A STUDY TO EXAMINE THE EFFECTS ON COGNITIVE LEARNING AND ATTITUDE OF TWO EXTREME ILLUSTRATION PRODUCTION COSTS IN A SLIDE-TAPE PROGRAM

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This is to certify that the

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ABSTRACT

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By

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There are increasing signs that the financial crisis for the support of education will continue. Financial aid especially for support services in higher education, appears to be in jeopardy. While funds are becoming more difficult to obtain there is increasing evidence that the use of illustrated instructional materials in education is becoming increasingly popular. With decreasing revenue and increased demand there is a need to examine the relationship between production costs and benefits of illustrated instructional material.

This study was designed to gather information on the effects of illustration production costs on learning and attitude. An expensive and an inexpensive version of a slide-tape program on canine heartworm disease was prepared; the former by a professional medical illustrator, and the latter by an amateur illustrator. The cost of executing the illustrations for the expensive version of the program was $2486.75, while the illustrations for the inexpensive version of the program cost $135.20.

An audiotape was prepared from a script to accompany both versions of the slide tape program. Since the visuals in the inexpensive version of the program were dramatically different in appearance from the corresponding visuals in the expensive slide-tape program, it was hypothesized that cognitive learning and attitude toward the program would be significantly different.

Three sample groups were selected from second term veterinary students to act as subjects. Since the majority of the subjects had some prior exposure to canine heartworm disease, a control group was established. The control group wrote the cognitive test without exposure to either program. The experimental groups viewed either the expensive or the inexpensive version of the program in separate rooms. The short-term cognitive performance test was collected from all three groups. The two experimental groups also completed an attitudinal instrument and a general information questionnaire.

Statistical analysis revealed no significant differences between the two experimental groups on either cognitive performance or attitudinal response towards the program. A significant difference was detected between the control group and the experimental groups on cognitive performance. The experimental group viewing the expensive version of the program tended to make slightly more positive comments in praise of the program although major differences were not readily apparent in the analysis of the general information questionnaire.

Implications included for the designers and producers of illustrated materials are that time should be spent in clearly portraying specified concepts, but not in simulating reality. The implication for administrators is that much valuable time and materials are being wasted in the realistic portrayal of visual material. The talents of gifted illustrators should be directed toward increased interpretation and simplification of complex concepts.

Suggestions for future research include the additional study of the effects of illustration production procedures and styles on learning efficiency and cost. A recommendation was also made that minimum acceptance levels of illustration criteria of instructors and production personnel be investigated.

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CHAPTER I

INTRODUCTION

Purpose of the Study

The purpose of this study was to determine the cognitive and attitudinal effects of exposing students in higher education to either an expensive or an inexpensive version of a slide-tape program.

An expensive version of a slide-tape program on canine heartworm disease was prepared by a medical illustrator for use by veterinary students. An inexpensive version of the same program was produced by an elementary school teacher. Only illustration costs were documented. An audiotape to complement the slides was prepared from a script and remained basically the same for both versions of the program.

Instrumentation designed to gather information about the effects of the expensive and inexpensive versions of the program included a researcher designed short-term cognitive instrument, a semantic differential to measure attitude, and an information sheet designed to gather general information.

Two treatment groups and a control group were selected from the second term of a 12 term veterinary program. The experimental groups each viewed one version of the program separately while a control group completed the cognitive instrument without exposure to either program. Information collected and compared included the

cognitive scores of all three treatment groups, along with the attitudinal and general information data collected from the two experimental groups.

The study specifically tested the following hypotheses:

1. All three treatment groups will have similar cognitive test performance scores.
2. The two experimental groups will have similar cognitive test performance scores.
3. The cognitive test performance scores of the experimental group exposed to the expensive version of the program and the control group will be similar.
4. Group membership does not significantly affect attitude toward the slide-tape presentation.

The Nature of the Problem

Many educators have accepted the fact that there is a place in the classroom for various forms of media and related programs which teach by other than conventional lecture methods. This acceptance of instructional media in the classroom has generated a market for hardward and instructional material that, according to most researchers has usually been able to teach about as well as the classroom instructor teaching the same material. Supposedly, instructors utilizing media can become more efficient by using their specialized skills in dealing with individual problems while the machines take over the more routine job of transmitting facts. According to Wittich and Schuller (1973):

> As we think about multisensory imagery-indeed, as we think about the whole vital, stimulating, and burgeoning field of instructional technology . . . we can be sure of one thing: the imaginative, creative teacher who refuses to be

> hemmed in by today's constraints, the teacher who looks on instructional technology as the essential tool he can use to help free himself of these constraints--such a teacher and his pupils have a most exciting future ahead of them (p. 682).

While improving teaching effectiveness is considered important it is also apparent that additional efforts must be made to find instructional procedures that are more efficient. The Carnegie Commission (1972a) examining the impact of instructional technology in higher education suggested that instructional technology could increase the productivity of college and university professors. They listed the following ways that technology can help:

1. By decreasing the time required by students to learn specified modules of information.
2. By taking maximum advantage of the capabilities of available technological capacity.
3. By releasing faculty time.
4. By prolonging the time during which instruction is available.
5. By utilizing quality instructional materials produced off the campus.
6. By sharing high-quality instructional programs and learning materials with other institutions (p. 83).

The potential of technology for decreasing educational costs is largely dependent on how it is used within the instructional setting. In a study at San Jose State College reported by Cafferella (1973) the use of television as a magnification device was documented. The investigators reported that:

> . . . in a majority of the course units investigated, closed circuit television as a magnification device was found to reduce substantially (in some cases by as much as 65 percent) the time required by the instructor to present a demonstration for an entire laboratory class (p. 58).

The number of students benefiting from instruction made possible by the use of technology is another important variable in determining educational benefits in terms of cost. In another study, also reported by Cafferella (1973), Carpenter and Greenhill found that:

> The economic advantages of using television begin with classes of about 200 students and increase progressively from this point as the number of students in the TV section increases (p. 45).

While the reported number of students required by the television to compete financially with conventional instruction varies; there is consensus that beyond a certain figure television can reduce educational costs. It follows that the larger the number of students the larger the potential savings can be.

The potential effects of technology increasing classroom productivity while stimulating classroom instruction, have apparently had little effect on reducing instructional costs which have continued to escalate at alarming rates. In attempting to describe the effects of technology Rogers and Hirsch (1971) claim that:

> Whatever set of educational assumptions is adopted the increase in inputs has been greater than the increase in output . . . productivity has steadily declined (p. 131).

Although our potential to transmit and duplicate instructional messages electronically has increased significantly, these advances appear to have had little significant impact on educational productivity. According to Tickton (1970) this decline in productivity can be directly related to the expenditure and management of money:

> High cost and inadequate costing techniques are clearly a major cause of instructional technologies lack of impact on American schools and colleges (p. 26).

It would appear that technology has not become or, is in the initial stages of becoming, an integral part of instruction. To date the cost benefits of instructional technology seem to be negligible since it has been merely added on to the cost of traditional education instead of replacing it. This is particularly true when a teacher uses technology to assist or supplement him rather than as a replacement for at least part of the instruction.

There is a danger that the current financial crises in education will result in decreasing funds for the support of instructional technology in education. Any information or justification regarding benefits derived from current expenditures would be of assistance to administrators and school boards who have to deal with increased demands for limited budgetary funds. It would also appear that any increase in productivity or more efficient expenditure of funds would be welcomed in education where the potential of technology has not been realized.

Miller (1971) succinctly stated this current dilemma in education in the following way:

> Pressing social considerations demand that our concern for instructional technology be more than perfunctory. The rising costs per student of education and the increasing demand for it by all the people face the society with costs that are causing taxpayer revolts . . . Yet, despite its great cost and its many problems, education is almost universally recognized as a necessity, the primary fashioner of a society's future (p. 1009).

Accountability, fostered by public pressure, has resulted in a greater emphasis on evaluation and sophisticated costing procedures within the educational environment. Although the expenditure of funds is being closely documented very little effort has been made

to measure the benefits obtained as a result of the money spent. This is especially true in the production of instructional materials. Financial support to improve instruction is generally greater at higher levels of education where message design becomes increasingly more complex and individual knowledge and skills tend to be more specialized. In many schools talented individuals hired for their specific production skills, are working in teams to produce highly refined, finished products which are professional in appearance.

Many institutions of higher education have set up special marketing procedures to disseminate locally produced quality instructional materials. These marketed productions are usually of a very high technical quality and represent the effort and pride of the professional people that produced them. To some degree, these products are also designed to support the reputation of the institution that produced the material. In most cases, however, material produced for instructional purposes is used by the individual instructor within the local instructional setting and may or may not be of superior technical quality.

The employment of instructional development procedures in the production of an instructional product involves a number of steps. Analysis of the problem, the development of objectives, evaluation and the construction and reconstruction of prototypes based on feedback are a few of the steps. A great deal of time, energy and expense are usually involved in the development of the final product. In order for materials to be effectively and efficiently designed and utilized designers must be able to apply a

variety of principles of instructional design. This study considers the effectiveness of production techniques and the cost of labor and materials with related benefits.

Allen (1960) after an extensive review of the literature on audiovisual communication stated the need to study factors within pictorial illustrations that lead to increased learning. Other factors he examined were identification of the kinds of content best communicated by still pictures, and evaluation of various techniques for implementing their use. In 1971 Allen wrote that there was a continued need to examine the role of media within the instructional process:

> We should observe more intensive research efforts to discover how to design and manipulate the media so as to enhance their effectiveness under specified instructional conditions (p. 14).

Carpenter (1962) has also stated his support for additional research in the production and use of effective and efficient instructional materials:

> It seems clear that a major and sustained effort must be made to invent, develop and employ new production methods and new ways of using the media so that their potential for stimulating learning can be fully realized (p. 306).

While the major part of the literature is concerned with the ability of instructional media to transmit a congitive message, increased interest has been shown for the affective component of learning. According to Urbach and Sparks (1971):

> In recent years we have reached a point in the evaluation process where we are concerned not only with the knowledge gained, but with the willingness of the student to identify himself with a given subject (p. 6).

The present study attempts to address these various issues by documenting the production costs associated with the illustrations of two variations of a slide-tape program and comparing their cognitive and attitudinal effects.

Need for the Study

Hitchens (1971), in discussing the cost of education and the implications for technology, has written that:

> One of the chief concerns of today is money--and/or the lack of it for education . . . Thus, the wedding of technology and the cost of instruction is particularly appropriate in this time of short budgets and long accountability (p. 7).

Due to increasing financial pressures and the need to extend the benefits of education, the effective use of resources in higher education is receiving increased attention. The Carnegie Commission (1972b), in studying the more effective use of resources in higher education, concluded that total institutional expenditures must be, should be, and can be reduced by nearly 10 billion dollars (in 1970 dollars) by 1980 as compared with the costs which would be incurred if the trends of the 1960's were to be continued. This represents a 20 percent reduction which the commission felt could be accomplished without any general deterioration in the quality of higher education. In describing how costs could be reduced no mention of the need for a more effective or efficient expenditure of funds for the purchase or production of instructional materials was made.

In a study of the financial situation at 41 colleges and universities, Cheit (1971) concluded that due to inflation and declining rates in the increase of income:

> . . . Schools will have to learn to live on budgets approaching "rock bottom" which allow for substantially no growth at all in several major cost components (p. 17).

These predictions, based on extensive studies, appear to be even more significant at the present time in view of national and international monetary crises, generally depressed economic conditions and escalating inflation.

Unfortunately, costing techniques and procedures vary and are difficult to document and compare across different conditions. The situation becomes more complex when considered in terms of total input, productivity and learner output.

Levin (1971) maintains that schools and school districts have little, if any, objective data with which they can make determinations based upon the relationship between costs and performance of alternative instructional strategies:

> There simply is no available knowledge that schools can draw upon to determine whether the new instructional approaches will be more effective, once costs are taken into account than are traditional instructional approaches (p. 3).

The financial crisis and the problem of making effective decisions in education is also addressed by Johnson and Dietrich (1971):

> At present cost data on educational technology is almost non existent. The lack of these data severely impedes the academic decision-making process. Regardless of costing procedures used . . . ways must be found to place costs of educational technology in perspective. Present inadequate cost data are frequently so subjective that they are nothing more than pious hopes. The time is here to come to grips with the reality of cost analysis in the academic decision-making process (p. 1).

With increasing financial constraints economic factors are becoming one of the main considerations in the selection of classroom instructional materials. According to the National Education Association (1972):

> Economic and financial considerations often act as constraints upon selection. Rightly or not, the persons involved in selection may reject or limit the purchase of certain materials because "they're too expensive for us," or "we can't get that kind of money from the front office" (p. 51).

Since production costs affect the nature and price of the final product it would appear logical to look at factors which influence these costs. If production costs can be reduced while maintaining efficient and effective learning procedures these results will have significant implications for the production of instructional materials. According to Wilkinson (1973):

> With limited funds possible increased output, due to design modifications, are viewed as having potentially significant implications for local production centers (p. 15).

Carpenter (1970) has written that:

> Few school systems can describe the resources that go into existing programs, let alone estimate what existing programs or alternative programs will require in the future (p. 27).

Wilkinson (1973), in examining the problem of trying to isolate learning differences caused by specific variables within instructional technology, remarks that:

> . . . There is that long history of no significant difference to contend with. With such a lack of established differences between instructional strategies, the cost of effectiveness question is often reduced to finding the cheapest method of presentation . . . (p. 16).

Dubin and Taveggia (1968), in re-analyzing the data of approximately 100 comparative studies of different college teaching methods, support Wilkinson's parsimonious stand. They found no evidence for preferring one teaching method over another as measured by student performance on course examination. The authors concluded:

> Indeed since there are no differences among a wide range of teaching technologies we may assume that their respective benefits are equal. This, then turns the attention in cost-benefit analysis to the cost side of the issue. In making the costing decisions the obvious strategy would seem to be to pay out as little as possible for instructional costs (p. 49).

Wilkinson (1973) implies that those strategies which can attain the objectives at the lowest cost are being considered in education. Whether or not this is actually the case is open to speculation.

Cheit (1971) has expressed the need for more efficient expenditure of funds in the following way:

> In a society devoted to human betterment in a world of scarcity, requiring that resources are productively used need not contradict the premises and values of higher education. Colleges and universities ought to know what their functions cost, what their purposes are, and whether by some responsible standard they are spending their money more efficiently (p. 55).

In considering the production costs of instructional materials one of the primary questions that should be asked before the expenditure of funds is: Can the costs incurred be justified by the results obtained? It would appear that this basically simple question has been ignored or is not receiving the amount of attention in education that it deserves. Few guidelines or studies are available to educators upon which to base production or expense decisions.

