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University of Alberta

The Role of Visual Testing when Learning from Instructional Multimedia

by

Richard Poon ©

A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfillment of the requirements for the degree of Master of Education.

in

Instructional Technology

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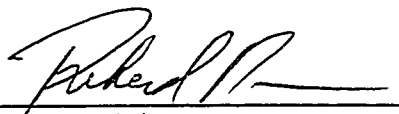

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UNIVERSITY OF ALBERTA

Faculty of Graduate Studies and Research

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled **The Role of Visual Testing when Learning from Instructional Multimedia** submitted by **Richard Poon** in partial fulfillment of the requirements for the degree of **Master of Education** in **Instructional Technology**

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February 28, 1997

DEDICATION

I would like to dedicate this thesis to my loving and caring wife, Kathleen and to my lovely children, Christopher, Kyle and Kassandra. Thank you for your perseverance and patience in allowing me to achieve this goal.

ABSTRACT

The purpose of this research was to investigate selected effects of visual testing upon learning from an interactive multimedia (IMM) program. The hypothesis tested was that after completing an IMM program, students who receive visual testing will obtain higher achievement levels on identification, terminology and comprehension tests than students who receive non visual versions of the tests.

An experimental methodology was used for the study. The independent variable was the presence or absence of visual testing and the dependent variables were learning as defined by student performance on identification, terminology and comprehension tests. All treatment groups completed an IMM lesson on the anatomy and physiology of the pregnant female, the stages of labour and delivery and the procedures to prepare for an imminent delivery. Sixty-two Emergency Medical Services students in the study were randomly divided into two treatment groups. Following the IMM lesson, treatment group one received a verbal test complemented with visuals and treatment group two received a verbal test with no visuals. Two to seven days later, the students received a second evaluation. In the second evaluation, treatment

group one was evaluated with a verbal test with no visuals and group two was evaluated with a verbal test complemented with visuals.

Data were analyzed using repeated measures analysis of variance and Scheffé pairwise comparisons. The results of the study showed that students who received the visual identification test did significantly better than students who received the verbal identification test. There was no significant difference found for student performance on the visual and verbal terminology test or the visual and verbal comprehension test.

The researcher concluded that visual testing is beneficial for identification learning objectives. The lack of significant difference for the terminology and comprehension tests might be attributed to influences of: the students' lack of familiarity with visual testing, the type of rehearsal activities used in the instructional lesson, the way the visuals were used and the types of visuals used for visual testing, the effect of novelty in learning by IMM and the high competency requirements of the IMM lesson content. Recommendations for application and further research were presented by the researcher.

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CHAPTER I

OVERVIEW OF THE PROBLEM

Introduction

Educators have long looked at emerging instructional technologies for help to assist and increase student learning. One of the current instructional technologies that has caught the interest of educators is multimedia. Multimedia can be defined as:

> ...the integration of text, audio, graphics, still image and moving images into a single computer controlled, multimedia product. (McCarthy, 1989, p. 26.)

The interest in, and use of, multimedia as an instructional tool has been growing in the last few years. Many educators have designed and developed interactive multimedia (IMM) programs and have indicated that they can increase student learning (Ambrose, 1991; Carlson, 1991; Cockayne, 1991; Schroeder, 1992).

Multimedia is not a new concept. Multimedia kits have been designed and used for a considerable time for instructional purposes. The early

interactive multimedia kits usually consisted of a text based program guide and tests that directed the user to various media, such as audio tapes, diagrams, film strips and models (Brown 1973). The IBM 1500, the first interactive multimedia computer based instructional (CBI) system, emerged in the 1960s and continued to be used into the 1980s (Szabo, 1993). The current resurgence in the use of multimedia is the result of advances in computer technology and digital information storage systems. Multimedia systems today can allow the learner to instantaneously access and interact with large databases of information that are composed of several media formats.

