criticized for its poor pedagogical quality and for its emphasis on learning of trivial information. Little microcomputer courseware exists that attempts to ensure deep understanding -- understanding that requires more than the mere knowledge of isolated facts or pieces of information. Instructional designers who use structural communication as a method for CAL can produce courseware that emphasizes not only the isolated facts and concepts, but also the interrelationships of these facts and concepts by ensuring understanding of the underlying knowledge structure.

Because the research presented here is somewhat innovative, further research is prescribed before structural communication can be fully evaluated as a method for CAL design. The results reported in this study justify further investigation. For educational technologists in the field of CAL design, there are numerous possibilities for advancing the use of structural communication as a CAL design method. The depth of feedback dialogue possible with computers is limited only by memory capacity, the imagination of educational technologists, and the limitations of the computer languages used to write the programs. Employing artificial intelligence languages when designing CAL structural communication study units could create 'human-like' dialogue personalized to individual learners and, perhaps, could permit highly interactive reciprocal dialogue where learners could debate as well as respond to discussion generated by computer programs. Perhaps future CAL developments utilizing structural communication will produce effective courseware that closely simulates the dialogue between instructor and learner and that truly adapts to the individual differences of learners.

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APPENDIX A

I

THE DASHMAN CASE

Intention

INTENTION

Since it was first written by George F.F. Lombard of the Harvard Business School in 1947, the Dashman case has been studied by thousands of university students and practicing managers to develop a deepened perception of some vital aspects of organizational administration. Although written more than thirty years ago, this classic case remains extremely relevant to management in today's organizations. Few managers or professionals have not faced a problem like that of Mr. Post's in the Dashman Company.

In this study unit, the Dashman case is presented in a new format designed to enable you to gain a high level of understanding of some of the problems faced by practicing managers in real-life situations. You will be asked to record what you consider to be the factors involved in five serious problems inherent in the situation, including questions of goal setting, organization, and communication within the company. Once you have recorded your response, you will be able to read some commentary in the form of discussion based specifically on the responses you have made.

The problems were designed with the intention of encouraging you to think about the circumstances of the case and give you suggestions on other aspects which you may not have previously considered. The technique employed here to do this is structural communication.

Structural communication used to analyse a case study in this manner:

1. produces a dialogue that takes into consideration individual differences of viewpoint;

2. draws attention constantly to aspects that have been overlooked or inadequately considered;

3. permits a variety of acceptable solutions demonstrating the realistic interrelationship of factors in the situation;

4. enables you to review your responses and make additional responses, as you gain more insight into the case by reading the commentary on each response; and

5. offers guidance in terms of coherence and consistency, rather than in terms of correctness or incorrectness.

Presentation

THE CASE

The Dashman Company was a large corporation making many types of equipment for the armed forces of the United States. It had over 20 plants, located in the central part of the country, whose purchasing procedures had never been completely coordinated. In fact, the head office of the company had encouraged each of the plant managers to operate with his staff as a separate independent unit in most matters.

Late in 1940, when it began to appear that the company would face increasing difficulty in securing certain essential raw materials, Mr. Manson, the company's president, appointed an experienced purchasing executive, Mr. Post, as vice president in charge of purchasing, a position especially created for him.

Mr. Manson gave Mr. Post wide latitude in organizing his job, and he assigned Mr. Larson as Mr. Post's assistant. Mr. Larson had served the company in a variety of capacities for many years and knew most of the plant executives personally. Mr. Post's appointment was announced through the formal channels usual in the company, including a notice in the house organ published by the company.

One of Mr. Post's first decisions was to begin immediately to centralize the company's purchasing procedure. As a first step he decided that he would require each of the executives who handled purchasing in the individual plants to clear with the head office all purchase contracts in excess of $10,000.

He felt that if the head office was to do any coordinating in a way that would be helpful to each plant and to the company as a whole, he must be notified that the contracts were being prepared at least a week before they were to be signed.

He talked his proposal over with Mr. Manson, who presented it to his board of directors. They approved the plan.

While the company made purchases throughout the year, the beginning of its peak buying season was only three weeks away at the time this new plan was adopted. Mr. Post prepared a letter to be sent to the 20 purchasing executives of the company. The letter read as follows:

Dear ______ :

The board of directors of our company has recently authorized a change in our purchasing procedures. Hereafter, each of our purchasing executives in the several plants of the company will notify the vice president in charge of purchasing of all contracts in excess of $10,000 which they are negotiating at least a week in advance of the date on which they are to be signed.

I am sure that you will understand that this step is necessary to coordinate the purchasing requirements of the company in these times when we are facing increasing difficulties in securing essential supplies.

This procedure should give us in the central office the information we need to see that each plant secures the optimum supply of materials. In this way the interests of each plant and of the company as a whole will be best served.

Yours very truly,"

Mr. Post showed the letter to Mr. Larson and invited his comments. Mr. Larson thought the letter an excellent one, but suggested that, since Mr. Post had not met more than a few of the purchasing executive, he might like to visit all of them and take the matter up with each of them personally.

Mr. Post dismissed the idea at once because, as he said, he had so many things to do at the head office that he could not get away for a trip. Consequently, he had the letters sent out over his signature.

During the two following weeks replies came in from all except a few plants. Although a few executives wrote at greater length, the following reply was typical:

Dear Mr. Post:

Your recent communication in regard to notifying the head office a week in advance of our intention to sign contracts has been received. This suggestion seems a most practical one. We want to assure you that you can count on our cooperation.

Yours very truly,

During the next six weeks the head office received no notices from any plant that contracts were being negotiated. Executives in other departments who made frequent trips to the plants reported that the plants were busy, and the season's usual routines were being followed.

Investigation

Problem 1: It has been stated that coordination is itself a function needing special attention -- at administrative levels as well as at the policy-making level. The organizational design of a company should include adequate means for coordinating decisions at a high executive level.

Which combination of factors (on the matrix) shows a confusion in the company in the understanding of organizational design?

Problem 2: Studies have shown that in distinct types of equally successful businesses, different management styles have been dominant. The style that is effective in one situation may be disastrous in another situation. Perhaps another type of manager should have been recruited instead of Post.

Which combination of factors (on the grid) should influence a personnel decision of this sort?

Problem 3: In a recent study Peter Drucker pointed out that information can be conveyed only after a situation has been established that is based on the perception of the receiver of the communication. "If," he wrote, "communication fits in with the aspirations, the values, the purposes of the recipient, it is powerful. If it goes against his aspirations, his values, his motivations, it is likely not to be received at all, or best, to be resisted."

We can view this case as a communication problem. Which combination of factors indicates the source of the breakdown?

Problem 4: It has been observed that for an organization to work effectively, change must be perceived by each member as increasing, rather than restricting, his scope and maintaining his sense of personal worth and importance.

We can consider this case as a problem of human relations centering around the actions of the new vice president. Which combination of factors indicates the human behavioral problem?

Probelm 5: Planning for orderly change requires a participative development of objectives for the functional units of the organization and consideration of the relation between short- and long-term goals.

Lack of such planning leads to management by crisis, in which the organization struggles with immediately perceived difficulties and managers tend to protect their own domains rather than defer to the interests of the organization.

Which combination of factors reflects a primary orientation at the Dashman Company toward short-term goals?

Response matrix

1 The fact that the suggestion of personal meetings with purchasing directors was not taken up	2 The type of appointments made by the president	3 The fact that the Dashman Company has 20 centrally located plants	4 The decision to centralize purchasing
5 The encouragement of independence given by the head office	6 The relevance of the previous experience of the new vice president	7 The latitude given to the new vice president by the president	8 The assistant's personal knowledge of the purchasing executives
9 The board of directors' forecast of increasing difficulty in purchasing	10 The letter issuing a directive on purchasing procedures	11 The fact that a few purchasing executives did not reply	12 The president getting the board's approval for the scheme
13 News of the appointment of the new vice president disseminated only formally	14 The inability of the new vice president to leave the head office	15 The imminence of the annual peak purchasing period	16 The fact that purchasing procedures had never been completely coordinated
17 The notification only of orders greater than $10,000 a week in advance	18 The fact that the new vice president signed the letter	19 The typical letter of response from the purchasing executives	20 The selection of a new vice president from outside the organization
21 The assignment by the president of the vice president's assistant	22 The attitude of the new vice president to the purchasing executives	23 The assistant's appraisal of the vice president's plan and letter	24 The submission of the vice president's plan to the president

Discussion

DISCUSSION OF PROBLEM 1

Compare your response with the following discussion:

It is questionable whether the president, Manson, had considered carefully the problem of bringing a high-ranking executive into the organization (ITEMS 2 and 13).