A number of authors such as Mager (1968) and Edling (1972), have documented the importance of attitudes in the learning process. Increasing attention has recently been focused on the ability of instructional media to influence attitudes in the learning process. According to Kinder (1973):

> Attitudes and behavior changes are facilitated by means of instructional media, as are the getting and holding of many students' attention. Instructional media have been shown to induce greater acquisition and longer retention of factual information and to stimulate interest in voluntary reading . . . (p. 19).

While the importance of cognitive test performance has been acknowledged, the role of attitudes in education is receiving increased attention. The importance of emotions and motivation in the learning process has been aptly stated by Mager (1968):

> The likelihood of the student putting his knowledge to use is influenced by his attitude for or against the subject; things disliked have a way of being forgotten (p. 11).

According to D. C. McLelland, as reported by Barber et al. (1971):

> Educational technology has been utilized to convey information better, arousing attention and arousing and sustaining achievement motivation. However, very little is known about the effect of quality of production on the affective and cognitive aspects of learning (p. 25).

A general lack of information about attitudes in learning is also expressed by McDonald, as reported by Barber et al. (1970):

> There are many instances in which instructors attempt to influence the attitudes of their students toward a subject matter area, but rarely is an attempt made to measure the effects of these efforts (p. 115).

While attitudes are generally accepted as an important part of the instructional process, there appears to be a very limited amount of information available about media and attitudes.

Assumptions of the Study

This study, which examines two basic hypotheses related to production costs, makes the following assumptions:

1. Learning is conveyed, in part, through the visual channel of audio-visual presentations;
2. The affective and cognitive domains can be measured independently; and
3. Evaluative meaning, as explained by Osgood et al. (1957) and as tested by the semantic differential technique, is a valid indicator of affective learning.

Definition of Terms

Cue: Any specifiable attribute of the environment, which the Gestalt psychologists or other students of perception discover as a consistent basis for discrimination.

Picture: A faithful picture, as defined by Gibson (1954), is defined as one which reflects or transmits a sheaf of light rays to a given point which is the same as would be the sheaf of rays from the original to that point. In general a good pictorial surrogate is one which corresponds to the original with maximum fidelity.

Expensive Program: Executed by a medical illustrator utilizing sophisticated production techniques to produce illustrations with a high degree of realism.

Inexpensive Program: Executed by an elementary school teacher utilizing rudimentary production techniques to produce illustrations with a low degree of realism.

Graphics: Words and graphs which have the potential to communicate ideas clearly and succinctly.

Illustrations: Drawings and pictures which have the potential to communicate concepts and ideas clearly and succinctly.

Affective Learning: Evaluative meaning, or the discriminative judgment made by an experimental subject on a series of 7-point semantic differential scales of bipolar adjectives with respect to a given concept or topic. Direction (positive or negative) and the intensity with the meaning is indicated by the location of the judgment from the neutral, central position.

Cognitive Learning: The recall of factual data as measured by scores on a presentation related post-test.

Semantic Differential: A measurement and scaling technique developed by Osgood, Succi and Tannenbaum (1957) by which objective measurements of the connotative meaning of a concept to an individual may be made. Subjects indicate valuative judgments on 7-point scales of bipolar objectives.

Limitations of the Study

1. This study limits itself to second-term veterinary students.
2. Only immediate, cognitive recall and attitudinal measures, were determined.
3. The cost of the program was restricted to determining the cost of production for the graphics and illustrations only. The same audiotape was used for both programs.
4. All learners started and finished the program at the same time with no opportunity to alter the pace, review the material or study for the test.

5. Elements that were available free, i.e., radiographs, photomicrographs and photographs were included in both versions of the study.

Summary

The financial crisis within education is forcing administrators to closely examine the expenditure of funds for instructional purposes. The lack of cost data relating cognitive and attitudinal benefits to the cost of producing illustrated materials makes the wise expenditure of funds extremely difficult.

The present study, by providing information on the cost of illustrations in an expensive and inexpensive slide-tape program, will provide cost documentation with its related benefits in the cognitive and affective domain. Hopefully, this information will be of value to educational administrators or producers of instructional illustrations. Guidelines or additional information on the execution of illustrations with cost implications is also viewed by the researcher as being very important for the future production of economical and efficient visuals.

CHAPTER II

REVIEW OF THE LITERATURE

The literature search for the present study was restricted to those areas dealing with the nature, interpretation and costs of visualized material in the instructional process. Information concerned with human limitations in perceiving a visualized message and the effect of individual feelings toward the instructional message itself were also examined.

Specific areas of interest that were searched included the characteristics of visuals, the role of visuals in education and comparative cost studies of modified media presentations. Factors affecting cost and their relationship to the learning process were also examined. They included quality of illustrated materials, color and the role of embellishment in the learning process. Information on characteristics of the viewer that could influence individual ability to perceive visual information was also studied. The search was concluded by examining the literature dealing with the effects of how attitude influences learning.

The literature reviewed in this chapter is divided into five general areas:

1. Effective visuals and their components.
2. Comparative cost studies involving illustrated instructional material.

3. Quality and the effect of additional information to basic visuals on learning.

4. Perceptual limitations and characteristics of the viewer.

5. Attitudes in the learning process.

Visualization

Horn (1963) has accounted for the widespread use of visual material as an aid to instruction in the following manner:

> The visually expressive instructor can overcome customary mental resistances of the student with the support of the striking graphic image. For the academically gifted child the visual can excite the imagination; for the average student, stimulate; for the retarded child, clarify the verbal image (p. 7).

The popularity and use of visuals within the instructional process has also been extensively documented and researched by individuals such as Dwyer (1972), Farris (1963), Felming (1960), Gropper (1963a) and Miller et al. (1957). According to Dwyer (1967):

> It is relatively apparent that visual illustrations are rapidly becoming an almost universal means of instruction: slides, photographs, cartoons, transparencies, filmstrips and sketches are now in use from kindergarten through college (p. 250).

The ability of visuals to condense, simplify and clarify information and ideas has led to their general acceptance within the classroom setting. Visualization within textbooks, in poster format and in projected, still and motion form, are used to bring the macroscopic and microscopic events of the world into the classroom.

Dwyer (1972), after an extensive review, has documented the following claims made in the literature in support of the use of visuals in education:

Visualization of content material is said to be able to:

1. Facilitate the accuracy and standardization of the message being communicated;
2. Bring into the classroom inaccessible processes, events, situations, materials, and phase changes in either space or time;
3. Illustrate, clarify, and reinforce oral and printed communication, quantitative relationships, specific details, abstract concepts, and spatial relationships;
4. Provide concreteness (realistic detail) in the learning situation;
5. Increase student interest, curiosity, and concentration;
6. Present to the learner the opportunity to perceive an object, process, or situation from a variety of vantage points;
7. Provide important instructional feedback (p. 1).

Based on research and observations by such individuals as Dwyer (1972) and Horn (1963), the potential role of illustrated instructional material in education is great. With an increasing demand for visualized material and an increasing need for more effective teaching methods, the present study is viewed by the researcher as being highly relevant to the needs of education today.

Visual Characteristics

A good graphic, according to Wittich and Schuller (1958), should be clear, precise, accurate, simple, bold, readable and interesting. Bowen et al. (1960) list the following requirement of recognizable shapes or form; simplicity, symetry, continuous contour, relatively large enclosed area, either shortly angular or simple curved forms, and familiarity in the sense of having a familiar name.

Thompson (1969) has described the characteristics of a successful graphic in the following way:

> An important attribute of graphics . . . is their ability to compress information, to remove the inconsequential and the superfluous in order to predict the essence of the referent. A successful graphic goes to the heart of the matter. It records and emphasizes what is truly important, ignoring details which tend to confuse or obscure relationships (p. 49).

Spaulding (1956) modified illustrations within booklets designed to help newly literate adults in Latin America with their farming skills. He found that illustrations usually, though not always, helped the reader get more information out of the booklets used in the study.

In a careful examination, designed to help account for learning differences in three of the booklets used, the author found an inverse relationship between complexity of an illustration and its effectiveness in communicating clearly. Spaulding listed the following implications of his study:

1. An illustration as such has no educative value, and may even be a detracting influence, if the drawing content has not been presented in terms of the past experience of the intended audience.
2. Illustrations that are intended to communicate specific ideas will be most effective if (a) the number of objects that must be seen to correctly interpret the illustration are kept to a minimum, (b) the number of separate actions necessary to correctly interpret the basic message of the illustration are kept to a minimum, and (c) all objects and inferred actions are realistically portrayed and not open to dual interpretation or secondary inference . . . (p. 45).

It should be noted that Spaulding in his reference to realism refers only to the need to portray actions and objects clearly, without fuzziness of detail. He does not advocate photographic realism.

Traverse (1964a), after examining the effects of realistic details on learning in one of his earlier studies, concluded that:

> . . Emphasis on "realism" found in books on the design and in use of audiovisual materials is the worship of a false god (p. 380).

On another occasion the author again concluded:

> . . . Flooding of the learner with information and a stress on realism is likely to provide a poor learning situation (p. 384).

Levi and Dickie (1973) in analysing the application of media to various instructional settings, summarized a number of studies in which the effects of varying the amount of detail in illustrated instructional materials were studied. They reported the findings of the following authors:

> Travers (1969) found that addition of interior detail and shading to outline drawings increased the recognizability of tachistoscopically presented pictures.
>
> Coburn (1961) compared photographs, perspective drawings and outline drawings in teaching fish anatomy, finding that while outline drawings were best for teaching nomenclature of external anatomy, photographs were best for internal structure.
>
> Dwyer (1970) varied pictorial cues (simple line drawings, models, photographs in color or black and white) in a unit of instruction to learners of several grade levels tested on several criteria . . . In cases where pace of presentation was fixed (slides, television), visuals containing little detail tended to be more effective. Visuals high in realism tended to be more effective when the individual learner could control his rate of exposure . . . (p. 873).

After reviewing the literature Levi and Dickie (1973) concluded that:

> Realism cues which are not relevant to the learning task may produce divergent responses, especially under conditions of high information loads. However, learners usually express preferences for realistic presentations, and if given adequate time, may learn more from them when they provide more information (p. 875).

Wheelbarger (1970) after examining the role of pictorial complexity in visual perception concluded that the amount of realism did not appear to be of primary concern. Significant differences were not found in the test scores of five groups of sixth grade students who were exposed to variations of line drawings and shaded drawings.

The influence of realism theories is strongly entrenched in most production centers for instructional materials. According to Wheelbarger (1970):

> Realism theories continue to determine practice in audiovisual education, but they have come into question in recent years (p. 2).

Dwyer (1972), after extensive research on the properties of visuals, has challenged the notion that learning will be more complete as the number of cues in the learning situation increases:

> . . . Presenting a student with a wealth of stimuli that approximate reality is not necessarily the most effective way to facilitat learning . . . Excesses of realism may actually interfere with the effectiveness of visual materials (p. 7).

Norbert (1966) referred to the amount of information within a stimulus as density. He also felt that density could become a factor impeding efficient transmission of information. In Norberg's words: "Some presentations may be too realistic" (p. 307).

Additional support for simplified visuals was obtained by Moore and Sasse (1971), who compared the effect of modified illustrations and photographs of various sizes on learning. They found that students exposed to medium sized line drawings had the highest mean scores while photographs, at all picture sizes, had the lowest mean scores.

Vitz (1966), in attempting to determine individual preferences for complexity within visualized material, concluded that humans have optimal or preferred amounts of visual complexity. However, he also obtained inconclusive evidence when he attempted to correlate increased exposure with the amount of complexity preferred.

According to Levie (1973):

> Learning cues may take on a wide range of physical variations without destroying their critical attributes, so long as image quality, sound quality, etc., are sufficient to allow the learner to "read" the appropriate cues, no decrement in learning should be expected (p. 24).

The literature reviewed suggested that the success of illustrations used in an instructional setting is dependent on the characteristics and appropriateness of the visual. The research seems to indicate that realism, which in many instances is still being sought, is inefficient in transmitting some information and may even be detrimental to the learning process. The difficulty appears to be in determining the amount of simplification required to obtain best results.

Comparative Cost Studies

While a number of studies have been conducted on the general effectiveness of visualized materials in the instructional setting, few researchers have examined the effects of varying the production costs.

Zuckerman (1954) conducted a study on picture quality. A storyboard-based filmstrip of about 250 frames was used. This filmstrip closely paralled a finished motion picture. The visuals in

the filmstrip were relatively crude sketches as contrasted with the combination of live action and elaborate animation used in the final color films.

Zuckerman (1954) concluded that the filmstrip, which represented a significantly smaller financial investment than the finished film, could be used to predict the relative teaching effectiveness of the final motion picture.

Moor and Sasse (1971) examined the hypothesis that a significant difference existed in the amount of content immediately recalled from pictures when the same subjects viewed pictures described as line drawings, as paintings, or as photographs. Three treatment groups were set up to examine the relationship among the characteristics of the visual, size of the projected image and cognitive test performance. At all picture sizes tested, line drawings consistently had the highest mean scores in comparison to paintings and photographs.

In a partial explanation for the popularity and effectiveness of line drawings Thompson (1969) has claimed that:

> Plain line drawings and cartoons are good examples of precompressed information for they emphasize the boundaries of things rather than the interiors--thus omitting unnecessary detail while stressing the most relevant information (p. 50).

In an exploratory study designed to assess the importance of factors generally regarded as entering into the degree of "polish" or quality of the pictorial component May and Lumsdaine (1958) compared two levels of 16mm production.

The authors compared a finished Kodachrome film with a crude black and white, semi-animated film called a "pencil-test running

reel." The latter was composed of motion picture footage taken of the preliminary "story board" sketches that had been used in the planning of the film.

The total cost for preparing the pencil-test version was estimated at about $1500.00 or $75/minute. The finished Kodachrome cost approximately 10 times as much or $750/minute.

An analysis of the learning generated by the two films disclosed that the final polished version of the film apparently taught no more than the crude pencil sketch presentation.

McBeath, as reported by May (1965), compared a silent captioned filmstrip, a sound captioned filmstrip, a sound filmstrip without captions, and a simplified version of a motion picture for relative effectiveness in teaching the facts and concepts contained in a 6th grade social science lesson. The sound filmstrip and the simplified 16mm film contained the same narration. The simplified film was more polished and used more audiovisual embellishments. All subjects were pre- and post-tested with a 60 item test on facts and concepts. A retention test was given after a period of three weeks. No differences were found on the immediate post-test or on the retention test. Other studies reported by May (1965) which compared filmstrips presenting the same content, were James (1924), McClusky and McClusky (1924), Brown (1928), Carson (1947), Vernon (1946), Hovland, Lumsdaine and Sheffield (1949), and Gibson (1947), all indicate that filmstrips are about as effective as films and in some cases more so, for teaching facts and concepts.