Problem Statement and Research Questions

The problem

The IMM learning environment is a visually rich one and evaluation by IMM should also be visually rich. One would assume that evaluation of student learning would be done by IMM but in most situations final evaluation of learning (exit or certification) is done in a textual paper and pencil format. The primary reason for use of the textual paper and pencil format for evaluation is because it is the easiest and more economical to design, develop and administer when compared to IMM. Does a difference in the method of evaluation, i.e., verbal or visual, result in different learning outcome assessments? A verbal test is defined as an evaluation where the questions and answer choices are only in text form. A visual test is an

evaluation that uses visual displays, i.e., graphics, photographs, motion pictures or animation, in the question and/or answer choices.

The literature supports the concept that learning and evaluation should be done in the same manner to produce the optimal learning experience. Research into visual testing within classroom instruction has shown that students who receive instruction and evaluation complemented with visual displays achieve higher levels of performance when compared to those who didn't receive evaluation complemented with visuals (Dwyer 1985; Dwyer 1986; Dwyer & De Melo 1983; Dwyer & De Melo 1984; Joseph & Dwyer 1986; and Szabo et al., 1981). These research studies investigated the use of visuals within the context of classroom instruction and paper and pencil based evaluation. Are these research findings transferable to learning and evaluation in an IMM environment? Szabo et al. (1982) stated:

> the validity and effectiveness of visual testing might depend intimately on the (a) degree of realism contained in the visualization used to complement the instruction, (b) the method of presentation employed to present the content material to students (external vs. self-paced instruction).

IMM can definitely present visuals in a very high degree of realism both in an external and self-paced mode.

There has also been some research into the role of testing within microcomputer based instruction (MCBI) (Mayton, 1991; Richards, 1987; Rieber, 1990; and Taylor, 1989). This research has indicated that visual testing is just as adequate or in some cases more effective in evaluating learning by MCBI.

There is also a theoretical basis for the justification of the use of visual testing. Tulving & Thompson's (1973) encoding specificity principle stated that recognition memory is better if the cues used in the original instructional/acquisition environment are used in the testing/retrieval environment. Batting (1979) and Nitsch (1977) indicated that any change in the retrieval environment from that which occurred in the original learning environment produces marked decrements in the learner's performance.

Purpose of the study

The purpose of this research was to investigate selected effects of visual testing upon learning from an interactive multimedia program.

Research question

Does visual testing following an interactive multimedia program contribute to learning as defined by student performance on identification, terminology and comprehension tests after initial training?

Hypothesis

After completing an IMM program, students who receive visual testing will obtain higher achievement levels on identification, terminology and comprehension tests than students who receive verbal versions of the tests.

Statement of Significance

Recent developments and advances in computer and imaging technology have enabled personal computer users to incorporate static visual displays (e.g. graphics and photographs) and dynamic visual displays, (e.g. animation and motion pictures) within computer mediated instructional lessons. Prior to these advancements the process of incorporating static and dynamic visuals involved an extensive amount of time, resources and expertise. Currently all educational institutions are facing financial restraint and must allocate resources in the most appropriate and efficient manner. Instructional designers and educators will still incorporate visual displays within IMM instructional programs, but due to increased workloads they may resort to only developing verbal evaluations. At the present time funding for post-secondary institutions is tied to performance parameters such as student achievement and satisfaction, e.g., the Key Performance Indicators system established by the Alberta Dept. of Advanced Education. If the use of visual testing can increase these parameters, then both the student and institute can benefit. It is hopeful that the results of this study will be of value to educational administrators, designers and developers of interactive multimedia programs to determine the merit of investing in visual testing on the basis of student achievement.

Delimitations

1. The sample group was limited to students enrolled in a Health Science program at a post secondary technical school.
2. The IMM lesson assessed in the study was scheduled in the middle of a course.
3. There were three (3X) nine item criterion tests used as data collection tools.
4. The content of the lesson was restricted to the subject of anatomy and physiology of the pregnant female, the stages of labour and delivery and the procedures to prepare for an imminent delivery.