Creation of this position would be expected to cause difficulties in any event, whether the new executive was an insider or an outsider (ITEM 20), and whether or not he had "local" support (ITEM 21), since corporate headquarters had encouraged independence and thus did not support the kind of decision flow -- from the periphery to the center -- which centralization of purchasing implied (ITEM 7).

The complex of policies and actions necessary to maintain a largely decentralized organization makes it hard to centralize a function like purchasing on an exception-reporting basis.

The president seems to have assumed that merely establishing a purchasing executive at headquarters would be sufficient to supply coordination between functions. Obviously, it was not. Although there was coordination in approving the decision to centralize purchasing, there was not good coordination in carrying it out (ITEMS 10 and 17) in the face of the relative autonomy of the plants (ITEM 5).

Only Manson could be expected to supply executive coordination over all functions, and it can be argued that the letter setting up the plan should have been sent over his signature (ITEM 18).

The submission of the plan to the directors may have seemed unnecessary, but Manson quite rightly may have wanted them to see that a practical step had been taken to head off the purchasing problem (ITEM 12).

Is it possible that the plant purchasing managers were not aware of any anticipated problems in finding materials (ITEM 3)? Is there evidence in the case that they had already experienced difficulty? Perhaps the board of directors, Manson, and Post were remiss in not laying the groundwork to make sure that the plant executives shared their perception of the purchasing problem (ITEMS 5 and 9).

It can also be argued that Larson should have made clearer to Post the organization's rhythm of purchasing peaks and slack periods. The peak purchasing period was an inopportune moment to introduce changes in Dashman's organizational structure (ITEMS 15 and 11).

On the other hand, it can be argued that Post was not the "experienced" purchasing executive he appeared to be to the president (ITEM 6). Post appeared to be lacking the experience that would have enabled him to handle the shift in organizational structure (ITEMS 4 and 17).

Factors that appear to us to be secondary aspects of the organizational problem are items 1, 8, 19, and 22. They may be more related to the psychological factors at play in the company.

DISCUSSION GUIDE FOR PROBLEMS 2, 3, 4, AND 5

PROBLEM 2

I	3 or more of 4, 7, 9, 15 and 16	A
O	2 or more of 4, 7, 9, 15 and 16	B
I	1 or both of 6 and 20	C
O	2 or more of 3, 5, 7, and 16	D
O	1 or both of 22 and 24	E
I	item 8	F

PROBLEM 3

I	1 or both of 3 and 16	G
O	2 or more of 5, 9, 18, and 20	H
O	3 or more of 5, 10, 11, 13, and 19	I
I	both 4 and 6	J
I	1 or both of 14 and 15	K

PROBLEM 4

I	3 or more of 2, 7, 11, 12, 18, 19, and 24	AND	O	2 or more of 1, 10, 14, and 22	L
O	5 or more of 2, 7, 11, 12, 18, 19, and 24	AND	O	2 or more of 1, 10, 14, and 22	M
O	2 or more of 1, 8, 20, and 23				N
O	2 or more of 4, 5, 11, and 19				O
I	3 or more of 2, 13, 7, and 20				P
I	item 6				Q

PROBLEM 5

O	1 or both of 4 and 9	R
I	1 or more of 6, 8, 10, and 22	S
O	2 or more of 11, 15, 20 and	T
O	2 or more of 1, 2, 7, and 14	U
I	item 3	V
O	item 13	W
I	1 or both of 12 and 24	X

about the way the new man will operate or how the people consulted will fare under the new organization setup.

On the other hand, in this case the risk of such commitments seems low if, by consultation, the president could have obtained a better idea of what the new executive would be up against.

G. We believe that the scale and degree of coordination are secondary factors relating to communication problems. If you included the number of plants and the absence of full coordination in purchasing procedures because you considered them to be primary communication difficulties, we suggest you consider the question: "Were communications between Manson and Post, and Post and Larson, a more serious source of difficulty?"

H. Taken together, several factors indicate a problem typical in trying to communicate a change. Generally, such communication is difficult when (a) it is unclear as to what it involves; (b) it comes from a source which the intended audience cannot trust; (c) the audience does not perceive the need or reason for change; or (d) the audience has no opportunity to influence that change. In light of these remarks, reconsider the relationship between Post in his position and the state of the company.

I. It is important to distinguish between one-way and two-way communication and the situation in which each can be effective. Where change is involved, one-way communication is inadequate because it does not permit participation. With managers who have been encouraged to be independent, only two-way communication can succeed. Each message between Post and the purchasing executives has both an explicit and an implicit meaning. The conflict or gap between explicit and implicit meaning becomes clear only when there is dialogue between the parties. We suggest that you please reconsider your views.

J. Post's experience and the top-level decision to centralize can give him formal authority, but they cannot ensure effective authority. Even in situations where there is more agreement on goals than there was at the Dashman Company between Post and the purchasing executives, effective authority or influence rests on a combination of forceful personal involvement on the part of the leader and of trust and acceptance on the part of the followers. In his short time with Dashman, Post had not been able to establish either a strong personal image or a relationship of confidence and trust.

K. It can be argued that this was not a time to try such an important change. The 20 plant purchasing heads had to give priority to getting through the peak buying period. Post may have been insensitive about the timing of the step to centralize, or perhaps Manson gave him too short a time in which to get things moving.

L. You appear to be placing considerable emphasis on the reaction of the purchasing executives to the vice president's directive -- even to the point of assuming that they are the ones chiefly at fault for not recognizing the need to change and the value of getting an experienced man like Post at Dashman. We do not agree with this interpretation -- but that does not render it invalid. We ask you, however, to reconsider your response in the light of this comment and to seek the sources of the behavioral problem elsewhere.

M. You seem to be overlooking some of the most important sources of the human relations problem. Post has somehow failed to get the response he expected. At the same time, he had assurances that the response he expected would be forthcoming. Did he really understand what he was doing?

N. Perhaps you have not considered the behavior of the assistant, Larson. Why, when he knew the company and the people involved in the centralization of purchasing, did he not warn Post of the problems of putting the plan into operation? Why did he not persuade Post that his priorities were wrong? Could it have been reluctance to see Post succeed in a role that perhaps he had wanted for himself? Post was, after all, an outsider.

O. It may not be immediately apparent that in proposing his plan in the manner and circumstances that he did, Post ignored prime motivating influences in the company for both purchasing executives and plant managers. These influences stem from the autonomy each plant had, giving scope to individual achievement and growth. As trends in the management of conglomerates and profit centers in other large corporations show, the value of providing motivation locally for achievement and growth often outweighs possible economies in centralizing functions like purchasing.

P. Another reasonable point of view is that the introduction from above of any high-ranking executive creates human relations problems, and that in the Dashman case those problems were tackled very ineptly by the president.

Q. It may be interesting to question the degree of Post's expertise. Did it show in his decision to centralize or in his communications? Did he demonstrate any experience in the management of change? Would experience in that regard be more important than knowledge of the purchasing function brought from other organizations?

R. Considerations of how have been uppermost in the discussion so far. It is also important, however, not to overlook the what for. The board of directors forecast difficulty; the president had to do something about it. Clearly some form of centralization was necessary, so he appointed a man to accomplish it quickly.

S. Some features of your response are not necessarily important from a short-range point of view. The psychological make-up of the parties involved, for example, is a factor in the situation whatever perspective is used to view it.

T. An outsider, coming in at a time when plant management is under pressure to perform familiar, routine tasks, is in a poor position to impose a review of priorities or a change in policy. Post's failure to recognize the impact of the peak purchasing period not only hurt his chances to accomplish this change, but has made future communication with the plant purchasing executives more difficult.

U. That Post did not take up Larson's suggestion of personal meetings may appear strange, but we are not told the whole story of how much time was involved or how many other tasks were assigned to Post. His "involvement" at the head office may have been an excuse, as noted in Problem 2; but he may have been under pressure to do work that kept him from traveling. Of course, one can still question the sense of priorities that led Post to ignore Larson's advice.