After an extensive search of the literature for information dealing with the relative effectiveness of films vs. simplified versions of films, and simplified versions of films vs. captioned sound filmstrips, May (1965) concluded that:

> . . . For some types of materials used for some purposes, the simpler presentations are about as good as the more complex ones. No dependable generalizations can be made from these experiments as to the kinds of materials that should be produced in simplified forms (p. 82).

Carpenter (1954) attempted to determine whether motion pictures could be as effective as simple and less expensive audiovisual aids. A 16mm film was compared with two versions of a filmograph made of the original film. One filmograph eliminated motion by copying frames from the base film. The other filmograph used still photographs and diagrammatic representations and substituted stock photographs in place of the original complex scenes. Both versions retained the original sound track.

The difference in means between the group viewing the original motion picture and the group viewing the first filmograph produced from stills of the original motion film, was small, but significant in favor of the group seeing the original motion picture. The difference between means of the groups seeing the two simplified versions of the film was not significant. Attitude measures showed no significant difference among the three groups tested. There appeared to be some question as to whether the more elaborate and expensive production justified the small mean difference in factual learning over the more simple filmographs prepared from the original motion picture.

May (1965), after examining the results of comparative studies with regards to complexity of production, felt that either costs could be reduced or efficiency could be increased, or perhaps even both, by the following procedure:

> . . . Eliminating from a film or ETV program all materials which by experiment are found to contribute little or nothing to the amounts learned and retained. Another is to substitute simpler and equally effective modes of presentation (p. 62).

Bullard (1969), in examining instructional differences associated with an expensive, static visual of high quality and a very inexpensive version of the same visual, found no significant differences in cognitive learning. The author also acknowledged the strong, direct relationship between cost and quality.

In discussing the need for additional information on illustrations to clarify concepts Miller (1957) has written that:

> . . . Special attention-gaining devices should help if they direct attention to the relevant cues and hinder if they fail to do this. These expectations are in line with the general opinion of experts that artiness and slick production techniques are of no use unless they contribute directly to the clarity of the presentation (p. 83).

After reading the above studies the researcher found little support directly relating the expenditure of funds for the production of instructional materials with positive learning benefits. Virtually all of the studies examined reported that the simplified version or the least expensive method of transmitting the information was as effective as the higher quality or more expensive product.

Quality

A number of authors have attempted to describe the components and nature of quality in illustrated materials. Lumsdaine (1958) has referred to the components of quality in the produced image as degrees of precision, neatness and fidelity. May and Lumsdaine (1958) refer to the combination of these variables as "degree of polish" or slickness. According to Bullard (1969) quality is determined by the production medium, the transmission medium and the precision, neatness and fidelity of the produced image. Carpenter (1971) views quality as being synonymous with effectiveness.

Studies by Bullard (1969), and Travers (1969), have attempted to define and analyse individual variables within visual symbols to determine the effects of variation on the level of learning.

Travers (1969) attempted to discover the effects of adding realistic details to recognition capabilities in a group of children and a group of adults. His data showed that as the number of cues increased by adding details to a drawing, identifiability increased. He also found that the addition of interior detail added as much to recognizability as shading which has the function of creating an illusion of depth. In addition Travers' data supported the position that children in the second grade have recognition processes that are closely similar to those of adults provided only familiar objects are involved. No evidence was found to support the hypothesis that young children were more dependent on cues related to contour.

Levie (1973), after examining the literature on information related to visual interpretation and quality concluded that:

> . . . Variations in technical quality do not affect the acquisition of information so long as the relvant cues are available to the learner. When the attainment of cognitive learning objectives is the criterion, insistence upon flawless technique is unjustifiable. Amateurish technique may, however, increase the likelihood of negative attitudinal reactions (p. 24).

Bullard (1969) produced a high quality graphic and compared it with an inexpensive, low quality graphic of the same visual. A number of hypotheses were stated to test the effects of both visuals on learning efficiency and reaction toward the reproduced graphic. Bullard concluded that graphic slickness did not significantly contribute to the learning of specific facts as measured by immediate recall on tasks which required only a few minutes of effort. It was noted that subjects, when asked to rank visuals of predetermined quality showed a preference for the "slick" or quality graphics.

Carpenter (1971) has described the problem of quality and its relationship to instructional media in the following way:

> The definition and delineation of factors, conditions and determinants of quality and/or effectiveness have largely eluded the grasp alike of investigators and practical educators. The disturbing and ubiquitous findings of "no statistically significant differences" have arisen by the hundreds to smite those who have striven by neatly controlled research and analytical procedures to bring the variables and contingencies of quality into ordered conceptual and operational frames (p. 868).

While an attempt has been made by such individuals as Bullard (1969) to list the factors affecting the quality of graphic materials, in the final analysis, the decision regarding degree of quality appears to be largely subjective. According to Bach (1963):

> There are no real standards which can be used to judge the effectiveness of artistic communication when the work of art is created. Only time really determines the effectiveness of any art and, even so, there are ups and downs of artistic acceptance (p. 84).

In conclusion, the literature in the area of artistic quality reveals some confusion regarding the nature and definition of instructional materials described as "quality" products. In cases where instructional products have been labelled as "quality" little evidence was found by the researcher to support justification for their production in the attainment of cognitive measures. Student preference, when obtained, was usually found to be in favor of the "quality" products.

Embellishment

Perhaps the best way to explain embellishment is to look at simplicity in terms of lack of embellishment. The following definition of simplicity by Thompson (1969) is useful in understanding embellishment:

> Simplicity is what is left when redundancy has been removed. It is the elimination of the superfluous and the disfunctional. To put it another way, simplicity means that "less is more" (p. 56).

In a learning situation anything that can be removed from the instructional material that does not impede the attainment of specific learning objectives could be considered to be embellishment.

Travers (1967a) has described the parts of an illustration that are not necessary in the communication of a specific piece of information as embellishment. According to Travers (1967a):

> The process of embellishment may . . . include embellishments which add to the realism of the visual display as when color is used, . . . as when a particularly significant component of a machine is shown in red. Embellishments do not add information and what they add is often not even remotely relevant to the message that the audiovisual instructional device is designed to convey (p. 37).

May and Lumsdaine (1958), in an exploratory study, examined factors generally regarded as entering into the degree of "polish" or quality of the pictorial component of teaching films. Both factors were considered closely related to the cost of producing and printing films. In comparing a crude pencil sketch film and a highly finished Kodachrome version of the film they found no differences in cognitive learning between the two films. Since the control of content presented between the two films varied slightly, the results were interpreted as meaning that a crude presentation could at least equal, in teaching effectiveness, a polished color film.

Lumsdaine and Gladstone (1958), in examining the effects of film modification suggested that the learner's attitude may in some way be modified by the embellished pictorial presentations. Their reasoning is that students who feel positive about the visual material they are observing may in fact be conditioned to respond to the subject matter in the same positive way.

Although attention may be improved, Levie (1973) has reported that studies cited by Reid and MacLennan, and Skornia show no improvement in learning as a result of additional refinements. Background music, sound effects, optical effects and professional graphics have not increased test performance.

Baker and Popham (1969) working with public school administrators, examined the value of three embellished and three unembellished versions of the same program. It was found that ratings on two of the programs favored the embellished version. On the third program all affective ratings favored the unembellished version. They explained these findings by stating that there were differences in the style or quality of embellishments used in the three programs which might account for these results. The authors arrived at the following conclusion:

> For similar topics and similar learners the cost of preparing embellished versions may not be justified by the results (p. 34).

Baker and Popham (1969) also noted that during the early developmental testing, several learners reported that they were distracted by the cartoons. They speculated that the perception of embellishments might be influenced by the sophistication of the learner along with the difficulty of the subject matter being transmitted.

In an experiment with preservice teacher education candidates Baker and Popham (1965) compared an embellished and unembellished version of a tape-slide program. The results indicated that there were no differences between the two programs with respect to cognitive measures, but affective differences favoring the cartoon-embellished version were found. Learners rated the embellished version significantly higher than its unembellished counterpart in terms of interest and enjoyment. The authors urged that further research be carried out to examine the merits of the increased cost of pictorial embellishments.

May and Lumsdaine (1958), after comparing the teaching effectiveness of a polished film presentation and a simplified version of the same film, came to the following conclusion:

> Slickness may possibly have some effect on acceptability to students and their consequent motivation (though this has never been clearly demonstrated). More likely, its major effect may simply be in impressing training supervisors and administrators . . . (p. 90).

The research cited above revealed little support for the practice of embellishment. Support for embellishment was found in only one case. In other studies the additional expense of adding extraneous material or information to the basic instructional message did not appear to have any positive effects on cognitive learning.

Color

The issue concerning the effects of color has received considerable attention in the literature. While some research does exist, largely in the affective domain, to support the use of color, it would appear that the usual doubling of production costs incurred by the addition of color, cannot be justified by increases in cognitive learning.

According to Spaulding (1956):

> Color in illustrative material adds to the interest potential of the drawings. However, unless used realistically and functionally, color may detract from the communication potential of the drawings. This is especially so in the case of drawings which utilize only one color or two colors in addition to black and white. In most cases where full color realism cannot be achieved, it may be wise to limit the use of color to border and decorative motifs (p. 45).

Dwyer (1972) in examining learning differences in favor of color when static pictorial materials were used, reported on 36

comparisons between color and black and white versions of illustrations used to complement verbal instruction. Color was found to be superior in all cases, most notably where color apparently served to accentuate details relevant to the learning objectives. Color was found to facilitate learning when used in a way to draw attention to critical learning cues.

Lumsdaine (1963) has summarized the general status of the color versus black and white issue as follows:

> The clearest case for the use of color is . . . where color cues are essential for a discrimination that is to be learned. In films and printed materials color differentiation is also obviously advantageous when multiple color codes keep otherwise confusing visual elements separable and readily followed . . . But the evidence suggests strongly that only general value of color for increasing learning through increased strikingness or attractiveness has probably been overrated (p. 635).

In a study designed to test the development of perception in children, Travers (1970) discovered the use of color in a picture facilitated very substantially the perception of the dynamic features. Travers (1970) explains:

> It seems that color gives a lifelike appearance which has great potential for changing a still picture into a dynamic ongoing scene (p. 55).

In another search into the effect of color Travers (1967a) concluded that:

> The reviewer found no adequate analysis of functions which color might perform in the transmission of information (p. 42).

On the other hand, Gibson (1954), in summarizing his research into the effects of color, concluded:

> Realistically colored illustrations are more effective than black and white, but the amount of added effectiveness may not always be significant. Addition of one color to black and white illustrations may not be worth it . . . (p. 43).

The literature reviewed indicated that the successful use of color is dependent on the nature of the specified objectives in the learning situation being considered. In situations where color identification is not a specified task the addition of color appears to be of questionable value in the attainment of cognitive objectives. Some evidence exists to suggest that the most important contribution of colored illustrations lies in the affective domain.

Perception

Since the perception of events surrounding the human learner is partly based on the physical limitations of the individual involved, the following principles are considered by Broadbent (1958) to be important:

1. A nervous system acts to some extent as a single communication channel, so that it is meaningful to regard it as having a limited capacity.
2. A selective operation is performed upon the input to this channel, the operation taking the form of selecting information from all sensory events having some feature in common.
3. Selection is not completely random, and the probability of a particular class of events being selected is increased by certain properties of the events and by certain states of the organism.
4. Properties of the events which increase the probability of the information, conveyed by them, passing the limited capacity channel include the following: physical intensity, time since the last information from that class of events entered the limited capacity channel . . . , high frequency of sounds, as opposed to low . . . , sounds as opposed to visual stimuli . . . (p. 297).

Fleming has attributed the limited ability of an audience to attend to and process the designer's message as limited capacity of the central nervous system. This limitation, according to Fleming, forces the individual to selectively perceive complex message inputs. In the words of Fleming (1970):

> Selective perception is in part physical, i.e., each input channel has load limits, and the total information processing capacity from all inputs is limited. The stimulus potential of the environment is great, but the perceiver can attend to only a limited amount at a time (p. 83).

Along with physical limitations, Gibson (1966) has acknowledged "economical perception" as a learned response in identifying the salient features of objects and events. According to Gibson, a minimum principle operates in the economy of selection. Gibson's rule is that:

> Only the information required to identify a thing economically tends to be picked up from a complex information. All the other available information that would be required to specify its unique and complete identity in the whole universe of things is not attended to (p. 286).

Hochberg (1964) has combined simplicity and the minimum principle as laws of combination:

> The principle appears to be . . . that our nervous systems organize the perceived world in whatever way will keep changes and differences to a minimum (p. 87).

In attempting to explain why we see things as we do, he concludes:

> Whether by early perceptual learning or by inborn arrangement, our nervous systems seem to choose those ways of seeing the world that keep perceived surfaces and objects as simple and constant as possible (p. 99).

Travers (1964b) after carrying out an extensive review of the research on visual perception concluded with the following comment:

> . . . The research leaves the overall impression that procedures which elaborate the process of transmitting information, either by embellishment or by other devices, do not facilitate reception perhaps because the human receiver does not have the capacity for utilizing this added information. This impression is consistent with the . . . picture of the human receiver as a limited capacity input channel (p. 2:56).

As articulated by Fleming (1970) the translation of perceptual research into practical graphic design applications is difficult at the present time. The author makes a strong recommendation that the following suggested applications be tested and validated with reference to the constraints of each kind of situation: the types of message, materials, learners, and objectives.

1. Man's perception is relative rather than absolute.
   A. Provide anchors or reference points to which perception can be related . . .
   B. Pace the message relatively . . .
2. Man's perception is selective
   A. Limit the range of aspects presented . . .
   B. Use pointers . . .
3. Man's perception is organized
   A. Make apparent the organization of messages . . .
   B. Choose organizations consistent with concepts or subject matter . . . (p. 97).

Fleming (1970) accounts for individual perceptual differences by stating that:

> In addition to the general tendencies for perception to be relative, selective, and organized, perception is variable, i.e., man perceives what he expects . . . to see (p. 97).

Unfortunately, as noted by Fleming (1970), the problems of perception are complicated by factors beyond the limitations of the central nervous system to absorb information. Cherry (1957) has explained this phenomenon in the following way:

> . . . Human recognition is a psycho-physiological problem involving a relationship between a person and a physical stimulus; it is a phenomenon which can scarcely be explained solely in terms of properties of the object or patterns alone. For when a person perceives or recognizes an object, a spoken phrase, a face or any pattern, he is making an inductive inference, and associating that perception with some general concepts, class, or universal; and part of the clues upon which that individual operates may be private to him and depend upon his own past experience (p. 299).