Limitations

1. Some of the students did not have any prior experience with learning from an IMM program. This limitation could create problems with the validity of whether the measure of performance in the lesson is a reflection of the evaluation method alone.

Definition of Terms

Achievement level - A measure of learning of specified objectives as defined by students' performance on criterion based tests.

CBT - Computer-based training, tutorial, and simulations consisting of text and possibly graphics, which provide training by means of a mainframe or personal computer. Also known as CAI (Computer-assisted instruction), CAL (Computer-assisted learning), CBI (Computer-based instruction) or MCBI (Microcomputer-based instruction) (Gayeski, 1992).

Comprehension test - A test that measures a type of understanding that occurs when an individual can understand what is being communicated and use the information to explain some other phenomenon occurring simultaneously (Dwyer & De Melo, 1983).

Emergency Medical Services (EMS) - The provision of emergency prehospital or out of hospital care and ambulance transport to hospitals

Identification test - A test that evaluates the students' ability to identify parts or positions of an object (Dwyer & De Melo, 1983).

Interactive Multimedia (IMM) - A computer delivered software program that has the capability for the learner and program to respond to each other. Interactivity has several ingredients. The level of response is related to the extent and presence of these ingredients: immediacy of response, non-sequential access of information, adaptability, feedback, options, bi-directional communication and grain size (i.e., time before next input) (Borsook & Higginbothman-Wheat, 1991).

Multimedia - In a review of the literature, it was found that there are several definitions of multimedia (Galbreath, 1992; Gayeski, 1992; McCarthy, 1989; Schroeder, 1992). Multimedia literally means more than one medium is used and in all the definitions of multimedia these were core terms. In addition to the core terms, the definition can be expanded to include these terms: computer controlled, learner control and varying modalities for delivering information. For the purpose of this project, multimedia will be defined as an application that uses two or more media and is controlled by a computer.

Terminology test - A test that measures the students' knowledge of specific facts, terms, and definitions (Dwyer & De Melo, 1983).

Text - the words or wording of something written or printed (Webster's II New Riverside University Dictionary, 1988).

Verbal - of, related to, or associated with words, (Webster's II New Riverside University Dictionary, 1988).

Verbal testing - a test where the questions and answer choices are only in text form.

Visual testing - a test that uses text plus visual displays, i.e., graphics, photographs, motion pictures or animation, in the question and/or answer choices.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

This study investigated selected effects of visual testing upon learning from an interactive multimedia program. The subject of visual testing has been explored in the literature for an extensive period of time. The use of multimedia as an instructional tool and testing within IMM have been also explored in the last several years. This literature review examines what is known about visual testing, the use of multimedia as an educational tool and the design and development of IMM. Specific topics that have been examined are: visual testing, visual displays, static visual displays, learning with multimedia, the design of interactive multimedia programs and testing and multimedia.

Visual Testing

Visual testing within the classroom

Research into visual testing was begun by Szabo et al. in 1981 and their study formed the foundation of further research into the topic. The studies that followed were replications or expansions of the original study (Dwyer, 1985; Dwyer, 1986; Dwyer & De Melo, 1983; Dwyer & De Melo, 1984; McNeal, 1994; Pimolbunyong, 1988).

Szabo et al. (1981) investigated the role of visuals in the instructional and evaluation phases of classroom learning in ninety-six high school biology students. In that study the students received instructional lessons that were either text plus visuals or text minus visuals. The final evaluation of learning used verbal and visual versions of three criterion tests: identification, terminology and comprehension. They found that students who received verbal instruction complemented with visuals performed better than those who had verbal instruction not complemented with visuals. Students who received both visual instruction and visual testing obtained the highest level of achievement on the identification tests only. There was no difference in the data to support the same effect for the terminology or comprehension tests.