V. Taken together with Post's involvement at headquarters, the fact that the Dashman Company had 20 purchasing executives would make meetings very difficult. However, the costs in staging a group meeting might have been returned many times over it it had solved the differences in orientation and priorities between Post and the plant purchasing ment.

W. Means of introduction, other than formal, can be both expensive and time consuming. The company house organ may have been a useful enough medium for doing this job.

X. You have included long-term features that seem to have had much attention from persons in the case. Be sure to consider the distinct characteristics of short-term and long-term goals.

Viewpoints

VIEWPOINTS

You have now had a chance to explore the Dashman case from five different standpoints: organizational communication, interpersonal behavior, organization structure, short-term vs. long-term pressures, and personnel recruitment.

Post's predicament, so apparently simple at first glance, encapsulates many important problems that we face each day as mangers or members of organizations. The lessons that can be drawn apply not only to business, but to involvement in community organizations and even to interactions within one's family.

Whether or not we have ever sent or received a memorandum on the approval of purchase orders, we all know what it is like to be new members of organizations or to have someone new imposed on us. We have all been in situations either where our assumed power to communicate and direct was not matched by the response we received or where we acted to ignore messages or directives that seemed to us inappropriate.

Managers who have discussed the Dashman case over the years have drawn many interpretations and lessons from it. Some have defended Post and argued that the top officers of Dashman should have done more to endorse and back his directives. Others have treated the problem as one growing out of Post's failure to understand the kind of purchasing practices required at the company and have suggested that it was a mistake to hire him for the job.

But most often the discussion has centered around a theme that we want now to develop in a more general way: i.e., that while structure, size, tradition, available communication media, and sometimes even employee expectations favor one-way transmission of information, guidelines, and instructions, effective management requires two-way communication.

Interactive dialogue among members of organizations often is hard to arrange, especially beyond the confines of small work teams; and, as the Dashman case shows, it is often rejected as a strategy because it is expensive in time and energy for those who get involved.

Discussion of the Dashman case hints at many ways in which a better dialogue among the parties involved would have helped to ensure that Post was the best man for the job, provide for his early integration into the organization, and speed constructive changes in purchasing practice.

II

INTENTION

Since it was first written by George F.F. Lombard of the Harvard Business School in 1947, the Dashman case has been studied by thousands of university students and practicing managers to develop a deepened perception of some vital aspects of organizational administration. Although written more than thirty years ago, this classic case remains extremely relevant to management in today's organizations. Few managers or professionals have not faced a problem like that of Mr. Post's in the Dashman Company.

In this study unit, the Dashman case is presented in a new format designed to enable you to gain a high level of understanding of some of the problems faced by practicing managers in real-life situations. You will be asked to record what you consider to be the factors involved in five serious problems inherent in the situation, including questions of goal setting, organization, and communication within the company.

The problems were designed with the intention of encouraging you to think about the circumstances of the case and to allow you to choose from a matrix of 24 different items those factors that in combination, form the key factors relevant to that problem.

IIIa

Instructions for Completing This Unit

This study unit consists of six sections: the INTENTION, PRESENTATION, INVESTIGATION, RESPONSE MATRIX, DISCUSSION, and VIEWPOINTS. To complete the unit, follow the directions below.

(Note !! use the enclosed flowchart as a quick reference while you read the instructions).

1. READ the INTENTION -- this will introduce you to the study unit and explain the method of structural communication.

2. READ the PRESENTATION -- this contains the actual material in the form of a case study for the study unit.

3. READ the INVESTIGATION -- this section poses five problems related to the case you have read in the PRESENTATION. Each problem is constructed so that a combination of 24 elements or events of the case may be relevant to that problem.

4. From the RESPONSE MATRIX select the combination of factors which you think are most relevant to the problem and mark your choices on the RESPONSE FORM.

5. Once you have selected a combination of factors and have recorded them on the RESPONSE FORM, turn to the DISCUSSION and READ the appropriate comments that relate specifically to the choices of factors you have made from the RESPONSE MATRIX.

   The discussion for PROBLEM 1 is given as a warm-up to introduce you to the method as it discusses PROBLEM 1 in general terms. The remaining discussion for the other problems introduces a series of inclusion and omission tests. Here is how it works:

   Suppose you have selected items 3,4,8,11,17,19,20, and 24 as relevant items to one of the problems. To make a particular point about an aspect of that problem -- where we anticipate that you may misunderstand or disagree with our interpretation -- you will be instructed to READ a particular lettered comment as follows:

   I | 2 or more of 2, 5, 8, 13, and 17 | **A**

   This can be interpreted to mean "If you have included 2 or more of the items 2,5,8,13, and 17, then READ comment A". You have, so you would READ comment A. The omission test works in a similar manner.

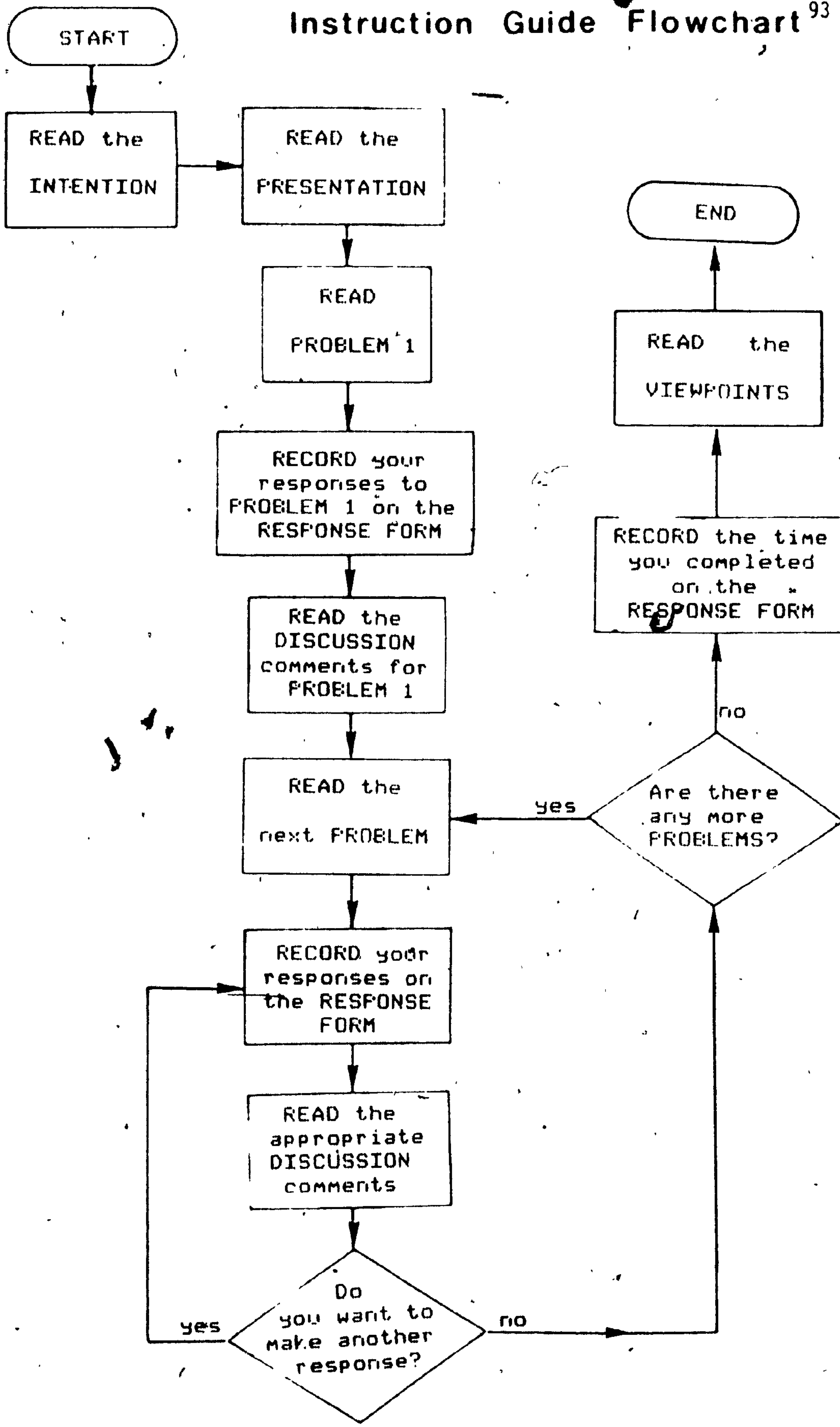
6. Once you have selected a group of items as a response and read the appropriate discussion comments, you may want to go back and make a revised response based on the comments you have received. The intent of this process is to encourage you to achieve as high a level of understanding of the problem as possible. Continue to make as few, or as many, responses as you consider necessary to reach an in-depth understanding of each problem.