The literature reviewed implied that perception is a complex phenomenon involving survival, limitations of the individual perceiver, circumstances surrounding the event to be perceived and the previous experience of the viewer. Perception was also described in the literature as being selective and difficult to predict because of individual differences. Little specific advice was found on designing efficient and effective graphics.

Viewer Characteristics

In examining chronological age and preference for different picture types within instructional settings, Moore and Sasse (1971), have summarized the following points from research by others:

1. Younger children prefer simple illustrations showing little detail (French, 1952).
2. Older children and adults prefer complex and detailed illustrations (French, 1952).
3. Young children tend to look at parts of an illustration rather than the illustration as a whole (Miller, 1938; Elkind, Koegler and Go, 1964).
4. The ability to receive information from a picture tends to be a developmental process (Travers, 1970) (p. 438).

The sophistication of the learner in the successful interpretation of visual cues is also acknowledged by Thompson (1969).

> Today's students are also thoroughly familiar with a variety of graphic clues to visual cues. They know that devices such as underlining, enlarging, changing color,

> encircling, boxing and the like are indicative of the importance of certain parts of a message . . . the more cues we already have within our response repetoire, the more meaning a graphic has for us (p. 57).

Travers (1964b) in examining the research and theory related to audiovisual information transmission found research to support a statement of a direct relationship between intelligence and the ability to interpret and remember visuals.

McBeath and Finn (1961), after comparing the relative effectiveness in factual learning of a captioned filmstrip, a captioned filmstrip with narration, a sound filmstrip and a filmograph, found that, although no one method was significantly superior, students with higher intelligence did significantly better than those with lower intelligence.

Miller (1957) concluded that the nature of the audience viewing illustrated material might influence the need for details which would influence the information transmitted:

> With highly motivated students who are experienced viewers of pictures, one might expect such factors as size of screen, distance from screen, angle of view, and illumination to be critical only if they interfere seriously with the presentation of the relevant cues (p. 82).

The literature cited above suggests that the ability to interpret and remember visuals is directly related to the intelligence and motivation of the viewer. It is also suggested that viewing skills increase with age and, if the message is relevant, can be interpreted with a minimum number of cues by the sophisticated viewer.

Attitudes in the Learning Process

The importance of emotions in the learning process has been summarized by Edling (1972):

> Historically the term affect has served as a class name for feeling, emotion or mood. As such, the concept has a great deal of relevance to the educational enterprises for it is clearly recognized that the feeling dimension of the learning process is as critical as the cognitive dimension, and that affective outcomes are as relevant as cognitive outcomes, when considering educational objectives (p. 91).

Authors such as Mager (1968), Kinder (1973), and Triandis (1971), have all attested to the importance of attitudes in the learning process. The ability of instructional media to affect attitude and even change attitude has also been documented and reported by Peterson and Thurstone (1933):

> . . . The experiments we conducted show that motion pictures have definite, lasting effects on the social attitudes of children and that a number of pictures pertaining to the same issue may have a cumulative effect on attitude (p. 66).

Kinder (1973) has also made strong assertions in favor of the media being able to positively affect attitude:

> Attitude and behavior changes are facilitated by means of instructional media, as are the getting and holding of many students' attention. Instructional media have been shown to induce greater acquisition and longer retention of factual information and to stimulate interest in voluntary reading . . . (p. 19).

Barber et al. (1970) has expressed a similar sentiment by stating that:

> Media presentations in themselves represent an important means of influencing attitude learning or implementing attitude change in the larger social context (p. 116).

In an expansion of the theme of continuing education and the importance of learning beyond the immediate classroom situation, Carpenter (1962) has written that:

> The higher levels of motivation lie close to some of the best educational objectives, such as the development of the self-motivated or autonomous learner, and the encouragement of the exceptional student to whom learning is its own reward (p. 300).

While many authors have acknowledged the importance of the affective domain in the learning process, Travers (1967b) has discussed some of the hazards involved in the measurement of attitude:

> Clearly this is an area of emerging knowledge but many of the discoveries are not yet so definite that straight forward application is possible . . . Simple communication sometimes changes attitude and sometimes does not, depending on the presence or absence of other circumstances (p. 404).

Similarly Osgood (1957) has cautioned:

> Attitude is one--but only one--of the dimensions of meaning, and hence provides only part of the information necessary for prediction (p. 189).

Instruments referred to in the literature designed to measure attitude include the following three which have received the most attention and use; the method of equal appearing intervals (Thurstone and Chave, 1929); the method of summated ratings (Likert (1932); and the semantic differential technique (Osgood, Suci and Tannenbaum, 1957).

While some information does exist, little is known about the role that attitude toward the nature of the instructional material itself plays in the learning prcess. According to Travers (1967b):

> Few studies of attitude have been undertaken as studies of learning phenomena. Most of the research undertaken represents the efforts of social psychologists to understand social phenomena. Interest in attitudes as the product of learning represents a new emphasis in this research field (p. 409).

The literature, while acknowledging the importance of attitudes in the learning process also cautions against the difficulty of interpretation of attitudinal measures. Instructional media are cited as having the potential to create or modify attitude through the use of mediated messages. A lack of studies regarding the nature and importance of attitudes in education is noted by Travers (1967b).

Summary

The literature reviewed above leaves the general impression that the realism strived for in most instructional media productions is difficult to justify. The additional expense and time involved in the pursuit of perfection, according to the majority of research reviewed, is open to serious questioning.

While some support can be found for the use of color, quality and other embellishments this support falls mainly into the affective domain. Apparently students, given the choice, will usually select "quality" materials, however, this selection is not reflected on cognitive test performance.

In the comparison of various levels of illustration complexity on cognitive learning, the results have almost consistently favored the simplified message design. This simplification has usually been associated with a savings in production costs and, in some cases, higher cognitive test performance when compared with results obtained in using more complex visuals.

Some evidence was also found to support the theory that the higher the ability level or sophistication of the learner, the less need there is for embellishment.

Support for the importance of attitude in the learning process was found. While most literature reviewed indicated that media was capable of influencing attitude, problems of significance and interpretation were well documented.

CHAPTER III

DESIGN OF THE STUDY

The principle concern of this study was to examine any cognitive and attitudinal differences resulting from student exposure to an expensive and inexpensive version of a slide-tape program. It was postulated that extreme differences in the production costs of illustrated materials might affect both the amount of information transmitted by the medium, and attitude of the viewers.

Population Description

The 111 subjects represented the entire second term class of veterinary students at Michigan State University. Forty were females and 71 were male. These second term students were the products of intensive competition to enroll in the College of Veterinary Medicine and academically, represented some of the most intellectually talented individuals in the educational system. They were selected from a total of 754 applicatants, had a science grade point average of 3.28 and an average age of 21.7 years.

Students were assigned to three groups by an alphabetic process. Instructions, on a typewritten page, were given to the classroom instructor to read (see Appendix A). The list contained the names of the first and last person in each group along with an assigned group location. With limited time this sample procedure

proved to be an efficient way of initiating the treatment. Tests were carried out later to determine if there were any group differences due to non-random assignment.

Message Design

A current problem in the field of small animal veterinary medicine has been the alarming increase in the incidence of heartworm disease in dogs. The following information, published by Michigan State University (1974), indicates the seriousness of the problem:

> In the pase decade, heartworm desease has moved from non-existence or insignificance in the State of Michigan to one of our major debilitating diseases of the dog (p. 1).

While the seriousness of the problem is generally accepted, support material for classroom instruction has been extremely limited and restricted to graphs, photographs of adult heartworms, photomicrographs of microfilariae and radiographs of infected dogs.

As part of the instructional development process the need for sequential, clearly illustrated instructional support material became apparent. Much of the existing support material examined was found to be confusing and incomplete in regard to the life cycle, treatment and prevention of the disease.

Financial support was obtained for the production of illustrations and hardward. The original intention was to reproduce prepared illustrations on microfiche with an accompanying written script. Each student could then purchase a copy of the program at a very reasonable price. In reality, the final product became a

synchronized slide-tape program which, in its expensive format, has since been placed on sale for national distribution.

Objectives for the program were established (see Appendix E) and an in-depth examination with feedback from parasitologists and other experts in the field was conducted. A rough storyboard including the problem, lifecycle, prevention and treatment evolved over approximately a six month period. Sketches of the storyboard were then prepared and photographed onto 2 x 2 slides. This rough prototype of the program was shown to senior students who commented on the clarity of the information being transmitted. Student feedback which primarily concerned itself with the crudity of the sketches, was taken into account and, based on student and additional faculty feedback, production commenced on the final version of the program in both versions.

The final versions of the program consisted of 49 slides (see Appendix F for sample slide reproduction). The participating veterinarian prepared a script (see Appendix G) to accompany the illustrations and a seventeen minute synchronized cassette audiotape was produced.

In the production of illustrations for the inexpensive version of the program differences were maximized to increase the chances of finding differences on measures of the independent variable--cost. Extremes of individual illustrator qualifications and production techniques were selected to increase the potency of the variables to try and avoid "no significant difference" results (see Appendix F).

Production Details/Expensive Version

Illustrator Qualifications

A medical illustrator with a Master of Science Degree in Medical and Biological Illustration prepared the illustrations. This person also has extensive experience in the production and packaging of medically related slide-tape presentations for instructional purposes.

Production Procedure

The majority of artwork done in the slide-tape presentation utilized cell animation techniques. They can be broken down into videoboard or carbon dust technique, backpainting and simple graphics.

The illustrations that it was felt required detail and a realistic look were accomplished by a carbon dust or videoboard technique. This was a new application of an old classical medical illustration technique. In this method, pastel dust was prepared in the colors to be used; then using brushes and other tools, the dust is applied to a clay coated paper called videoboard. After basic forms are laid down, further details are added with dust and colored pencils. Great flexibility and detail can be accomplished with this technique.

Another technique utilized was cell acetate backpainting and simple forms on cell acetates. In this technique, a prepared sketch is placed under an acetate cell and an inked tracing made of the sketch. When dry, the inked cell is flipped over; and using acrylic paints, the reverse side is painted in reverse light to dark. This

effective method utilizing flat color is the same method used by Walt Disney Studios for their cartoon films. Another effective flat technique utilized is to cut paper forms attached to cell acetate. This resembles backpainting and allows flexibility with background colors and overlays. Additional cells may be added above or below the prepared cell acetate. Approximately one-third of the illustrations in the expensive version of the slide-tape program used these methods.

Other simple graphic methods were used for the remaining illustrations. All graphics (basic lettering) was done with dry transfer lettering (white and black) directly on acetate cells. The original layout, style, and point sizes were predetermined prior to actual production. Use was also made of 3M Color-Key for special effects and color graphics. These simpler methods were employed in the graphics unit of the medical art department and did not involve the medical illustrator to any great extent.

The use of cell animation techniques and special color effects was specifically planned so the final result was a smooth flow of visual material in a slide-tape format.

Artwork Progression

- Thumbnail sketches prepared
- Approval of thumbnail sketches
- Small, more detailed sketches prepared
- Correction of small sketches
- Large, full scale master drawings completed. At this point the visuals for the slide-tape program were essentially completed. All ideas were then finalized and put into

finished graphic format. These drawings were then ready to photograph for the initial evaluation of the program.

- Final artwork completed
- Photographed in final format

Production Details/Inexpensive Version

Illustrator Qualifications

An elementary school teacher who had a special interest in media illustrated the inexpensive version of the program. This individual had limited experience in free lance photography and had completed one graduate level introductory course in graphics.

The coordinator of the original program worked closely with the elementary school teacher who produced the inexpensive version of the program. The script and the thumbnail sketches from the original production were used by the coordinator to insure that the illustrated messages on both programs conveyed the essential information. Care was taken not to expose the illustrator of the inexpensive version of the program to any of the illustrations or rough storyboard sketches produced for the expensive version of the program. The original rough storyboard prepared for the expensive version of the program was used as a guide in the preparation of visuals for the inexpensive version of the program. The design for the inexpensive version of the program was transferred from the original rough storyboard onto 3 x 5 cards by the researcher. Final design details were planned by the researcher and the illustrator using the prepared cards and the script to determine the essential message components.

Working closely with the script, only details necessary for transmission of the essential message components were included in the inexpensive version of the program. Every attempt was then made to keep cost at a minimum in the production of the final product.

The techniques and methods employed were designed to provide results as efficiently as possible. The difference in production time, approximately 300 hours, is reflected in the following table:

TABLE 3.1.--Production Time (hours) Required for the Preparation of the Expensive and Inexpensive Versions of the Program.

	Expensive Program	Inexpensive Program
Illustrator	180	21
Photographer	6.5	3.5
Student	145.5	____
TOTAL	332.0	24.5

Production Procedure

Basic outlines were copied from medical journals and related articles onto tracing paper. These tracings were then transferred onto colored construction paper and cut out. Labels were typed using a primary typewriter, cut into squares which could be readily moved, and were re-used on a number of illustrations. Acetate overlays were drawn so the same basic figures or base cell could be used in illustrating a number of different situations.

Two x two 35mm slides were taken of the various illustrations using different overlays in combination along with the appropriate descriptive labelling.

The cut-outs, reusable labels and acetate overlays resulted in a minimum expenditure of effort and materials for the results obtained.

Materials utilized in the production of the inexpensive version of the program consisted of: an xacto knife, scissors, metal straight edge, colored felt pens, Hunt crow-quill pen and penholder with India ink, primary typewriter, paper cutter, ball point pen, #2 pencil, rubber cement, and colored construction paper.

Artwork Progression

Consultation between the producer and the illustrator was carried out on a continuing basis and constant communication was maintained to insure that the same essential content information would be transmitted in both versions of the program.

Common Elements

Common elements to both programs consisted of five photomicrographs, three photographs and two radiographs. These 2 x 2 transparencies were supplied by the participating veterinarian. These slides depicted either heartworms in the dog's heart, radiographs of infected dogs or photomicrographs of microfilariae in the dog's blood. For identification purposes these slides would have been extremely difficult, if not impossible, to reproduce by artistic or other techniques. On this basis and since they were provided free,

they were incorporated into both the expensive and inexpensive versions of the program.

Narration

A final script (see Appendix G) was prepared by the participating veterinarian after corrections were made based on feedback by the researcher. The 17 minute audio portion of the tape was narrated by the veterinarian. A slight modification was made in the narration of the inexpensive version of the tape (see Appendix G). Since the inexpensive version was not produced by the Biomedical Communications Center and two of the credits were no longer appropriate, this information was edited out of the narration for the inexpensive program. The recorded information regarding canine heartworm disease remained the same in both programs.