Using one hundred and fifty-one undergraduate students, Dwyer & De Melo (1983) expanded on Szabo et al's (1981) investigation. They introduced two additional variables: order of a drawing test, (before or after the criterion

tests) and mode of drawing test, (free recall or verbal cued recall). They also investigated level of retention by administering the evaluations twice; the second evaluation was administered two weeks after the first. They found that the order and mode of the drawing tests had no significant effect on student performance but there was a significant effect for visual testing. Students who received verbal instruction complemented with visuals and visual testing performed better on all three criterion tests of the second evaluation.

Dwyer & De Melo (1984) replicated their 1983 study and found conflicting results. They used one hundred and fifty-one undergraduate students in the study. In this study, visual testing did not show any significant effect over verbal testing for any of the three criterion tests. They also found no effect for order and mode of testing. They postulated that the study's results were the effect of: the student's lack of familiarity with visual testing, limitations of the visual distracters in the visual test to convey information and the visuals were regarded as only icons by the students that then compounded the complex material content.

The research on visual testing that followed began to also investigate the effects of various rehearsal strategies on student achievement. Dwyer (1985) using one hundred and sixty-one undergraduate students found that covert rehearsal strategies were more effective in increasing learning. In regard to the effects of evaluation type, she only found a significant difference for the visual comprehension test. She also noted that the students who

received visual rehearsal and visual evaluation performed better than those who received visual rehearsal and verbal evaluation.

Dwyer (1986) expanded on her 1985 study by investigating the variable of time on instruction. One hundred and thirty-six university students were used for this study. The study revealed a significant effect for visual rehearsal and visual testing in all three of the criterion tests. In addition, it was noted that students who spent more time with the learning material obtained a higher level of retention of learning.

Dwyer's 1986 study was subsequently replicated by McNeal (1994) and Pimolbunyong, (1988). Pimolbunyong (1988) used one hundred and thirty-six Thai freshman students enrolled in a teachers' college. All the prose used in the instructional lessons and evaluations were written in the Thai language. The results of the study showed that the varying rehearsal activities did not improve student achievement for any of the learning objectives and there was also no difference in student performance between visual and verbal forms of evaluation. She postulated that the study's results were affected by an incongruence between the teaching-learning methods of the study and the students' learning style, characteristics, educational background and cultural differences.

McNeal (1994) used one hundred and fifty-two nursing and university biology students in her study. She found that students who read a prose passage and then used an active rehearsal method, i.e., answering questions complemented with visuals, obtained higher levels of achievement. She found no significant difference between the visual and verbal forms of

evaluation. She indicated that the students' performance on the visual tests were possibly influenced by their lack of familiarity with visual testing and their limited learning strategies, i.e., lack of ability to benefit from visual testing.

Summary

The common purpose of this body of research was to investigate the role of visuals in the instructional and evaluation phase within the classroom. The major findings of this research showed that the use of visuals within instructional material does increase learning and that students do obtain higher levels of achievement if they receive instruction complemented with visuals and visual testing.

Visual testing and microcomputer-based instruction

The role of visual testing and microcomputer-based instruction (MBCI) has also been investigated (Mayton, 1991; Richards, 1987; Rieber, 1990; and Taylor, 1989). A unique aspect of some of this research, (Mayton, 1991; Richards, 1987; and Taylor, 1989), is that the instructional content and sequence used for the MCBI lessons were developed and used by F. Dwyer in his research study (Dwyer, 1985; Dwyer, 1986; Dwyer & De Melo, 1983; Dwyer & De Melo, 1984: and Szabo et al., 1981).

Richards (1987) used one hundred and sixty freshmen university students to investigate the effects of varying feedback strategies and visual

and verbal testing on student achievement when learning by MCBI. This study was an adaptation of Dwyer's (1984) research. Richards found that not all methods of computer generated feedback were equally effective in aiding student achievement. He stated that covert feedback strategies were superior to overt and simple feedback strategies, but he also stated that his covert feedback strategy used in the study could technically be relabeled as overt. He found no significant difference between visual and verbal testing for any of the three criterion tests. He noted that his findings on visual testing were in contrast to Dwyer's (1984) research findings. He attributed this contrast to a substantial difference between the instructional levels of the verbal and visual content of his study and Dwyer's (1984).