7. Once you feel you understand the problem in-depth, respond to the next problem in the same way.

8. When you have completed all responses and have READ the appropriate DISCUSSION comments for every problem, record the time you completed the unit in the space provided on the RESPONSE FORM.

9. Finally, READ the VIEWPOINTS section in the booklet. This section discusses the Dashman case as a whole and gives you some more information to think about.

Instruction Guide Flowchart



Instructions for Completing This Unit

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3. READ the INVESTIGATION -- this section poses five problems related to the case you have read in the PRESENTATION. Each problem is constructed so that a combination of 24 elements or events of the case may be relevant to that problem.

4. You are now ready to begin the computer-assisted learning portion of this study unit. At the computer terminal enter your name (eg. J Doe) when asked to do so. The computer will request you to enter a selection of responses from the RESPONSE MATRIX. When you have entered all the responses you wish to make, or if you decide to change an entered response, enter a zero (0).

5. Once you have selected a combination of factors and have entered them at the computer terminal, the computer will generate appropriate comments for you to READ that relate specifically the choices of factors you have made from the RESPONSE MATRIX.

   The discussion for PROBLEM 1 is given as a warm-up to introduce you to the method. The computer will direct you to this discussion in the booklet. The remaining discussion for the other problems will be computer generated.

6. Once you have selected a group of items as a response and read the appropriate discussion comments generated by the computer, you will be allowed to go back and make a revised response based on the comments you have received. The intent of this process is to encourage you to achieve as high a level of understanding of the problem as possible. Continue to make as few, or as many, responses as you consider necessary to reach an in-depth understanding of each problem.

   To help you determine your level of understanding, the computer will assess each group of responses in terms of a COHERENCE INDEX. This index is a measure of the relevancy of your responses to the given problem from the point of view of management experts.

7. Once you feel you understand the problem in-depth, you can respond to the next problem by indicating that you do not wish to make any further responses. The computer will automatically allow you to respond to the next problem.

8. When you have completed your responses to all five problems, READ the VIEWPOINTS section in the booklet. This section discusses the Dashman case as a whole and gives you some more information to think about.

IIIc

Instructions for Completing This Unit

This study unit consists of five sections: the INTENTION, PRESENTATION, INVESTIGATION, RESPONSE MATRIX, and VIEWPOINTS. To complete the unit, follow the directions below.

1. READ the INTENTION -- this will introduce you to the learning material in thestudy unit.

2. READ the PRESENTATION -- this contains the actual material in the form of a case study for the study unit.

3. READ the INVESTIGATION -- this section poses five problems related to the case you have read in the PRESENTATION. Each problem is constructed so that a combination of 24 elements or events of the case may be relevant to that problem.

4. From the RESPONSE MATRIX select the combination of factors which you think are most relevant to the problem and mark your choices on the RESPONSE FORM.

5. Once you have selected a group of items as a response and thought about the relevancy of your responses to the problem, you may want to go back and make a revised response. The intent of this process is to encourage you to achieve as high a level of understanding of the problem as possible. Continue to make as few, or as many, responses as you consider necessary to reach an in-depth understanding of each problem.

6. Once you feel you understand the problem in-depth, respond to the next problem in a similar manner.

7. When you have completed all responses for every problem, record the time you completed the unit in the space provided on the RESPONSE FORM.

8. READ the VIEWPOINTS section in the booklet. This section discusses the Dashman case as a whole and gives you some more information to think about.

APPENDIX B

I

Max Wertheimer*: Thinking as imaginative reconstruction

What occurs when, now and then, thinking really works productively? What happens when, now and then, thinking forges ahead? What is really going on in such a process?

If we look for answers in books, we often find apparently easy ones. But confronted by actual processes of this kind — when one has just had a creative idea, however modest the issue, when one has begun really to grasp an issue, when one has enjoyed a clean, productive process of thought — those answers often seem to cover up the real problems rather than to face them squarely. The flesh and blood of what has happened seem to be lacking in those answers.

Surely in the course of your life you have been curious about a lot of things, sometimes seriously. Have you been equally serious about what this thing called thinking may be? There are, in this world of ours, eating, thunderstorms, blossoms, crystals. Various sciences deal with them; they attempt by great effort to get real understanding, to grasp what these things really are. Are we equally serious when we ask what productive thinking is?

There are fine cases. You can find them often, even in daily life. If you have had your eyes open, you have probably encountered somewhere in your life — if nowhere else, then in children — this surprising event, the birth of a genuine idea, of a productive development, the transition from a blind attitude to understanding in a productive processs. If you have not been fortunate enough to experience it yourself, you may have encountered it in others; or you may — fascinated — have glimpsed it when reading good books.

Many are of the opinion that men do not like to think; that they will do much to avoid it; that they prefer to repeat instead. But in spite of many factors that are inimical to real thinking, that suffocate it, here and there it emerges and flourishes. And often one gets the strong impression that men, even children, long for it.

What really takes place in such processes? What happens if one really thinks, and thinks productively? What may be the decisive features and the steps? How do they come about? Whence the flash, the spark? What are the conditions, the attitudes, favorable or unfavorable to such remarkable events? What is the real difference between good and bad thinking? And in connection with all these questions: how improve thinking? your thinking? thinking itself? Suppose we were to make an inventory of basic operations in thinking — how would it look? What, basically, is at hand? Could the basic operations themselves be enlarged and improved, and thus be made more productive?

For more than two thousand years some of the best brains in philosophy, in logic, in psychology, in education, have worked hard to find real answers to these questions. The history of these efforts, the brilliant ideas brought forward, the hard work done in research and in theoretical discussion, present on the whole a rich, dramatic picture. Much has been achieved. In a large number of special questions solid contributions to understanding have been made. At the same time there is something tragic in the history of these efforts. Again and again when great thinkers compared the ready answers with actual, fine thinking, they were troubled and deeply dissatisfied — they felt that what had been done had merits, but that in fact it had perhaps not touched the core of the problem at all.

The situation is still somewhat of this kind. To be sure, many books deal with these questions as if, fundamentally, everything were settled — in one way or another. For there are basically different ideas about what thinking is, each with

*Extracts taken from *Productive Thinking* published by Harper, New York in 1945 (pages 1-3, 5-11, 14-17, 45, 46, 48-50, 56-58).

serious consequences for behavior, for education. When observing a teacher we may often realize how serious the consequences of such ideas about thinking can be.

Although there are good teachers, with a natural feeling for what genuine thinking means, the situation in schools is often not good. How teachers act, how a subject matter is taught, how textbooks are written, all this is widely determined by two traditional views about the nature of thinking: the view of traditional logic and the view of association theory. These two views have their merits. To a degree they seem adequate to certain types of thought processes, to certain jobs in thinking; but it is at least an open question whether the way in which they interpret thinking does not cause serious hindrance, an actual impairment of genuine abilities. . . .

As a kind of background for the following discussions, I present first a very short characterization of the two traditional approaches. They surpass all others in the rigor and completeness with which they consider operations and establish basic concepts, standards, criteria, laws and rules. Other approaches — even if they seem at first in strong opposition to these two — often still contain as their very meat, in one way or another, precisely the operations, the rules of these two. Modern research in thinking is largely determined by one or the other, or both at the same time. I shall indicate their main lines, but shall omit some points which appear as additions of another nature and which, besides, are not clear in themselves.