Synchronization of both slide-tape programs was identical and was accomplished by placing a 1000 hz. signal onto a cassette audio-tape.

Equipment and Facilities

Both versions of the slide-tape program were played back on Wollensak model 2550 tape recorders synchronized with Kodak carousel slide projectors with four to six inch zoom lenses. Both treatment rooms contained wall mounted projection screens which permitted the projectors to be placed in such a way that the images were the same size and filled each screen.

Production Time

Difficulty in interpretation of differences in production time between the two programs is complicated by the production sequence followed. The inexpensive version of the program utilized the rough storyboarding which was planned and developed for the expensive version of the program. Although this material was not used directly, it was of great assistance to the researcher who used it to plan the sequence and basic layout of the inexpensive program.

Students were employed by the Biomedical Communications Center mainly for the production of graphics. Their production efforts were supervised by the medical illustrator. The time reported for the illustrator represented time spent on production only and did not include other supervisory and developmental time.

Production Costs

The illustration production costs represent estimates provided by support services at Michigan State University. These figures were compiled during the winter and spring of 1974 and have risen dramatically since. Thus the current cost of producing the program would be considerably higher (see Table 3.2).

The expensive version of the program, except for the composite titling of six slides, was produced by the Biomedical Communications Center. The facilities of the Instructional Media Center were utilized for the production of the inexpensive version of the program. Cost estimates were provided by these support services at Michigan State University. (See Appendices H and I for a documentation

TABLE 3.2.--Production Cost Summary for Labor and Materials Required in the Production of Illustrations for the Expensive and Inexpensive Versions of the Program.

Item	Expensive Program		Inexpensive Program	
Labor	Illustrator	$ 900.00	Illustrator	$ 48.30
	Photographer	32.50	Photographer	17.50
	Student	727.50		
		$1660.00		$ 65.80
Materials		$ 826.75		$ 69.40
TOTAL		$2486.75		$135.20

of labor and material cost for both programs.) When compared to rates charged outside the university, the cost of producing instructional materials within the university can be considered conservative.

Cognitive Instrumentation

Based on the objectives developed for the program on canine heartworm disease (see Appendix E), a 34 item quiz was assembled by a veterinary parasitologist. Two tenth term students assisted in the initial construction of the instrument. They viewed the program and then attempted to answer the quiz. Their comments and suggestions for change were helpful in constructing the initial instrument. The original revisions resulted in a 34 item constructed response quiz. The validity of this instrument was tested with 25 tenth term students since second term students were unavailable at the time. The answers, which consisted of either a single word or a short phrase, were scored by a veterinary parisitologist. The results were then submitted to the University Evaluation Services for analysis.

On the basis of calculations of their index of discrimination and index of difficulty scores, nine of the original 20 questions were revised and three eliminated. The veterinary parisitologist and the coordinator of the program then worked on the final revision of the cognitive test which contained a total of 19 items and 31 blanks. Students were requested to respond with either a single word or a short phrase to complete the sentence in the space provided. (See Appendix B for a copy of the final instrument.)

Based on revisions made during the pre-testing and the development of the cognitive measuring instrument by an expert in the study of canine heartworms, the instrument was considered valid although no validity measure was obtained. Content on the slide-tape program and the information required to complete the cognitive measuring instrument were closely examined to determine content validity. All of the information required to answer the questions was found on the slide-tape program.

Attitudinal Instrumentation

One of the most widely used methods of measuring affect is the semantic differential. This instrument allows the researcher to present a variety of attitude objects. A series of scales, bound by bipolar adjectives, are employed and the subject reacts to the attitudinal object on this set of standards.

The popularity of the semantic differential is partly explained by Darnell (1964) in the following manner:

> One of the strong advantages that the SD (semantic differential) has over other comparable instruments is the speed with which it generates data. It can be administered to groups of subjects limited in number only by convenience (p. 4).

The criterion instrument used for measuring attitude in this study was a Semantic Differential. The scales used were selected intuitively to simulate an evaluative response from lists developed by Osgood. Three tenth term students provided feedback on the suitability of the bipolar adjectives selected to evaluate the program. Based on their response four of the adjectives were replaced. (See Appendix C for a copy of the final instrument.) The procedures followed are described below and were drawn from a dissertation by Bollman (1972).

1. Twenty scales were selected from Osgood's list and written in polar position as given by Osgood.
2. The scales were numbered for purposes of random drawing.
3. Individual slips were prepared for numbers 1 to 20.
4. The numbers were drawn to determine their order of presentation according to the following decision rules:

   A coin was flipped to see if the first draw should be "+" or "-" in polarity where "+" polarity is the order given by Osgood and "-" polarity was considered to be the reverse.

5. After appropriate instructions were developed, an example was given followed by the 20 ordered scales as determined in number 4.

Additional Information Questionnaire

A questionnaire was constructed to gather additional information for comparative purposes. The first question was designed to compare whether students liked or disliked the program with the

results of the semantic differential. Questions 2 and 3 asked if subjects had any difficulty seeing or hearing the program and if they had previously seen the program on canine heartworm disease. The last question was open-ended and asked for general comments on the program viewed.

The Experimental Design

The experimental design for the present research incorporates two treatment groups and a control group. The second term veterinary class, consisting of 111 students, acted as subjects for the experiment. The subjects were divided into three groups of 37, 36 and 38 respectively. A cognitive test instrument was designed to measure short-term factual recall of information presented on the slide-tape program on canine heartworm disease. Experimental group number one viewed the expensive version of the program while experimental group number two viewed the inexpensive version of the program. The control group was not exposed to either version of the program. All three groups completed the cognitive test instrument. Since there was reason to suspect that the subjects had some prior information regarding canine heartworm disease, it was considered important to determine how much information the subjects had prior to exposure to the program. The control group served this function. In addition to the cognitive instrument the two experimental groups also completed an attitudinal instrument designed to measure student attitude toward the slide-tape program viewed. A general information questionnaire designed to gather general information was also completed by the two experimental groups.

Due to non-random assignment to groups, possible differences were tested by an analysis of variance using first term grade point average as a measure. It was postulated that this grade point average would be the best indicator of future student success.

An "F" test was selected to test for significant differences among group mean scores. An alpha level of .05 and a two tailed test were selected for rejecting the null hypothesis.

The specific null hypothesis tested was:

> There is no difference in first term grade point average among the three sample groups.

TABLE 3.3.--Analysis of Variance for Determining First Term Grade Point Average Group Differences.

Sources	df	MS	F	P
Treatment between groups	2	.8476	3.8478	P<.0244
Treatment within groups	108	.2203		

F = 3.15 at alpha .05

The null hypothesis that there was no difference among the treatment groups based on first term grade point average was rejected. An estimate of contrasts was then performed at the 95% confidence interval to explore for differences between specific groups. An indication of the possible difference between the group means was obtained by computing a confidence interval as described by Kirk (1968). The confidence interval provides the estimated range of values with a given probability (1-alpha) of including the true difference between

the population means. If a confidence interval does not include zero, the hypothesis that the two population means are equal is rejected. According to Kirk (1968), confidence interval estimation permits an experimenter to reach the same kind of decision as when significant tests are used. In addition, confidence interval procedures permit an experimenter to consider all possible null hypotheses simultaneously.

TABLE 3.4.--Least Square Estimate of Contrasts to Determine Group Differences in First Term Grade Point Average Between the Expensive and Inexpensive Treatment Groups.

$\hat{o} \pm t/_2$ s.e.
$\hat{o}_1$ is Expensive vs. Inexpensive
C.I. = $-.08 \pm (2.0)\ (.11)$
C.I. = $(-.30 < o_1 < .14)$

Since the confidence interval spans zero the null hypothesis that there was no significant difference between the first term grade point averages between the two experimental groups was not rejected. This finding was considered important by the researcher since both treatment groups were exposed to alternate versions of the program. Significant differences in first term grade point average would have jeopardized cognitive score comparisons between the two groups.

A second comparison was made to determine if there were any differences in first term grade point average between the expensive treatment group and the control group.

TABLE 3.5.--Least Square Estimate of Contrasts to Determine Group Differences in First Term Grade Point Average Between the Expensive and Control Group.

$\hat{o}^2$ is Expensive vs. Control
C.I. = -0.29 ± (2.0) (.11)
C.I. = (-.51 < σ_2 < -.07)

Since the confidence interval does not span zero, thus the null hypothesis was rejected. A significant difference between the first term grade point averages between the expensive experimental group and the control group was found. The null hypothesis was rejected.

Since no difference was found between the two experimental groups it was assumed that the control group also differed in grade point average from the inexpensive experimental group. The raw mean scores among the three sample groups reflected the differences determined by analysis of least square estimates (see Table 3.6).

In summary, the analysis of grade point average revealed a significant difference among the three groups at a P value of less than .02. Least square estimate of contrasts between the two treatment groups revealed no significant differences as indicated by the confidence interval (-.30, .14). A significant difference was found

TABLE 3.6.--First Term Grade Point Average Scores for the Three Sample Groups.

Group	Score
Treatment 1 (Expensive)	3.34
Treatment 2 (Inexpensive	3.26
Control	3.05

between the expensive treatment group and the control group since the confidences interval did not span zero (-.51, -.07). Since there was no difference between the two treatment groups it was inferred that the control group was also different from the inexpensive treatment group.

Due to initial group differences it was decided to test the predictive powers of first term grade point average as a predictor of cognitive test scores. The correlation between grade point and cognitive measure was relatively low (.13).

Since sample group sizes were slightly unequal, a statistical test, as recommended by Kirk (1968), was performed to determine homogeneity of population-error variance. The Fmax statistic was selected because of its relative simplicity in comparison to more complex methods (see Table 3.7).

Since the Fmax statistic was less than the tabled value, the assumption of equal variance among the groups was not rejected. The assumption of normality was also made for statistical purposes. Both experimental groups viewed the slide-tape programs under similar

TABLE 3.7.--Fmax Test to Determine Homogeneity of Variance Among the Treatment Groups.

$$F\max = \frac{\hat{\sigma}_j^2 \text{ largest}}{\hat{\sigma}_j^2 \text{ smallest}} = \frac{4.31^2}{3.01^2} = \frac{18.58}{9.06} = 2.05$$

$n - 1 = 37$

n = largest sample group

Tabled Fmax (α- 0.5) 3, 37 $\sim$ 2.40

conditions. Crowded conditions were not seen as factors influencing test results. The projected picture size in both classrooms was the same and the acoustics were similar. Thus the assumption of independence was made based on the above observations.

An analysis of covariance, using first term grade point average as a covariate was carried out to enhance the statistical test. Although the correlation between first term grade point average and cognitive test performance was below what normally would have been considered of value, it was postulated that this adjustment could only strengthen the statistical test. According to McNemar (1962) an analysis of covariance is not dependent on a minimum degree of correlation or on a definite amount of group difference on the uncontrolled variable. The author goes on to explain, however, that if there is only a small chance difference between groups on the uncontrolled variable the use of the covariance adjustment may not be worth the effort.

Since a difference in first term grade point averages was found among the groups, an analysis of covariance was performed to test the first null hypothesis.

Null Hypothesis 1:

> No difference will be found in the cognitive mean scores among the three sample groups.

If a significant difference is found in cognitive test performance among the groups then a least square estimate of contrasts will be used to compare differences between the treatment groups and between the expensive treatment group and the control group toward the two versions of the program.

Null Hypothesis 2:

> No difference will be found between the mean cognitive test performance score of the expensive and inexpensive treatment groups.

Since the control group had some previous knowledge of canine heartworm disease it was hypothesized that:

Null Hypothesis 3:

> No difference will be found between the mean cognitive test performance scores of the control group and the treatment group receiving the expensive treatment.

For the attitudinal instrument it was decided that since no difference was found in first term grade point average between the two treatment groups, an analysis of variance would be an appropriate statistical test.

Null Hypothesis 4:

> No difference will be found between the mean attitudinal scores of treatment groups exposed to the expensive and inexpensive version of the program.

Additional information was collected on a questionnaire completed by the two treatment groups. Students were asked whether they liked or disliked the program, whether they had trouble seeing or hearing the program and if they had seen the program before. General comments and reactions to the program were also requested in an open ended question. Results collected by the researcher were listed and summarized into appropriate categories and reported.

Summary

The second term veterinary class of 111 students at Michigan State University acted as subjects for this study. An expensive and inexpensive version of a slide-tape program on canine heartworm disease was prepared. An appropriate cognitive short-term recall instrument was developed along with an attitude response form to determine attitude toward the slide-tape program viewed. A general information questionnaire was also developed to gether additional information. Three groups were selected for the experiment by an alphabetical procedure. An analysis of variance using first term grade point average was performed to determine possible differences due to non-random assignment to groups. A difference was found between the control group and the two experimental groups. Based on this result an analysis of covariance was used as the appropriate statistic to attempt to adjust mean cognitive scores based on initial differences.

The two experimental groups viewed the two versions of the program under similar conditions and completed the cognitive instrument, the attitudinal response form, and the additional information questionnaire. The control group completed the cognitive instrument

without exposure to the program to determine student knowledge of canine heartworm disease prior to exposure to the program. After collection of the instruments, coding was carried out and the results of the cognitive instrument were shuffled and given to a veterinary parasitologist to act as a blind scorer. After collection by the researcher, results from the semantic differential were transformed where appropriate and summed to determine group evaluative response toward the slide-tape program. Responses to the general questionnaire were summarized according to each question and analysed for notable differences or specific trends between the two experimental groups. The null hypotheses were then listed for statistical test purposes. Statistical procedures used to test the four null hypotheses included an analysis of covariance on possible cognitive test performance differences among groups, estimates of least square contrasts to determine possible differences between groups, and an analysis of variance to test for attitudinal differences between the two treatment groups. Results from the general information questionnaire were summarized and presented for comparative and analytical purposes.

CHAPTER IV

FINDINGS

Findings

The results of statistical tests on the null hypothesis and responses to the general questionnaire are reported in this chapter.

The first hypothesis tested in the present study for differences due to treatment was:

Null Hypothesis 1

> No difference will be found in the cognitive mean scores among the three sample groups.

The reader will recall the initial group differences were determined by analysis of variance on first term grade point averages. Initially it was postulated that this average would be a good indicator of future student success in the veterinary program.

TABLE 4.1.--Analysis of Covariance on Cognitive Test Performance Scores with First Term Grade Point Average as a Covariate.