Taylor (1989) investigated the effects of embedded cognitive strategies within a MCBI lesson and the effects of verbal and visual testing on student performance. They found that students who received instruction by an externally paced (EP) learning strategy performed better on a verbal exam but the interactions were borderline statistically different. Students who received instruction with the learning strategy of EP with imagery cueing or EP with attention direction did not show any significant difference between verbal and visual testing. The researchers hypothesized that visual testing would be more effective than verbal but the study's results did not support it. They stated that the lack of support for their hypothesis was because the study was a preliminary one.

Rieber (1990) used 70 fourth grade students to investigate the effects of animated visuals on incidental learning and motivation. He found that the

use of animation was more effective in teaching incidental learning objectives than the use of verbal instruction with or without static visuals. The students tended to answer incidental learning questions more accurately when they contained visuals. He states that animation can be used effectively as an attention gaining cue that can increase student motivation. Student motivation was at its highest when they were involved in some structured simulations that incorporated animation. He references Gagné (1985) noting that gaining attention and motivation are an important part of the learning process.

Mayton (1991) used seventy-two psychology undergraduate students to investigate the effects of animated visual information when used with text and static visuals in MCBI. He reported that the use of animation in MCBI to teach dynamic processes can be beneficial. He also observed that retention of learning was more superior for the animated visual learning group compared to a static visual learning group. He was unable to find any significant difference between visual and verbal forms of any of the three criterion tests. He did not postulate on why no significant difference was found between the two evaluation formats.

Summary

The common purpose of this body of research was to investigate of the role of visuals in the instructional and evaluation phases within MCBI. The findings of this research indicate that the use of visuals (static and dynamic) within a MCBI does increase student achievement. In regards to visual and

verbal testing within MCBI, the majority of the research indicates that there is no significant difference between the two testing formats. The balance of the research does provide some indication that visual testing is more effective in increasing student achievement. The researchers in all these studies did state that the role of visual testing in MCBI does warrant further study.

Learning theories which support the use of visual testing

There are some learning theories and principles that do support the concept that learning is more effective when visuals are used in both instruction and testing and they are: the transfer appropriate principle by Morris, Bransford, & Franks (1977), the encoding specificity principle by Tulving & Thompson (1973), and the dual coding theory by Paivio (1986).

Morris, Bransford, & Franks' (1977) transfer appropriate principle implies that information processing must be appropriate to the intended use of the information. The concept of this principle incorporates acquisition activity, the level of processing, elaboration, and the nature of the test situation, with attention on the "relationships between acquisition and test situations." Tulving & Thompson's (1973) encoding specificity principle is more specific than the transfer appropriate principle. The encoding specificity principle includes the assumption that recognition memory is better if the cues used in the original instructional/acquisition environment is used in the testing/retrieval environment. Research by Batting (1979) and Jacoby & Craik (1979) has shown support for the encoding specificity principle.

Paivio's (1986) dual coding theory gives equal weight to verbal and non-verbal processing. The theory postulates that there are two cognitive subsystems for encoding and retrieval of information, i.e., one for verbal and the other for visual. Each of these systems functions as a separate entity with the capability of working in unison with each other. The fundamental principle of this theory is that recall/recognition is enhanced by presenting information in both visual and verbal forms.

Learning with Multimedia

How is multimedia being used

Multimedia has been successfully used for instruction with various settings, audiences and subject matters. It has been demonstrated to be a good instructional tool for individualized, small and large group learning settings (Carlson, 1991; Cockayne, 1991; Falk & Carlson, 1992; Jenkins, 1990; and Schroeder, 1992). Audiences of all ages have found learning with multimedia to be effective and positive. Jenkins (1990) states that multimedia can provide a rich interactive environment for early childhood education to promote understanding and mastery. Multimedia has been shown to address the learning needs of illiterate adults (Sorge, Russell & Campbell, 1991). Educators have used multimedia to teach various subject matter such as: Japanese language usage (Ashworth & Stelvosky, 1989), history and drama (Schroeder, 1992) and mathematics (Sorge, Russell & Campbell, 1991).