Traditional logic attacked the problems in an ingenious fashion: how are we to find the main issues in the vast variety of the topics of thinking? As follows: thinking is concerned with truth. Being true or false is a quality of assertions, propositions, and only of these. The elementary form of proposition asserts or denies some predicate of a subject, in the form 'all S are P,' or 'no S is P,' or 'some are,' or 'some are not.' Propositions involve general concepts — class concepts. These are basic to all thinking. For the correctness of a proposition it is decisive that its 'intension' or 'extension' be dealt with correctly. On the basis of assertions inferences are drawn. Logic studies formal conditions under which inferences are or are not correct. Certain combinations of propositions make it possible to derive 'new', correct propositions. Such syllogisms, with their premises and their conclusions, are the crown, the very heart of traditional logic. Logic establishes the various forms of syllogism which guarantee correctness of the conclusion.

Although most of the textbook syllogisms seem barren, a kind of circle, like the classical example —

All men are mortal
Socrates is a man
therefore, Socrates is mortal—

there are examples of real discoveries which can in a first approach be regarded as syllogisms, as for example the discovery of the planet Neptune. But formally, basically, there seems to be no real difference between the two kinds of syllogism. The decisive characteristics and the rules are identical for both — the somewhat silly and the really sensible ones.

Traditional logic is concerned with the criteria that guarantee exactness, validity, consistency of general concepts, propositions, inferences and syllogisms. The main chapters of classical logic refer to these topics. To be sure, sometimes the rules of traditional logic remind one of an efficient police manual for regulating traffic.

If we disregard differences of terminology, controversies of a subtle nature, we may list as characteristic the following operations of traditional logic:

definition
comparison and discrimination
analysis
abstraction
generalization
forming class concepts
subsumption, etc.
forming propositions
forming inferences
forming syllogisms, etc.

These operations as conceived, defined, and utilized by the logician have been and are being taken by psychologists as subjects for investigation. As a result, we have many experimental investigations on abstraction, generalization, definition, drawing conclusions, etc.

Some psychologists would hold that a person is able to think, is intelligent, when he can carry out the operations of traditional logic correctly and easily. The inability to form general concepts, to abstract, to draw conclusions in syllogisms of certain formal types is viewed as a mental deficiency, which is determined and measured in experiments.

However, one may view classical logic, it had and has great merits:

- in the decisiveness of its will to truth;
- in the concentration on the basic difference between a mere assertion, a belief, and an exact judgment;
- in its emphasis on the difference between hazy concepts, hazy generalizations, and exact formulations;
- in the development of a host of formal criteria which are suited to testing for, and discovering mistakes, haziness in thinking such as unjustified generalization, jumping at conclusions;
- in its emphasis on proof;
- in the seriousness of the rules of discussion;
- in the insistence on stringency and rigor in each individual step in thinking.

The system of traditional logic, as envisaged in its main lines in the *Organon* of Aristotle, was recognized as final through the centuries; elaborations were added here and there, but these did not change its main character. A new branch started at the time of the Renaissance, a development that was essential to the growth of modern science. The central point was the introduction, as fundamental, of a procedure which until then had been regarded as of minor value because of lack of complete conclusiveness. This is the procedure of induction, with its emphasis on experience and experimentation, a methodological concept which reached its greatest perfection in John Stuart Mill's famous canon of rules of induction.

The emphasis here is not on rational deduction from general propositions but on gathering facts, on studying the empirically constant connections of facts, of changes, and on observing the consequences of changes introduced into factual situations, procedures which culminate in general assumptions. Syllogisms are viewed as tools by which one can draw consequences from such hypothetical assumptions in order to test them.

It is widely believed that inductive logic adds to the classical rules and operations the emphasis on:

empirical observations
careful gathering of facts
studying problems empirically
introducing experimental methods
correlating facts
developing crucial tests

The second great theory of thinking is centered in the classical theory of associationism. Thinking is a chain of ideas (or, in more modern terms, a chain of stimuli and responses, or a chain of behavior elements). The way to understand thinking is clear: we have to study the laws governing the succession of ideas (or, in modern terms, of behavioral items). An 'idea' in classical association theory is some remnant of perception, a copy, in more modern terms, a trace of stimulations. What is the fundamental law of the succession, of the connection of these items? Answer — very elegant in its theoretical simplicity: if two items, *a* and *b*, have often occurred together, a subsequent occurrence of *a* will call forth *b* in the subject. Basically the items are connected in the way in which my friend's telephone number is connected with his name, in which nonsense syllables become reproducible when learned in a series of such syllables, or in which a dog is conditioned to respond with salivation to a certain musical sound.

Habit, past experience, in the sense of items repeated in contiguity — inertia rather than reason, are the essential factors, just as David Hume had maintained. As compared with classical associationism, this theory is now being developed in a most intricate way; but the old idea of repetition, in contiguity, is still the central feature. A leading exponent of this approach stated explicitly not long ago that the modern theory of the conditioned reflex is essentially *of the same nature* as classical associationism.

The list of operations here looks about as follows:

association, acquiring connections — bonds on the basis of repetitions
role of frequency, of recency
recall from past experience
trial and error, with chance success
learning on the basis of repeated success
acting in line with conditioned responses, and with habit

These operations and processes are now being widely studied with highly developed methods.

Many psychologists would say: ability to think is the working of associative bonds; it can be measured by the number of associations a subject has acquired, by the ease and correctness with which he learns and recalls them.

No doubt there are merits in this approach also, with regard to the subtle features at work in this kind of learning and behaving.

Both approaches had difficulties with regard to sensible, productive processes of thinking.

Consider first traditional logic. In the course of the centuries there arose again and again a deep-felt dissatisfaction with the manner in which traditional logic handles such processes. In comparison with actual, sensible, and productive processes, the topics as well as the customary examples of traditional logic often look dull, insipid, lifeless. To be sure, the treatment is rigorous enough, yet often it seems barren, boring, empty, unproductive. If one tries to describe processes of genuine thinking in terms of formal traditional logic, the result is often unsatisfactory: one has, then, a series of correct operations, but the sense of the process and what was vital, forceful, creative in it seems somehow to have evaporated in the formulations. On the other hand it is possible to have a chain of logical operations, each perfectly correct in itself, which does not form a sensible train of thought. Indeed there are people with logical training who in certain situations produce series of correct operations which, viewed as a whole, nevertheless form something akin to a flight of ideas. Training in traditional logic is not to be disparaged: it leads to stringency and rigor in each step, it contributes to critical-mindedness; but it does not, in itself, seem to give rise to productive thinking. In short, there is the danger of being empty and senseless, though exact; and there is always the difficulty with regard to real productiveness.

Realization of the latter point — among others — led in fact to the emphatic declaration by some logicians that logic, interested in correctness and validity, has nothing at all to do with factual thinking or with questions of productivity. A reason was also given for this: logic, it was said, has timeless implications and is, therefore, in principle, divorced from questions of actual thought processes which are merely factual and, of necessity, processes in time. This separation was certainly meritorious for certain problems; from a broader view, however, such assertions often look somehow like the declaration of the fox that the grapes were sour.

Similar difficulties arose in association theory: the fact that we have to distinguish between sensible thought and senseless combinations, and the difficulty in dealing with the *productive* side of thinking.

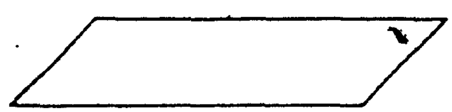
If a problem is solved by recall, by mechanical repetition of what has been drilled, by sheer chance discovery in a succession of blind trials, one would hesitate to call such a process sensible thinking; and it seems doubtful whether the piling up of such factors only, even in large numbers, can lead to an adequate picture of sensible processes.

(The distinction between productive thinking and the approaches more commonly encouraged in school work can best be illustrated by concrete examples. One such example is a problem children are often given – finding the area of a parallelogram.)

I am visiting a classroom. The teacher: 'During the last lesson we learned how to find the area of a rectangle. Do you all know it?'

The class: 'Yes.' One pupils calls out: 'The area of a rectangle is equal to the product of the two sides.' The teacher approves, then gives a number of problems with rectangles of varying sizes, which all solve readily.

'Now,' says the teacher, 'we shall go on.' He draws a parallelogram on the blackboard: 'This is called a parallelogram. A parallelogram is a plane quadrilateral the opposite sides of which are equal and parallel.'