Sources	df	MS	F	P
Treatment between groups	2	1435.6231	108.55	P < .001
Treatment within groups	107	13.2253		

F = 3.15 at alpha .05

The null hypothesis that there was no difference among the groups was rejected at the .05 level of confidence. It was apparent from the statistical results that major differences existed between at least two of the three groups.

Since a significant difference was found among the groups, comparisons between specific groups was performed to determine which groups were different from each other. These post hoc group comparisons were made by using least square estimates of contrasts to determine confidence intervals.

The second hypothesis tested is:

Null Hypothesis 2:

> No difference will be found between the mean cognitive test performance score of the expensive and inexpensive treatment groups.

An adjusted least square estimate of contrasts was calculated to determine the 95 percent confidence interval between the two groups.

TABLE 4.2.--Adjusted Least Square Estimate of Contrasts to Determine the Treatment Group Differences in Cognitive Test Scores.

Adjusted $\hat{\sigma}^1 \pm t/2$ s.e.
$\hat{\sigma}_1$ = Expensive vs. Inexpensive
C.I. = .32 ± 2 (.85)
C.I. = $(-1.39 < \sigma_1 < 2.03)$

Since the confidence interval spans zero no difference was found between the adjusted mean cognitive scores of the two experimental groups. Thus the null hypothesis is not rejected. In other words, subjects viewing the expensive version of the program did not score higher than subjects viewing the inexpensive version of the program. In fact, this is consistent with the raw mean scores of 17.5 and 17.8 respectively, for subjects viewing the expensive and inexpensive versions of the program.

The next pair of interest is the treatment group exposed to the expensive version of the program and the control group.

The third hypothesis tested is:

Null Hypothesis 3:

> No difference will be found between the mean cognitive test performance scores of the control group and the experimental groups viewing the expensive version of the program.

An adjusted least square estimate of contrasts was calculated to determine the 95 percent confidence interval between the control group and the treatment group exposed to the expensive version of the program.

TABLE 4.3.--Adjusted Least Square Estimate of Contrasts to Determine Treatment Group Differences in Cognitive Scores Between the Control Group and Treatment Group Number One (Expensive).

Adjusted $\hat{\sigma}_2 \pm t/2$ s.e.
$\hat{\sigma}_2$ = Expensive vs. Control
C.I. = $-10.90 \pm 2\ (.87)$
C.I. = $(-12.64 < \sigma_2 < -9.16)$

The confidence interval, which does not span zero indicated a significant difference between the adjusted cognitive scores of treatment group number one (expensive) and the control group. Thus, the null hypothesis was rejected.

Since no significant difference was found in cognitive test scores between the two treatment groups, and the raw mean score for subjects viewing the inexpensive version of the program was slightly higher than subjects viewing the expensive version of the program, it was inferred that the control group test performance was also different from the inexpensive treatment group. The raw mean scores for the groups were:

TABLE 4.4.--Raw Mean Scores for Cognitive Test Performance.

Group	Score
Treatment 1 (Expensive)	17.51
Treatment 2 (Inexpensive)	17.75
Control	6.32

A semantic differential was constructed to measure student evaluative response to both versions of the programs. Two extreme variations in the cost of producing illustrations for the programs led to the hypothesis that student attitude toward the two programs would be different.

The fourth hypothesis tested is

Null Hypothesis 4:

> No difference will be found between the mean attitudinal scores of treatment groups exposed to either the expensive or inexpensive versions of the program.

Attitudinal results were transformed so that in all cases one represented the most positive attitude and seven the least positive attitude. The results were then summed and a group evaluative response of the program was obtained.

Since no differences were found between the two treatment groups and the attitudinal instrument was restricted to the treatment groups, an analysis of variance was used to compare group attitudinal responses.

TABLE 4.5.--Analysis of Variance for Estimating Attitudinal Differences Between the Two Experimental Groups.

Sources	df	MS	F	P
Treatment between groups	1	23.1380	.1289	P < 7209
Treatment within groups	68	179.5213		

F = 4.00 at alpha .05

The resulting F value of .13 is well below the critical value necessary for significance at the .05 level of confidence. Thus the null hypothesis of no difference in attitudes between the two groups cannot be rejected. Because the null hypothesis was not rejected no difference in attitude between the two groups was found.

The following raw scores were obtained from the attitudinal instrument.

TABLE 4.6.--Semantic Differential Group and Average Scores.

Group	Total Group Score	Average Score for 20 Items
Expensive	58.06	2.90
Inexpensive	59.21	2.96

The results indicate that scores for the two treatment groups were very similar with the inexpensive treatment group being slightly more negative than the experimental treatment group. This slight difference was not statistically significant.

Additional data was generated by a questionnaire designed to gather information about treatment conditions and reactions to the program (see Table 4.7).

Reaction by each treatment group was generally positive toward its version of the slide-tape program. Suggestions were made that such a program would be useful in a self-study situation or, with some modifications, for educating the public about this disease. Some individuals in each group felt that too much information was presented in the allotted time and that a second viewing would have been extremely helpful.

Students viewing the inexpensive version of the program noted the rather confusing nature of some of the illustrations, i.e., the

TABLE 4.7.--Additional Information Questionnaire with Summarized Results.

		Expensive	Inexpensive
1. Did you like or dislike the slide-tape presentation, CANINE HEARTWORM DISEASE?			
	Like	36	33
	Dislike	1	3
2. Had you ever seen the slide-tape program on CANINE HEARTWORM DISEASE before?			
	Yes	37	35
	No	0	1
3. Did you have difficulty either seeing or hearing the program on CANINE HEARTWORM DISEASE?			
	Yes	6	3
	No	31	33
4. Please list any comments about the program which you may wish to express in the remaining space.*			
Category of Comments:			
Positive or complementary		4	4
Negative or derogatory		2	2
Presentation rate too fast (additional repetition required)		5	6
Improvement of technical quality required		1	3
Suggestions made to improve presentation format to increase learning		2	4
Improvement of evaluation instrument, i.e., multiple choice instrument suggested		4	1
Complexity of difficulty of subject matter mentioned		2	2
Self-study use suggested		0	1
Should not be used to teach veterinary students		0	1

*The total number of comments for the expensive version of the program was 16 while there were 21 comments on the inexpensive version of the program. Some comments are reported under more than one category.

mosquito, and the general grey appearance of some of the figures. Suggestions to improve the inexpensive version of the program included improving the clarity of the illustrations, adding microscopic slides, increased repetition and some form of questioning to accompany the presentation.

Comment from students viewing the expensive version of the program tended to be more positive in their appraisal of the program, i.e., "excellent, outstanding presentation." Suggestions to improve the expensive version of the program included the need for increased repetition and final evaluation in the form of multiple choice questions was suggested.

In each group some difficulty was reported either seeing or hearing the program. This was attributed to the crowded conditions of the experimental classrooms where the programs were viewed. While playback conditions were not considered to be ideal for both groups, they were considered to be adequate for the basic transmission of the message. Cognitive test performance of the treatment groups also indicated that learning had taken place.

Discussion of the Findings

The first hypothesis tested was designed to determine any effect that treatment might have among the three sample groups.

An analysis of covariance using first term grade point average as a covariate rejected the null hypothesis of no difference among the three sample groups at the .05 level of confidence. On closer analysis of the tabled values it was revealed that the null hypothesis

was rejected beyond the .001 level of confidence indicating a strong difference due to treatment between at least two of the groups.

In analysing the effectiveness of the covariate it was obvious that first term grade point average was a poor predictor of cognitive test performance. At a correlation value of .13 it would have been desirable to obtain other possible covariates such as aptitude. Since other possible predictors were unavailable the researcher decided to continue his analysis using first term grade point average. It was apparent that the adjusted scores would not significantly effect the results, however, the slight adjustment could only improve the results. The difference between subjects exposed to the expensive program and the control group was significant at the .05 level of confidence.

The second hypothesis dealt with the effects on cognitive learning of exposure to either version of the program. The estimate of least square contrasts revealed no significant differences in short term cognitive recall between the two treatment groups. It is interesting to note that, although not statistically different, the mean of the treatment group exposed to the inexpensive version of the program was 0.236 higher than the treatment group exposed to the expensive version of the program.

Recent publicity on canine heartworm disease and previous student experience with veterinary practices prompted the formulation of the third hypothesis. It was hypothesized that cognitive test results would not be significantly different between the experimental and control groups. The results of the adjusted least square estimate

of contrasts demonstrated, at a 95 percent level of confidence, that a difference existed between the control and experimental groups. The results, as measured by short term cognitive recall, demonstrated that vital information required to pass the cognitive test in canine heartworm disease had been transmitted during the treatment effect. The mean score for the experimental groups exposed to the expensive and inexpensive versions of the program were 17.5 and 17.8, respectively. The mean score for the control group was 6.3. From these scores it appears evident that the slide-tape program had a significant impact in transmitting new information about canine heartworm disease to second term veterinary students.

The qualifications of the two illustrators, the techniques used to produce the illustrations, and the costs of the two versions of the program varied considerably. The price differential of approximately $2,300.00 was reflected in the appearance of the illustrations in the two programs. The fourth hypothesis stated that student attitude would be more positive toward the expensive, professionally prepared program when compared with the inexpensive version of the program. An analysis of variance of semantic differential scores revealed no significant difference in the attitude between the two groups toward either version of the program. A P value of less than .7209 indicated no significant difference between the groups. Apparently the attitude, or evaluative response as measured by the instrument, did not detect any differences between the two groups.

Raw mean scores for the expensive and inexpensive treatment groups on the semantic differential were 2.90 and 2.96, respectively.

Since four represented a neutral score and one was the most positive score possible, the results were interpreted as being somewhat positive toward each version of the program.

One possible explanation for the lack of differences in attitude is the desire and the ability of highly competetive second term veterinary students to absorb new information. It is also possible that the primary concern of the students was the mastery of new complex concepts. Under these conditions the method or techniques used to illustrate the concepts may have been reduced to a level of secondary importance. The importance of the message in relation to the seriousness of the problem of canine heartworm disease would tend to heighten the above effect.

The additional information questionnaire revealed that students in both treatment groups generally liked the program. This may partly be explained by the previous lack of information in an illustrated program about canine heartworm disease. It is also possible that students liked the logical or sequential development of the program.

Apparently some difficulty either seeing or hearing the program was reported by a total of 9 out of a possible 73 subjects. One possible explanation for this result was the lack of desirable space in the veterinary clinic for conducting the experiment. The decision to conduct the experiment under less than ideal conditions was prompted by the limited options available to the researcher. Since it was necessary to minimize disruption of normal classroom procedures, the two available instructional spaces most conveniently located were

utilized. It was postulated that although some communication interference occurred due to limited space, treatment conditions were sufficient for transmission of the basic message.

No differences in the number of positive responses was noted in comparing both versions of the program. It was noted, however, that a few student responses toward the expensive version of the program tended to be somewhat more positive, i.e., "an excellent program," "outstanding." Apparently a few students did appreciate the talent and the resources required to produce the final expensive version of the program.

A major concern of a number of students was the presentation rate. One possible explanation for this observation was the complex nature of the transmitted message and the automated manner in which it was presented. Since students had no control over the rate of presentation and were not given the opportunity to view the material a second time it was to be expected that comments on the presentation rate would be made. The rate of presentation and the complexity of the subject resulted in suggestions to improve the teaching efficiency of the program. These suggestions included greater repetition within the program, the use of questioning to accompany the program and improved evaluation techniques.

Results from the attitudinal measures and the general questionnaire were difficult to compare directly. However, it did appear that the respective programs were each favorably received by the groups.

CHAPTER V

SUMMARY AND CONCLUSION

Summary

The present research studied the effect on cognitive learning and attitude of an expensive and inexpensive version of a slide-tape program. The automated presentation was designed to provide veterinary students with information on canine heartworm disease. Two illustrators, with wide differences in professional preparation and graphic ability, prepared and documented the cost of producing the illustrations. Production costs for the two versions of the program are restricted to the cost of producing illustrated material for 39 out of a total of 49 slides. The inclusion of ten visuals (eight photographs and two radiographs) in both versions of the program were a possible source of contamination to the final results of this study. These visuals, which were provided by the veterinarian and considered important to the program, were included because the researcher did not know of any way to economically reproduce the visualized concepts.

The 17 minute script, which was prepared by the veterinarian, in consultation with the researcher, was transcribed onto an audiotape by the veterinarian. Professional recording facilities and expertise were utilized. The final cost of reproducing the script onto a cassette audio tape was approximately twenty dollars and required one

hour of recording time. This cost was not included in the comparative costs for both versions of the program.

Developmental time, which was also not accounted for in the final cost comparison, was substantially greater for the expensive version of the program. The fact that existing information was limited and often confusing, required a concerted effort over an eight month period to research and prepare the first rough storyboard on which the final versions of both programs were based. Since the inexpensive version of the program was based on the rough storyboard prepared for the expensive version of the program, the developmental time was much shorter. Consequently, suitable illustrations for tracing purposes were collected over a two week period by the researcher.

Although the costs of producing the visualized materials in both programs have risen dramatically during the last year, the researcher feels that the absolute production costs between the two programs has remained basically the same.

Two experimental groups and one control group of second term veterinary students, selected alphabetically, acted as subjects. The experimental groups viewed either the expensive or inexpensive version of the program while the control group completed the cognitive instrument. In addition to the cognitive instrument, which was designed to measure short term recall of program content, the experimental groups also completed an attitudinal instrument and a general questionnaire.

Due to non-random assignment to sample groups an analysis of variance was performed to determine possible group differences using first term grade point averages. No difference was found between the

experimental groups, however, a significant difference was found between the control group and the experimental groups. This finding was not viewed as a significant threat to the study since the difference was restricted to the control group. Since no ethnic or other group differences could be identified within the sample population the researcher could only attribute significant group differences in first term grade point averages within the control group to chance.

The results from the cognitive, attitudinal and general information questionnaire were collected and coded. All the results from the cognitive instrument were then shuffled and submitted to a veterinary parasitologist to act as a blind scorer. The researcher collected and sorted the other results. The final results from the cognitive and attitudinal instruments were subjected to statistical analysis. Since a difference in first term grade point average was found between the control group and the two experimental groups, first term grade point average was used as a covariate to test for differences in cognitive test performance. First term grade point average was a weak predictor of cognitive performance (.13), however, since no other predictors were available, it was used.

The following four hypotheses were examined by the following statistical procedures. Hypothesis one was examined by analysis of covariance. Hypotheses two and three were examined by adjusted least square estimates, and hypothesis four was examined by an analysis of variance.

The appropriate null hypotheses were:

1. No difference will be found in the cognitive mean scores among the three sample groups.

2. No difference will be found between the mean cognitive test performance score of the expensive and inexpensive treatment groups.