Multimedia has been successfully developed and used for teaching medical subjects. Manning, Balson, Eberner, & Brooks (1983) used multimedia to teach paramedics the procedure of administering an intramuscular medication injection. Hon (1983) and Lyness (1987) have successfully used multimedia to teach CPR to nursing students.

The advantages of learning with interactive multimedia

Advocates of IMM state that there are two advantages of learning with well-designed IMM (Ambrose, 1991; Carlson, 1991; and Schroeder, 1992). The first advantage is that the computers used in IMM systems have the capability to facilitate learner control of the pace and direction of the instructional lesson (Ambrose, 1991; and Schroeder, 1992). Further, computers have made it possible to automate the links between chunks of information. In a well-designed IMM program there are several relevant information branches linked to the main stream of instruction. A student can access these branches and explore related information to varying degrees of complexity and depth.

The second advantage is the ability of multimedia to provide a variety of modalities for presenting information to a student. This ability can allow the student to select the method of delivery according to his/her learning styles, abilities and informational needs (Carlson, 1991; and Schroeder, 1992).

Problems when learning with interactive multimedia

There are some problems that can be encountered when learning with multimedia systems. These problems are mainly the result of poor instructional design and not the medium itself. The first problem is that the learners can become lost in the multimedia program and increase their learning time by exploring numerous branches due to curiosity and distractions (Roselli, 1991). This problem is further increased if the IMM program has a large amount of superfluous information hyperlinked in an illogical pattern. A second problem is that the learners can also be cognitively overloaded by the information presented when they are exploring the branches of the multimedia program (Oren, 1990). Another problem is the presence of an unfriendly user interface. A learner's frustration with an unfriendly user interface can interfere with perception and understanding of the information presented and navigation within the multimedia program.

Effectiveness of learning by interactive multimedia

The research on the effectiveness of learning by IMM is inconclusive but the existing research does point towards some optimistic observations. Students learning by IMM do achieve higher test scores. They complete the learning task in less time and are more receptive to the learning experience (Carlson, 1991; Kearsley & Frost, 1985; Lyness, 1987: Hon 1983; Manning, Balson, Eberner & Brooks, 1983: Smith, 1987: Szabo & Poohkay, 1995).

One should be aware of the concerns raised by Clark & Salomon (1987) and Clark (1991) of whether the medium is really responsible for any observed increase in learning effectiveness. Clark states that it is not the special attributes of a medium that influences learning but rather the improved instructional strategies and methods used in preparing material for the medium. Another factor that will influence learning is that the student will be engaged by the novelty of the new medium.

The Design of Interactive Multimedia

Interactive multimedia programs should be done in a systematic method with consideration to the following major factors: interactivity, learner control, instructional strategy and method, screen layout and the appropriate use of video.

Interactivity

Interactivity is the ability of the learner and multimedia program to respond to each other. Schaffer & Hannafin (cited in Hannafin, 1985) found that as interactivity increased, the intended knowledge gain increased. Interactivity should not be considered just the ability of the student to push buttons to proceed to the next page of the lesson. Cates (1992) states that interactivity within a multimedia program should be meaningful to the user. The program should call for the learner to make decisions that will involve, challenge and help them see connections. Borsook & Higginbothman-Wheat

(1991) state that the term interactivity is an ill-defined concept, with respect to computers and teaching. They have stated that the recipe for interactivity has several ingredients. The level of interactivity is related to the extent and presence of these ingredients: immediacy of response, non-sequential access of information, adaptability, feedback, options, bi-directional communication and grain size (i.e., time before next input).

Learner control

According to Ambrose, (1991) and Schroeder, (1992), learner control in a hypermedia lesson is considered a significant benefit to learning. Interactive multimedia programs should be designed to allow the learner the ability to select presentation style, pace and lesson direction. There must also be safeguards designed and built into the program to prevent the learner from becoming lost in the program and/or becoming cognitively overloaded with information.