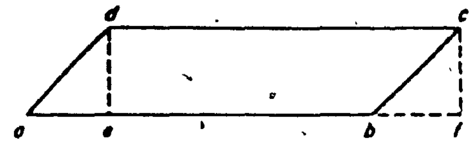


Here a pupil raises his hand: 'Please, teacher, how long are the sides?' 'Oh, the sides may be of very different lengths,' says the teacher. 'In our case one line measures 11 inches, the other 5 inches.' 'Then the area is 5 × 11 square inches.' 'No,' answers the teacher, 'That's wrong; you will now learn how to find the area of a parallelogram.' He labels the corners *a, b, c, d*.

'I drop one perpendicular from the upper left corner and another perpendicular from the upper right corner.

'I extend the base line to the right.

'I label the two new points *e* and *f*.'



With the help of this figure he then proceeds to the usual proof of the theorem that the area of a parallelogram is equal to the product of the base by the altitude, establishing the equality of certain lines and angles and the congruence of the pair of triangles. In each case he states the previously learned theorem, postulate, or axiom upon which the equality or congruence is based. Finally he concludes that it has been proved that the area of a parallelogram is equal to the base times the altitude.

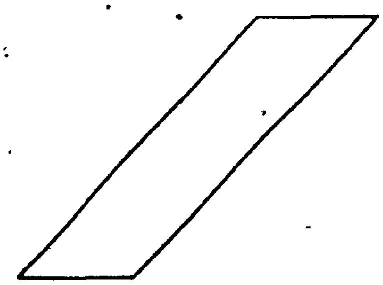
'You will find what I have shown you in your textbook on page 62. Do the lesson at home, repeat it carefully so that you will know it well.'

The teacher now gives a number of problems all of which require finding the areas of parallelograms of different sizes, sides and angles. This being a 'good' class, the problems are all correctly solved. Before the end of the hour the teacher assigns ten more problems of this kind for homework.

At the next meeting of the class, one day later, I am there again.

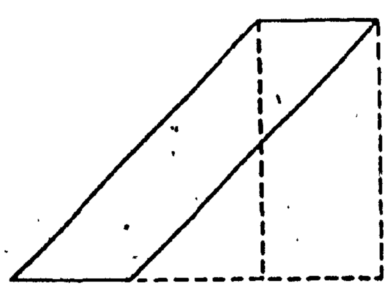
The lesson begins with the teacher calling on a pupil to demonstrate how the area of a parallelogram is found. The pupil does it exactly. One sees that he has learned the problem. The teacher whispers to me: 'And he is not the best of my pupils. Without doubt the others know it as well.' A written quiz brings good results.

Most people would say, 'This is an excellent class; the teaching goal has been reached.' But observing the class I feel uneasy, I am troubled. 'What have they learned?' I ask myself. 'Have they done any thinking at all? Have they grasped the issue? Maybe all that they have done is little more than blind repetition. To be sure, they have solved promptly the various tasks the teacher has assigned, and so they have learned something of a general character, involving some abstraction. Not only were they able to repeat word for word what the teacher said, there was easy transfer as well. But — have they grasped the issue at all? How can I clarify it? What can I *do*?'



I ask the teacher whether he will allow me to put a question to the class. 'With pleasure,' he answers, clearly proud of his class.

I go to the board and draw this figure.

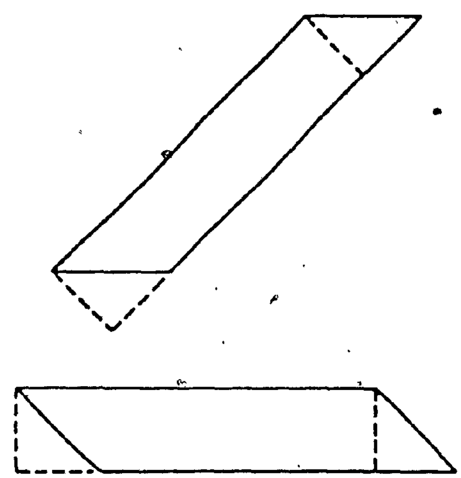


Some are obviously taken aback.

One pupil raises his hand: 'Teacher, we haven't had that yet.'

Others are busy. They have copied the figure on paper, they draw the auxiliary lines as they were taught, dropping perpendiculars from the two upper corners and extending the base line. Then they look bewildered, perplexed.

Some do not look at all unhappy; they write firmly below their drawing: 'The area is equal to the base times the altitude' — a correct subsumption, but perhaps an entirely blind one. When asked whether they can show it to be true in this case, they too become perplexed.



With still others it is entirely different. Their faces brighten, they smile and draw the following lines in the figure, or they turn their papers through 45°, and do it.

The teacher, observing that only a minority of the pupils has mastered the problem, says to me with some indignation: 'You certainly gave them a queer figure. Naturally they are unable to deal with it.'

Now just between us, haven't you too been thinking: 'No wonder so many failed when he gave them a figure so unfamiliar!' But is it less familiar than the variations of the original figure which the teacher previously gave and which they solved? The teacher did give problems in which the figures varied greatly with regard to length of sides, size of angles, and size of areas. These were decided variations, and they did not appear at all difficult for the pupils. Did you notice, perchance, that my parallelogram is simply the teacher's original figure turned around? With regard to all the part-qualities it was not more but less different from the original figure than the teacher's variations. . . .

Now I shall tell what happened when I put the problem of the area of the *parallelogram* to subjects, especially children, after having briefly shown how the area of the rectangle is found, saying nothing further, giving no help, simply waiting for what they would say or do. There were grown ups of all types, students who showed by their reactions that they had entirely forgotten this theorem, and children who had never heard of geometry, even children as young as five.

There are different types of reactions.

First type. No reaction at all.

Or someone says, "Whew! mathematics!" and dismisses the problem with, "I don't like mathematics."

Some subjects simply wait politely for what is to come or ask, 'What else?'

Others say, 'I don't know; that is something I have not learned.' Or, 'I learned that in school but I have completely forgotten it,' and that is all. Some show indignation: 'How do you expect me to be able to do that?' To which I reply, 'Why not try it?'

Second type. Others search their memory intensively, some even frantically, to see if they can recall anything that might be of help. They search blindly for some scraps of knowledge that might apply.

Some ask, 'Could I ask my older brother? He surely knows.' Or: 'Could I look for it in a geometry book?' Which is certainly one way of solving problems.

Third type. Some start making speeches. They talk around the problem, telling of analogous situations. Or they classify it in some way, applying general terms, perform some subsumptions, or engage in aimless trials.

Fourth type. But in a number of cases one can observe real thinking at work — in drawings, in remarks, in thinking out loud.

'Here is this figure — how can I get at the size of the area? I see no possibility. The area just in this form?'

'Something has to be done. I have to change something, change it in a way that would lead me to see the area clearly. Something is wrong.' At this stage some children produce Figure 1. In such cases I add: 'It would be nice to be able to compare the size of the area of the parallelogram with the area of the rectangle.' The child is helpless, then starts anew.

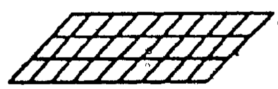
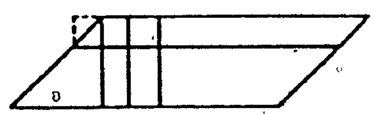


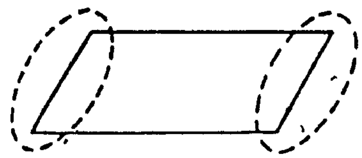
Figure 1

There were other cases in which the child said: 'I have to get rid of the trouble. This figure cannot be divided into little squares.'

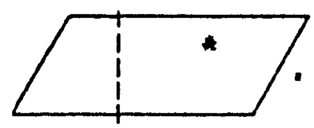


But there were cases in which the thinking went straight ahead. Some children reached the solution with little or no help in a genuine, sensible, direct way. Sometimes, after strained concentration, a face brightened at the critical moment. It is wonderful to observe the beautiful transformation from blindness to seeing the point!

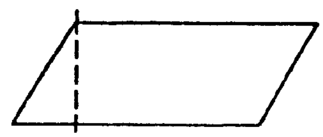
First I shall report what happened with a 5½-year-old child to whom I gave no help at all for the parallelogram. Given the parallelogram problem, after she had been shown briefly how to get at the area of the rectangle, she said, 'I certainly don't know how to do *that.*' Then after a moment of silence: 'This is *no good here,*' pointing to the region at the left end; 'and *no good here,*' pointing to the region at the right.