3. No difference will be found between the mean cognitive test performance scores of the control group and the experimental group receiving the expensive treatment.

4. No difference will be found between the mean attitudinal scores of treatment groups exposed to the expensive and inexpensive versions of the program.

One of the primary difficulties encountered by the researcher was finding a suitable time and space to conduct the experiment. An extremely heavy course schedule and limited available space to conduct the study imposed certain hardships on the researcher and the subjects. Although the arrangements made were not considered to be ideal, they were considered adequate to test the statistical hypotheses and are assumed not to have affected the results.

Based on exposure to the program the findings revealed a significant difference in cognitive test performance among the three sample groups. On closer analysis no difference was found between the two experimental groups. A significant difference was found between the control group and the two experimental groups.

The attitudinal hypothesis of no difference between the treatment groups was not rejected, thus finding no support for the hypothesis that increased expense for illustrations improves student attitudes. The researcher speculates that one possible reason for failing to reject the null hypothesis was student motivation and the nature of the message. Under circumstances in which students are

highly motivated and the message perceived is considered to be important, it is possible that the importance of attitudes is diminished.

A second possible explanation for similar cognitive test performance scores between the two treatment groups is that students viewing the inexpensive version of the program may have received all their information from the audio channel. It is possible that the poor visuals may have caused students to completely ignore the illustrated messages.

A third possible explanation for similar cognitive performance scores is that students viewing the inexpensive version of the program may have consciously blocked out imperfections in the visual channel while switching to the audio channel for their information. In other words, channel selection for information may have been based on the clarity and synchronization between the audio and visual message. It is recommended that future research in this area isolate specific channels of communication for examination purposes.

The information gathered in the general questionnaire did not reveal any major differences between the two experimental groups. This finding was consistent with the results of the semantic differential which revealed no major differences in attitude between the two groups. A few comments on the questionnaire were noted as being slightly more positive for subjects viewing the expensive version of the program but were not reflected in cognitive test performance or attitudinal scores. Difficulty in either seeing or hearing the program was attributed to less than ideal treatment group conditions, however,

it was postulated that conditions were adequate for the basic transmission of the message. It was also noted that treatment conditions for both groups were essentially the same.

Conclusions

Several conclusions are made from the findings summarized above:

1. Cognitive test performance, as measured by the cognitive instrument, was not significantly different between students exposed to the expensive and inexpensive versions of the program.

2. Students who were not exposed to the program had cognitive scores significantly lower than students exposed to the program indicating that the program did in fact teach.

3. The attitudes of students as measured by the semantic differential was not affected by the cost involved in the production of illustrations for the expensive and inexpensive versions of the program.

4. A few student comments toward the expensive version of the program were interpreted as being more positive, however, this was not reflected in group cognitive test performance or attitudinal scores.

Implications

Similar cognitive performance and attitudes toward both versions of the program indicate that the time (8 weeks), and the expense ($2486.75) required to produce the expensive version of the program was unwarranted. Despite possible contaminants of the study

such as two channels of information and use of ten of the same visuals in both versions of the program, the researcher feels that production costs for illustrations can be lowered without reducing the effectiveness of instruction. The results of this study imply that the designers and the producers of illustrated material should give more attention to excluding extraneous visual details in the attainment of specified objectives. The efforts of talented individuals would thus be spent in clearly portraying specified concepts and not in the simulation of reality. While developmental time may remain essentially the same, substantial time could be saved and output increased during the production stage. Material cost could also be reduced by emphasizing simplicity and legibility in the transmission of information designed to meet basic instructional objectives. These findings are in accord with research reviewed for this study which has established the increased learning effectiveness of simplified visuals.

Implications for administrators are that money spent on highly refined, realistically portrayed products may be a waste of money. Where alternative inexpensive products are available that convey the same message, they should seriously be considered for purchase. This may be even more true in areas of education such as medical education where new information and changing theories tend to date the production of much illustrated material in a short period of time. The ultimate success of the final product is closely related to the amount of time and effort spent in determining the essential features to be illustrated.

Illustrations produced to simulate reality may be useful for identification purposes, however, based on the results of this study and the literature reviewed, the researcher has concluded that the effort and expense of realistically portraying most illustrated material cannot be justified on the basis of improved learning outcomes.

Suggestions for Future Research

The results of this study along with the majority of the literature reviewed indicated no direct relationship between the cost of production of instructional materials and the educational benefits derived. Additional support to either refute or support the above statement is required.

The following research is recommended:

1. Cost-benefit studies be carried out at all production levels to determine the most efficient means to design and produce more effective instructional materials.

2. In comparing the effectiveness of production costs an attempt should be made to identify the separate channels of communication along with their specific contribution. This would allow a more detailed comparison of cost and benefit.

3. Instructor tolerance levels for varying production procedures should be determined. It is postulated that these minimal standards would be well above student stimulation threshold limits. Guidelines or information in this area could be extremely useful for the designers and producers of instructional materials.

4. Additional research is required to determine the exact nature of the perceptual process and the minimal cues required in the identification of messages.

5. Research is required to document the amount of "realism" being produced or used within an instructional setting. Documentation of individuals using this material, instructional effectiveness and the establishment of quality standards would all help in analysing and understanding this phenomenon.

6. A study is needed in which a professional illustrator produces two extreme cost variations of the same program and a comparison is made of learning efficiency and effectiveness between the two programs.

7. Replication of this study with refined instrumentation and random sampling procedures in medical education is highly recommended.

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APPENDICES

APPENDIX A

INSTRUCTIONS READ TO CLASS

READ THE FOLLOWING TO THE ENTIRE CLASS:

Today, thanks to the cooperation of Dr. Cunningham, you are asked to participate in a short experiment. Your assistance will be invaluable and in return it is hoped that you will find the experience interesting.

Group I	A-149	Anderson Gorham
Group II	S-123 (Instrumentation Room)	Goring Novosac
Group III	Auditorium	Nurse Zimmer

Please return to the Auditorium as soon as you have completed the examination.

Thank you.

APPENDIX B

COGNITIVE RECALL INSTRUMENT AND INSTRUCTIONS

CANINE HEARTWORM DISEASE

COLLEGE OF VETERINARY MEDICINE

MICHIGAN STATE UNIVERSITY

NAME _____

TERM _____

DATE _____

GROUP _____

This instrument has been designed to measure your knowledge of and attitude towards the slide-tape presentation on CANINE HEARTWORM DISEASE.

Please print your answers in the right hand column and follow all instructions.

This instrument is solely for experimental purposes and has nothing to do with your course evaluation.

Your assistance and cooperation are appreciated.

Thank you.

CANINE HEARTWORM DISEASE

POSTEST

Answers may be a single word or a short phrase:

The two techniques used to detect circulating larval stages by concentration and killing are (1) and (2). (1) _____ (2) _____

Development of the second stage takes place in the (3) of the vector. (3) _____

Clinical signs of an infected animal may include (4), (5), and (6). (4) _____ (5) _____ (6) _____

Chemotherapy may include use of (7) and (8) for killing of Adult and Microfilaria Larvae respectively. (7) _____ (8) _____

The primary host of the heartworm is the dog; another domestic host occassionally infected is the (9). (9) _____

A surgical procedure which could be used for removal of heartworm is a (10). (10) _____

Juvenile worms appear in the (11) of the heart after (12) months post infection. (11) _____ (12) _____

The larval stage (L_1) ingested by the vector is called a (13). (13) _____

Signs seen on radiographs of the thorax of a clinically affected dog may include (14) and (15). (14) _____ (15) _____

Length of the adult heartworm is approximately (16). (16) _____

An animal in the wild that has been occasionally found infected is (17). (17) _____

The following characteristics of dirofilaria immitis larva provide a differential diagnosis based on morphology (18), size (19), and motility (20). (18) _____ (19) _____ (20) _____

Clinical signs of heartworm disease principally involve the (21) system. (21) _____

The stage of larva most susceptible to prophylactic chemotherapy is the (22) at (23) days post infection. (22) _____ (23) _____

Mature adults are found in the (24) by (25) months post infection at the earliest. (24) _____ (25) _____

The infective larval stage is called the (26) and exists from the vector via the (27). (26) _____ (27) _____

The cell type which may increase in numbers during a heartworm infection is the (28). (28) _____

Differential diagnosis must be made between (29) and (30). (29) _____ (30) _____

Diagnosis of heartworm infection in the asymptomatic dog is accomplished by the following kind of test. (31). (31) _____

APPENDIX C

ATTITUDINAL INSTRUMENT AND INSTRUCTIONS

INSTRUCTIONS

The purpose of this instrument is to measure the meaning of things to various people by having you judge them against a series of descriptive scales.

The next page contains a topic followed by several pairs of adjectives which are opposite in meaning. You are to check one of the seven blank spaces between each pair of objectives according to how you rate the concept at the top.

EXAMPLE

FARMING

IMPORTANT ____: ____: ____: ____: ____: ____: ____: UNIMPORTANT

The more "IMPORTANT" you feel this concept is, the closer to the word "IMPORTANT" you would place your check mark. the more "UNIMPORTANT" you feel the concept is, the closer to the word "UNIMPORTANT" you would place your check mark.

If it is hard to decide if it is "IMPORTANT" or "UNIMPORTANT", or you feel the adjective pair is not relevant to the particular concept, place a check mark in the central space. A check mark at the center of the scale means "undecided" or "Irrelevant". You are to rate the concept at the top of the page on all the scales on that page.

There are no right or wrong answers. Your task is to indicate your personal feeling toward the concept by placing a single check mark ( ) on each adjective scale. The best response is what you feel is appropriate RIGHT NOW. Put down your first impression. Although the adjectives may not express your exact feelings, you should work fairly quickly and give your first impression on each scale.

EXAMPLE

GOOD _____:_____:_____:_____:_____:_____:_____: BAD
(very) (quite) (slightly) (neutral) (slightly) (quite) (very)

Please place a check mark ( ) between each pair of adjectives to show your personal feelings at this moment toward the SLIDE-TAPE PRESENTATION:

CANINE HEARTWORM DISEASE

REPUTABLE ___: ___: ___: ___: ___: ___: ___: DISREPUTABLE

SUBTLE ___: ___: ___: ___: ___: ___: ___: OBVIOUS

INTERESTING ___: ___: ___: ___: ___: ___: ___: BORING

DIRTY ___: ___: ___: ___: ___: ___: ___: CLEAN

SMOOTH ___: ___: ___: ___: ___: ___: ___: ROUGH

CARELESS ___: ___: ___: ___: ___: ___: ___: DELIBERATE

SIMPLE ___: ___: ___: ___: ___: ___: ___: COMPLEX

FALSE ___: ___: ___: ___: ___: ___: ___: TRUE

SUCCESSFUL ___: ___: ___: ___: ___: ___: ___: UNSUCCESSFUL

WORTHLESS ___: ___: ___: ___: ___: ___: ___: VALUABLE

COLORFUL ___: ___: ___: ___: ___: ___: ___: COLORLESS

SUPERFICIAL ___: ___: ___: ___: ___: ___: ___: PROFOUND

CLEAR ___: ___: ___: ___: ___: ___: ___: HAZY

UNPLEASANT ___: ___: ___: ___: ___: ___: ___: PLEASANT

IMPORTANT ___: ___: ___: ___: ___: ___: ___: UNIMPORTANT

VAGUE ___: ___: ___: ___: ___: ___: ___: PRECISE

VALUABLE ___: ___: ___: ___: ___: ___: ___: WORTHLESS

COMPLEX ___: ___: ___: ___: ___: ___: ___: SIMPLE

PLEASING ___: ___: ___: ___: ___: ___: ___: ANNOYING

BAD ___: ___: ___: ___: ___: ___: ___: GOOD

APPENDIX D

ADDITIONAL INFORMATION FORM

The following information will also be of assistance:

1. Did you like or dislike the slide-tape presentation, CANINE HEART-WORM DISEASE?

   _____: Like

   _____: Dislike

2. Had you ever seen the slide-tape program on CANINE HEARTWORM DISEASE before?

   _____: Yes

   _____: No

3. Did you have difficulty either seeing or hearing the program on CANINE HEARTWORM DISEASE?

   _____: Yes

   _____: No

4. Please list any comments about the program which you may wish to express in the remaining space.

   _____

   _____

   _____

   _____

   _____

APPENDIX E

PROGRAM OBJECTIVES FOR CANINE HEARTWORM PROGRAM

COLLEGE OF VETERINARY MEDICINE

MICHIGAN STATE UNIVERSITY

CANINE HEARTWORM PRESENTATION

Program Objectives:

After studying the slide-tape program on canine heartworm disease, the veterinarian will be able to:

1. Identify the seriousness of the problem

2. List the microfilaria developmental sequence and molting time in the mosquito and the dog.

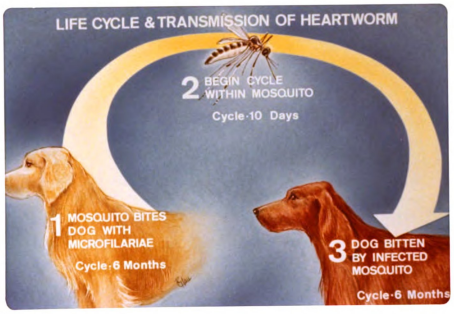
3. List diagnostic procedures for heartworm detection.

4. List a preventive medicine program for dogs in an endemic area.

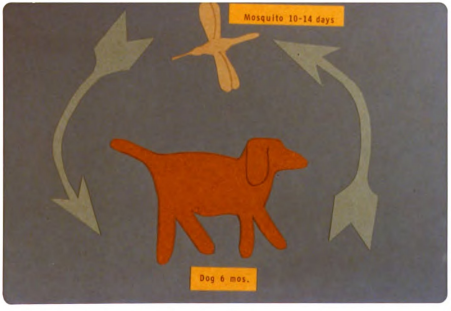
5. List therapeutic measures for dogs found infected.

APPENDIX F

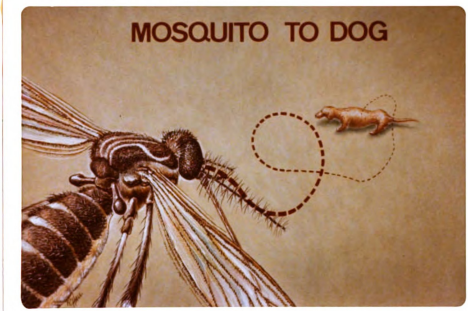
SAMPLE COLORED PHOTOGRAPHS OF SLIDES FROM THE EXPENSIVE AND INEXPENSIVE VERSION OF THE PROGRAM



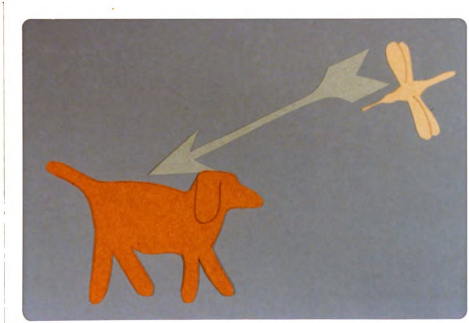
Slide No. 5 - Expensive S/T Program



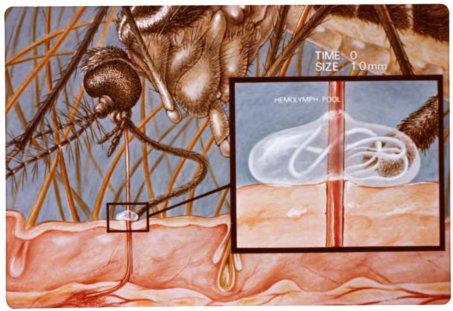
Slide No. 5 - Inexpensive S/T Program



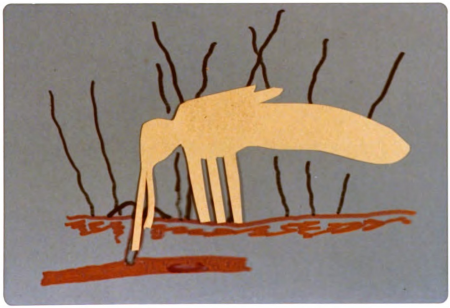
Slide No. 14 - Expensive S/T Program



Slide No. 14 - Inexpensive S/T Program



Slide No. 16 - Expensive S/T Program



Slide No. 16 - Inexpensive S/T Program

APPENDIX G

SCRIPT

CANINE HEARTWORM DISEASE

SLIDE - TAPE PRESENTATION

SCRIPT ( ) - Omitted from altered version
P - Microphotographs, photographs, radiographs

CANINE HEARTWORM DISEASE

Produced for the College of Veterinary Medicine

Prepared by the Biomedical Communications Center

Slide No.	Description
1	"Canine Heartworm Disease," is a slide-tape program.
2	Created and produced for the College of Veterinary Medicine (by Bio-medical Communications Center,) Michigan State University.
3	Canine dirofilariasis or heartworm disease has become of national importance as it has spread from the costal areas of the South Atlantic and Gulf States to the northern and western United States.
4	In Michigan, canine dirofilariasis has reached epidemic proportions during the past decade.
5	The life cycle of *Dirofilaria immitis* principally involves the dog and mosquito. The cycle in the dog requires about 6 months and in the mosquito 10-14 days.
6	The dog is regarded as the primary definitive host. Only a few cats have been found infected, but this may be misleading since we have not examined many cats for this infection. In the wild, the red fox in the North Central States has been

found to occasionally harbor heartworm. It is a doubtful reservoir host. Over 40 human cases have been reported, but these are mostly incidental findings.

7 Over 30 species of mosquitoes have been reported as possible vectors. Most of these have been experimentally infected with few showing development of infective forms. In any given geographic area, it is likely that there is a certain species best suited for transmission of heartworm.

8 The mosquito becomes infected by ingestion of the first larval stage (L_1) or microfilaria, when it feeds upon blood of an infected dog.

9 In the mosquito, a biological development of three larval stages occurs. The mosquito then is a necessary vector. As stated previously, this requires 10-14 days.

10 The L_1 is ingested via the food channel of the proboscis and arrives in the posterior part of the midgut in approximately 12 hours. It is 300μ at this time. After 36 hours, the L_1 is found within the cells of the Malpighian tubules and shortens in length to 170-210μ. It is then known as the "sausage" form.

11 An intracellular molt to the second larval stage or L_2 form occurs during the first week.

12 A second molt then takes place during the second week, and the third larval stage or L_3 form moves into the hemocoel. The L_3 is the potential infective stage, and may fulfil that

role if it passes into the labial channel which is an extension of the hemocoel.

13 To recapitulate the cycle in the mosquito, the L_1 is ingested via the food channel of the proboscis, moves to the Malpighian tubules via the alimentary tract, molts to the L_2 stage while within cells which line the tubules, and then molts to the L_3 or infective form which passes into the labial channel of the proboscis.

14 To continue the life cycle of the heartworm, the infected mosquito must then find a dog. Mosquitoes are infective for life and thereby serve as an important reservoir of infection for the dog population.

15 The dog also is a biological host as it is necessary for development of the heartworm from the L_3 to the L_4 and then to the L_5 or juvenile adult stage.

16 The mosquito penetrates the skin with its proboscis, except for the labium which is bent back. A pool of hemolymph escapes from the labium and collects over or near the puncture wound caused by the piercing mouthparts.

17 Infective larvae present in the hemolymph may then pass down through the skin as the proboscis is withdrawn. The L_3 form at this time is about 1000μ or 1.0 mm in length. After 10 days in the subcutaneous tissues, it molts to the L_4 stage.

18 The L_4 may begin its migration after 60-70 days. Its route through the viscera is poorly understood. It may reach the heart after passing through the liver, or may arrive in the lungs, and then reach the heart via the pulmonary arteries. The L_5 or juvenile adult then appears in the right side of the heart.

19 The L_5 is seen about 3-4 months after infection, and is 1-3 cm
20 in length. Maturation is reached by 4-7 months, with adults often moving from the right ventricle into the pulmonary arteries. Females are 20-30 cmm long and males 15 cmm. At this time, microfilariae are produced. Here it should be emphasized that 6-7 months may be required from time of infection (mosquito season) until circulating microfilariae are found (time of patency in an asymptomatic dog).

21 To summarize, the L_3 is an infective form transmitted by the mosquito, the L_4 migrates through the viscera, and the L_5 or juvenile adult is found in the right ventricle. Microfilariae are produced by the adult, circulating through the peripheral vasculature, and may be ingested by mosquitoes during a blood meal.

22 P Adults may congregate in the right ventricle, sometimes in large numbers such as 1-2 dozen as shown here.

23 P The arrow just to the right of center points out the entrance to the pulmonary artery into which these worms may move.

24 P Adult males are fewer in number than females and are readily distinguished by their cork-screw-shaped tail.

25 Diagnosis of heartworm disease can be made based on (1) clinical signs, (2) thoracic radiography, (3) blood exam for microfilariae, and (4) eosinophilia.

26 Clinical signs may include decreased exercise tolerance, dyspnea, possible prostration, frequent respiratory infections, and even death due to cardiac failure.

27 If an adult heartworm infection is suspected confirmation can often be made by thoracic radiography. Lateral and dorsoventral radiographs may show right ventricular hypertrophy (RVH), pulmonary artery hypertrophy (PAH), post vena cava dilatation, and increased tortuosity of pulmonary vessels.

28 P This lateral radiographic view of the thorax shows loss of both anterior and posterior waists (arrows at base of heart) and PAH (arrows at upper right).

29 P This dorsoventral view of the thorax shows rounding of the cardiac silhouette. Note the arrow pointing to the left border of the heart.

30 Examination of venous blood for microfilariae is recommended, especially in the Spring prior to the mosquito season. A direct smear may be made to determine if microfilariae are present and to ascertain type of motility if they are found. Concentration techniques are frequently used so that false negatives due to low numbers are not reported. One of these

methods is the use of the microhematocrit tube, in which microfilariae will appear in the plasma near the buffy coat after centrifugation. Plasma may be placed on a microslide by breaking the tube, and motility may then be observed microscopically. The other two techniques kill and concentrate the microfilariae and are described by the following two slides.

31 The modified Knott's technique employs formalin (2%) to preserve integrity of size and shape of the microfilaria. A one ml blood sample is mixed with 10 ml of formalin, the supernatant decanted and methylene blue is then added to the precipitate, mixed, and a drop of this stained preparation is examined microscopically.

32 A newer technique is the filter method in which blood is mixed with a detergent for lysis of cells using 35 ml lysing fluid to 5 ml blood, the mixture is passed through a 5μ pore filter and the filter is then stained and examined microscopically. The lysing solution causes a shrinkage of microfilaria by 75-100μ. To prevent this, formalin may be used in lieu of lysing solution.

33 Eosinophilia often accompanies heartworm disease, with eosinophils accounting for 50-70% of the total white blood cell count. This may be due to sensitization of body tissues.

34P A canine eosinophil is shown here in the middle of the field.

35 A diagnostic problem results from confusion of the microfilariae of *Dipetalonema reconditum* with those of *D. immitis*. *Dipetalonema* adults are nonpathogenic parasites of the subcutaneous tissues, their microfilariae are found in the peripheral circulation, and the flea serves as their vector.

36 Differential diagnosis is therefore important.

37 *Dirofilaria* microfilariae are many in number, vigorous but with little forward progress, and 290-320μ x 6.7-6.9μ. In contrast microfilariae of *Dipetalonema* are few in number, exhibit rapid and progressive motility, and are 240-285μ x 4.7-5.8μ.

38 *Dirofilaria* microfilariae have tapered heads and straight tails, whereas about 1/3 of the *Dipetalonema* microfilariae have button-hook tails and blunted heads with anterior sides being parallel.

39 P This is a photomicrograph of a *Dirofilaria* microfilariae which illustrates the tapered anterior and posterior ends.

40 P The *Dipetalonema* microfilaria shown here has a blunted anterior end and a button-hook tail.

41 P A comparison of the anterior ends of *Dirofilaria* and *Dipetalonema* microfilariae.

42 P A comparison of the posterior ends of *Dirofilaria* and *Dipetalonema* microfilariae.

43 A treatment program may employ either chemotherapy or surgery.

44 Surgery is indicated if marked cardiorespiratory changes are detected by clinical signs, electrocardiography and thoracic radiography. Often large numbers of adults may be responsible for clinical changes, and require surgical removal, e.g., pulmonary arterotomy. Dogs which are seriously diseased may not tolerate chemotherapy which kills the adult worms and produces emboli which are then carried to the pulmonary circulation.

45 Chemotherapy may be elected to rid a dog of its adult heartworm burden. This is usually initiated in late Winter or early Spring in the temperate zone, often because it is not until then that microfilariae are detected. Prophylaxis is used during the mosquito season.

46 Chemotherapy begins with intravenous injection of an arsenical such as Caparsolate^{R} twice a day for two days, in order to kill the adult heartworm. It is suggested that the animal be hospitalized during the treatment period in order to monitor liver function. After 6 weeks, a microfilaricide such as dithiazine iodide or Dizan^{R} should be used until microfilariae are no longer found in blood samples. Prophylactic treatment is used to kill migrating larvae, i.e., the L_4 stage, just following its molt (10-20 days post-infection). Diethylcarbamazine compounds such as Caricide^{R} may be used in tablet or liquid form on a daily basis during the mosquito season. If a dog does not tolerate daily dosing, treatment every second or third day can be tried.

47 The compounds displayed are commonly used in therapy, viz., Caparsolate^{R}, Dizan^{R} and Caricide^{R}.

48 In summary, canine heartworm disease has become a problem in much of the United States. It principally involves a dog-mosquito cycle with the length of the cycle about 10-14 days in the mosquito and 6-7 months in the dog. Dogs clinically affected display dyspnea, decreased exercise tolerance and cardiac changes. Therapeutic treatment may be surgical or pharmaceutical. The goal is to eliminate adults and then microfilariae. Prophylactic treatment is necessary to prevent visceral invasion of the migratory larval form.

49 This material has been prepared by Robert M. Corwin (and Richard C. Hall of) Michigan State University (with grateful acknowledgement for the counsel and coordinating efforts of George Koski.)

APPENDIX H

COST DOCUMENTATION

EXPENSIVE VERSION OF THE PROGRAM

BIOMEDICAL COMMUNICATIONS CENTER

LIFE SCIENCE A-252 353-9700

JOB ORDER

DATE DELIVERED February 15, 1974 JOB NUMBER #1499

ACCOUNT NUMBER _____ DATE January 3, 1974

CLIENT Dr. R. M. Corwin, Vet. Med. PHONE 353-9667 - Vet Clinic A17 DEPARTMENT Vet. Med.

FINAL DUE DATE _____ TAKEN BY R. C. Hall APPROVED BY H. Andrews

JOB DESCRIPTION	ASSIGNED TO	DUE
Partial or complete revision of slide lecture program on dirofilaria immitis (heartworm) in dogs. Multi media drawings and graph -- approx. 40 - 50 pieces total with some drawing modified for student b & w handout	Rich Hall	
Estimated developmental time - 60 hours		
SPECIAL INSTRUCTIONS (Final format, Reproduction technique, Publication specifications)		

LABOR

ARTIST — HOURS

Developmental Time -- 8 weeks
180 hr. prod'n. (plus 60 admn.)

Student: Linda - 8.5 Sam 12
Thom - 30.0 Ruth 9
Judy - 72.0 Kathy 14
Photographers - 6.5

JOB COST

Artist - 180 hr. @ 5.00	- 900.00
Student 145.5 hr @ 5.00	727.50
Photographer 6.5 hour @ 5.00	32.50
Materials	416.75
25 Medical Illustrations @ 8.00	200.00
42 graphics (lettering graphs) @ 5.00	210.00
TOTAL	$2486.75

MATERIALS

3- 11x14 Pos. I Prints @ 1.00 -- $3.00	
15 I1 Ford Process 8 x 10 prints @ 2.00 - $30.00	
39 8x10 photo prints @ 2.00	78.00
150 Acme Animation Cells @ .11	16.50
40 Pos 1 Neg. film Kodelith-11x14@ 2.50	100.00
50 sheets 3M color key (wh .) @ 1.50	75.00
10 sheets Chartpak lettering @ 1.50	15.00
25 sheets 3M color key @ 1.25 (transpare)	31.25
3.5 rolls of film and processing plus composite titling	68.00
	416.75

Department Head or Authorized Representative — Date

Harry T. Andrews 15 Feb '74

APPENDIX I

COST DOCUMENTATION

INEXPENSIVE VERSION OF THE PROGRAM

COST: INEXPENSIVE VERSION

Labor:

Illustrator -- 21 hr. at $2.30/hr.	$48.30
Photographer -- 3.5 hr. at 5.00/hr	17.50
	$65.80

Materials:

12 Sheets acetate (8 x 10) @ .05¢.	.60
10 Sheets multi colored construction paper (18 x 12) @ .04.	.40
40 Sheets tracing paper @ .01¢	.40
3.5 Rolls of film plus processing.	31.50
Composite titling of 6 slides.	36.50
	69.40
TOTAL	$135.20