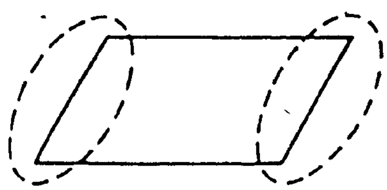
'It's troublesome, here and there.' Hesitatingly she said: 'I could make it right here. . . but . . .' Suddenly she cried out, 'May I have a scissors?' What is bad there is just what is needed here. It fits.' She took the scissors, cut vertically, and



placed the left end at the right. Another child proceeded in a similar way to cut off the triangle.



In several cases the procedure ran this way:



1.	'Disturbance'	'Disturbance also'
2.	'Too much here'	'Too much here'
3.	———————	'No! This needs over here at the right just what is too much at the left,'

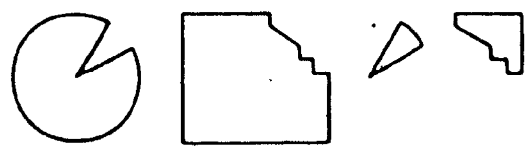
and she put the left end 'in order.' Then, looking at the other end, she tried to do the same thing there, but changed suddenly from seeing it as 'too much' to seeing it as 'gap.'

There were other ways. A child to whom I had given the parallelogram, a long one cut out of paper, remarked in the beginning, 'The whole middle part is all right, but the ends —' She continued to look at the form, clearly interested in the ends, suddenly took the paper figure, and, with a smile, made it into a ring, bringing the two ends together. Asked what this meant, she answered, holding the two ends together with her little fingers: 'Why, I can cut it now, this way' and indicated a vertical somewhere in the middle, 'Then it is all right.'...

What are the operations, the steps in the procedure?

We saw that in such genuine, positive processes as those just described, there are operations (such as) regrouping with regard to the whole, reorganization, fitting; factors of inner relatedness and of inner requirements are discovered, realized, and followed up. The steps were taken, the operations were clearly done in view of the whole figure and of the whole situation. They arose by virtue of their part-function, not by blind recall or blind trial; their content, their direction, their application grew out of the requirements of the problem. Such a process is not just a sum of several steps, not an aggregate of several operations, but the growth of one line of thinking out of the gaps in the situation, out of the structural troubles and the desire to remedy them, to straighten out what is bad, to get at the good inner relatedness. It is not a process that moves from pieces to an aggregate, from below to above, but from above to below, from the nature of the structural trouble to the concrete steps.

It is also interesting to observe the behavior of children (even of very young children) in the following situations. Four solid figures of this kind are given:



a *b* *c* *d*

Children often show a strong trend to bring them together properly, to fit *c* into *a*, *d* into *b*. If the grownup tries to do it the other way, insists on placing *d* with *a*, and *c* with *b*, or puts *c* with *a*, and *d* with *b* but improperly, children are often not only puzzled, or amused, but interfere passionately, fitting the figures into their proper positions.

In all these cases we have structural changes, tendencies toward the better structure, toward fitting, with the disappearance of disturbances.

Such changes are often dramatic in productive processes, much more so than in this modest example of the parallelogram. Indeed, the whole process is often a kind of drama with powerful dramatic forces — with tension and dramatic structural changes in the transition from an incomplete or inadequate structure to a view of the complete, consistent structure, in the transition from not having understood structurally, from being troubled, to really grasping and realizing the requirements.

The most urgent need in the experimental investigation of the problems seems to be not so much to get the quantitative answer, 'How many children achieve a solution, how many fail, at what age?' etc., but to get at an understanding of what happens in good and in bad processes.

A physicist studying crystallization may try to find out in how many cases he finds pure crystals and in how many he does not — there are crippled crystals some corners of which are jagged, there are impure crystals, there are Siamese twin crystals improperly grown together, there are even crystals shaped by artificial polishing into perfect forms entirely incongruous with their nature. All such cases are of primary interest to the physicist, not as problems of statistics but for what they reveal of the inner nature of genuine crystallization.

It is also important to find out what are the conditions under which pure crystallization may take place, what conditions favor it, what factors endanger it.

And so in psychology.

• • • • • •

II

QUESTIONNAIRE ON THE WERTHEIMER ARTICLE

DO NOT LOOK AT THIS QUESTIONNAIRE UNTIL YOU HAVE FINISHED READING THE WERTHEIMER EXTRACT

Answer the first question before turning over to look at subsequent questions.

1. **Write down what you have learned from the article. Imagine you were going to describe what the article is about to someone who had not read it. What would you say?**

2. **Specific questions**

(a) What is traditional logic mainly concerned with?

(b) To what did Wertheimer compare the rules of formal logic?

(c) What was John Stuart Mill's contribution to logic said to be?

(d) How does associationism treat thinking?

(e) On what grounds did Wertheimer's consider each of these approaches to thinking to be inadequate?

   (i) logic

   (ii) associationism

(f) What method did the teacher in Wertheimer's example use to teach children how to find the area of a parallelogram?

(g) Why did Wertheimer consider this method to be inadequate?

(h) Wertheimer uses the analogy of a physicist's interest in the growth of crystals to illustrate the research approach he recommends for studying thinking. What is that approach and how does the analogy illustrate it?

3. Students tackle the task of reading articles or books in many different ways, and with different expectations of what is required of them and of what they should be getting out of their reading. How did you tackle this article? Was this approach typical of, or different from, what you would do in your normal studying?

APPENDIX B*

Categories of Response to Questionnaire

Question 1
Examples of different levels of outcome from reading the Wertheimer article (First-year students)

A. Conclusion-orientated, detailed

The article is about the failings in traditional methods of analysing thinking, the methods of logic and association.

The article also goes on to show how lack of understanding about the thought process can have adverse effects in education, and can actually inhibit progress.

Wertheimer uses the case of a classroom situation to emphasize his point further, the fact that the children could not solve the parallelogram problem unless it was presented to them in a new way is evidence of this. Wertheimer says that in this case the wrong emphasis was being placed by the teacher i.e. the ability to get the homework problems right with no thought of whether the children really understood the theory behind it.

Children fitting shapes were then allowed to 'teach themselves' rather than being given a set formula which they would apply without thinking.

Wertheimer was showing that there was more behind the thought process than can merely be shown by performance in solving problems.

B. Conclusion-orientated, mentioning

This article was mainly about the way pupils learn. It stressed that we don't really think about what we are reading. Given a problem to solve we do not think about it but merely follow the example given so as to solve the problem. Learning in this way is repetitive — we are merely repeating what we have already been taught — we do not think about why we solve it in that way. Hence when the same problem is approached from a different angle we cannot follow the given example exactly and so are completely lost.

* From Entwistle, N. (1981). Styles of learning and teaching. John Wiley: New York.

C. Description-orientated, detailed

Wertheimer's article was on the subject of thinking. It was attempting the question — how do we think? It provided two main areas of thought. First the classical idea of a logical progression of ideas which result in a positive answer to a particular question; and second the idea of association of thoughts, various thoughts which link together to form the answer. Wertheimer spoke of the way children think, using the example of asking children to find the area of a parallelogram with an unfamiliar position and showed that they were conditioned only to find the area of a 'normal' parallelogram. He then showed that very young children were better equipped to answer this problem — having no previous knowledge of it.

D. Description-orientated, mentioning

Article about logic principally, and what makes process of thinking meaningful — analyses traditional logic. Asks rhetorical questions about the logic of thinking — what process we use in thinking out a problem.

Article goes on to cite the example of school children learning the area of rectangles and parallelograms — how feedback experiments can show that school children may merely regurgitate mathematical formulae and methods without actually understanding them.

Note

The main difference between the two extracts which showed an emphasis on *detail* is that A brought together two main points to emphasize the author's main message, while C listed the main points without integrating them effectively. B understands the author's message but does not relate it to any evidence, while D lists a series of topics. Note that C and D follow the order in which the article presents its main points indicating more reliance on sequential memorization than on personal understanding.

Question 2

(a) Traditional logic is concerned with the criteria that guarantee exactness, validity, consistency of general concepts, propositions, inferences, and syllogisms.
(b) An efficient police manual for regulating traffic.
(c) The rules of induction; the empirical approach of collecting facts, using experimental methods and testing hypotheses.
(d) Thinking is seen as a chain of ideas or of as a series of stimuli and responses.
(e) Logic is rigorous, but is also barren, boring, empty, unproductive. Associationism has failed to distinguish between sensible and senseless

combinations of ideas; it also relies on mechanical repetition and chance to solve problems.

(f) The teacher presented the traditional proof that the area of the parallelogram was equal to the product of the base by the altitude and then asked the pupils to work out examples based on the use of that formula.

(g) The pupils could not deal with unusual examples where the formula could not be applied directly. He contrasted attempts to apply the formula blindly with children who solved these examples by imaginative reconstruction of the unfamiliar into the familiar.

(h) Wertheimer urges psychologists to understand thinking through discovering the differences between good and bad instances, as a physicist compares pure crystals with various distortions to reveal the inner nature of genuine crystallization.

Note

It is very unlikely that you would be able to remember the article in sufficient detail to give full answers to question 2. These questions were designed as caricatures of the exteme factual questions found in some examination papers and which may influence a student's subsequent approach to learning. It would, however, be possible to answer most, or all, of these questions correctly without really understanding the main message the author was trying to present.

Question 3

Examples of different categories used in classifying processes of learning will be found on pages 77-78.

Approaches to learning and studying

The transcripts also provided a clear-cut distinction between students in their approaches to learning. Marton has described these differences as deep-level compared with surface-level processing (Marton and Säljö, 1976a). Some students described a *deep approach* to learning. They started with the intention of understanding the meaning of the article, questioned the author's arguments, and related them both to previous knowledge and to personal experience, and tried to determine the extent to which the author's conclusions seemed to be justified by the evidence presented. Other students seemed to rely almost exclusively on a *surface approach*. Their intent was to memorize those parts of the article which they considered to be important in view of the types of questions they anticipated afterwards. Their focus of attention was thus limited to the specific facts or pieces of disconnected information which was rote learned. These students also tended to be conscious of the conditions of the learning experiment and to be anxious about them.

In later experiments in Gothenburg (Fransson, 1977) and in Lancaster (Entwistle and Robinson, 1976; Entwistle *et al*, 1979a) it has been necessary to subdivide each of these approaches into two, depending on the degree of activity, attention, and involvement shown by the student. The four categories can be described as deep active; deep passive; surface active; and surface passive Typical of the *deep active* approach was the folowing comment of a Lancaster student.

> 'I read more slowly than usual, knowing I'd have to answer questions, but I didn't speculate on what sort of questions they'd be. I was looking for the argument and whatever points were used to illustrate it I could not avoid relating the article to other things I'd read, past experience, and associations, etc. My feelings about the issues raised made me hope he would present a more convincing argument than he did, so that I could formulate and adapt my ideas more closely, according to the reaction I felt to his argument '

Another student with a deep active approach said:

> 'Whilst reading the article, I took great care in trying to understand what the author was getting at, looking out for arguments, and facts which backed up the arguments I found myself continually relating the article to personal experience, and thus facilitated any understanding of it . The fact of being asked questions on it afterwards made my attention more intense.'

In contrast the next extract shows an example of a *deep passive* approach.

> 'I read it in a casual interested manner, not being influenced by the fact that I was to be questioned, mainly because I didn't expect the questionnaire to ask for any details of the article. Consequently, I read with impartial interest — extracting the underlying meaning but letting facts and examples go unheeded.'

The *surface active* approach can be illustrated by two more students from Lancaster.

> 'In reading the article I was looking out mainly for facts and examples. I read the article more carefully than I usually would, taking notes, knowing that I was to answer questions about it. I thought the questions would be about the facts in the article . . . This did influence the way I read; I tried to memorize names and figures quoted, etc.'
>
> 'I tried hard to concentrate — too hard — therefore my attention seemed to be on "concentration" rather than on reading, thinking, interpreting and remembering, something I find happening all the time I'm reading text-books.'

An interesting point about these two students is that both of them recognized that their approach had been rather ineffective. Later on in the questionnaire the first of these students added, when asked to comment on the adequacy of his answers.

> 'I feel that some of my answers are vague and need more detail I made the mistake of trying to retain everything, rather than just the important features'

Finally, the *surface passive* approach was described by Fransson (1977) from his transcripts.

> '*Interviewer.* If I have understood what you have said you were not thinking of what the text was about.. , but of memorizing the details,
> *Student:* Yes, I did.
> *Interviewer:* Would you like to tell me something about how you read? Did you read it as you read a newspaper, as you read a good book, or as you read course material?
> *Student:* In the beginning I read very carefully, but after that I hurried through it. I lost interest, I didn't think about what I was reading.' (page 249).

APPENDIX C

Opinion Questionnaire

OPINION QUESTIONNAIRE

CLASS/SECTION __________

FOR EACH OF THE FOLLOWING STATEMENTS, CIRCLE THE NUMBER THAT BEST DESCRIBES YOUR OPINION OF THE STATEMENT.

1 Strongly Agree   2 Agree   3 Neutral   4 Disagree   5 Strongly Disagree

OPINIONS ABOUT THIS CASE STUDY

1. The preliminary readings for this unit were easy to understand.	1 2 3 4 5
2. The instructions for this unit were easy to follow.	1 2 3 4 5
3. The method used to discuss the Dashman case helped me to understand the 5 problems very well.	1 2 3 4 5
4. The discussion comments helped to focus my thoughts on the items I was choosing.	1 2 3 4 5
5. I made additional responses to the problems so I could improve my understanding of each problem.	1 2 3 4 5
6. If I had known the coherence index value after each response trial, it would have motivated me to improve my score.	1 2 3 4 5
7. Knowing the coherence index value after each response trial motivated me to try to improve my score on the next trial.	1 2 3 4 5
8. I was always trying to do my best with each response trial I made.	1 2 3 4 5
9. The Dashman case was a realistic case -- one which I could encounter in a real job situation.	1 2 3 4 5
10. The INTENTION section was a good introduction to the study unit.	1 2 3 4 5
11. The VIEWPOINTS was a good summary of the case.	1 2 3 4 5
12. The VIEWPOINTS helped to focus my thoughts on what the major problem was.	1 2 3 4 5
13. I agreed with the discussion comments I read after I responded to a problem.	1 2 3 4 5

OPINIONS ABOUT THIS COURSE

14. Using debates in class has made the course more interesting. 1 2 3 4 5

15. Using debates is a good way to help me learn the material better. 1 2 3 4 5

16. The time required for debates is worthwhile. 1 2 3 4 5

CIRCLE Y for YES or N for NO for each of the following questions.

17. Have you ever studied the Dashman case prior to doing this study unit? Y N

18. Would you like to do more study units like this one in Management 340? Y N

19. Would you recommend using the approach of this study unit in other classes you take? Y N

20. Rank the following teaching methodologies by placing a "1" beside the most useful in this course, a "2" beside the next to the most useful in this course, etc.

___	lectures	___	%
___	group exercises	___	%
___	short cases	___	%
___	film|video	___	%
___	class discussion	___	%
		TOTAL	100%

21. In the space to the right of each methodology above, indicate the percentage of class time you would like to see allocated to that method.

PLEASE ADD ANY ADDITIONAL COMMENTS YOU WISH TO MAKE:

____

____

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____

____

OPINIONS ABOUT THIS COURSE

14. Using debates in class has made the course more interesting. 1 2 3 4 5

15. Using debates is a good way to help me learn the material better. 1 2 3 4 5

16. The time required for debates is worthwhile. 1 2 3 4 5

CIRCLE Y for YES or N for NO for each of the following questions.

17. Have you ever studied the Dashman case prior to doing this study unit? Y N

18. Would you like to do more study units like this one in Management 340? Y N

19. Would you recommend using the approach of this study unit in other classes you take? Y N

20. Rank the following teaching methodologies by placing a "1" beside the most useful in this course, a "2" beside the next to the most useful in this course, etc.

___	lectures	___	%
___	group exercises	___	%
___	short cases	___	%
___	film|video	___	%
___	class discussion	___	%
		TOTAL	100%

21. In the space to the right of each methodology above, indicate the percentage of class time you would like to see allocated to that method.

PLEASE ADD ANY ADDITIONAL COMMENTS YOU WISH TO MAKE:

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