The research findings on learner control are inconclusive but do point towards a negative effect instead of a positive one (Carrier, Davidson, & Kalwiet, 1986; Steinberg, 1977; Ross & Morrison, 1989; and Tennyson, 1980). Chung and Reigeluth (1992) state that the negative findings may occur because many students, in particular low-achievers, do not have the knowledge and motivation to make appropriate decisions about pacing, sequencing of content, use of learning aids, and amount of practice. The negative findings may also exist because most learner-control strategies used in research have been piecemeal or insufficient. They advocate that the use

of a comprehensive, integrated, and prescriptive theory of learner control may lead to a more effective implementation of learner control. Their prescription for learner control involves the components of: content control, sequence control, pace control, display (or strategy) control, internal processing control and advisor strategies.

Instructional strategy and method

The design of an interactive multimedia lesson should incorporate various learning strategies and methods for the development of concepts. This feature will allow an interactive multimedia program to address the varying learning styles of the learners. Students are more satisfied when learning with multimedia if the instructional strategy matches their learning style (Carlson, 1991).

Screen layout

The design of the screen layout is a factor that can affect student learning in an interactive multimedia program (Ambrose, 1991). Kanuka (1997) showed that poor screen design had no effect on achievement but it resulted in significantly longer study time and a higher rate of non-completion. The screen layout should be user friendly to allow the learner to perceive and understand information presented. It should be graphically pleasing and not too distractive to the learner. Navigational tools should be present on the screen to inform the learners of where they are within the

lesson. Help and escape features should be incorporated into screen design to assist confused or lost learners.

Appropriate use of video

The design and production of quality video is very costly in terms of time, manpower and resources, therefore video should be used where it is most appropriate for the message. It would seem logical that within a multimedia program, video should be used in situations where it's attributes and advantages are considered a benefit to learning.

There are some special attributes of video that are beneficial for teaching (Heinich, Modenda & Russell, 1989). The first attribute is the ability to manipulate time. Through the use of time lapse techniques, video can compress long events and processes (e.g., development of a flower). Slow motion techniques can expand rapid processes and events (e.g., the popping of a balloon). A second attribute is the ability to manipulate space. Small objects can be magnified with close up techniques and large images can be reduced.

In addition to the special attributes, there are other instructional advantages of the use of film/video. Video can show motion and processes that would be advantageous for teaching psychomotor skills (Heinich, Modenda & Russell, 1989; Hon 1983; Lyness 1987; Manning, Balson, Eberner & Brooks, 1985). Video can allow students to safely observe dangerous events and situations. Video can present uncommon situations and events

for the student to experience. Affective learning can be accomplished with video because of the great impact it has on shaping personal and social attitude via dramatizations or documentaries (Heinich, Modenda & Russell, 1989). Boud & Person (1984) have used trigger films to successfully teach attitudes, values and problem solving skills. Trigger films are short dramatized sequences of an unresolved situation that are designed to elicit a response from the viewer.

Concluding Remarks

Interactive multimedia can be used as an instructional tool for various settings, audiences and subject matter. The advantages that interactive multimedia have to offer are only possible through proper systematic instructional design and development with consideration to: learner control, instructional strategy and methods and the user interface. The literature shows that the use of visuals definitely does assist learning and is it more appropriate for evaluating identification, terminology and comprehension learning objectives. It would seem logical that the use of visuals in evaluation components of an interactive multimedia program would be beneficial to learning.

CHAPTER III

METHODOLOGY

Introduction

This chapter presents the purpose and hypothesis of the study, target population data, sample data, treatment conditions, instructional content, data collection tools, and how the data were analyzed.

The purpose of this research was to compare selected effects of visual and verbal testing upon learning from an interactive multimedia program. The hypothesis for this study was that after completing an IMM program, students who receive visual testing will obtain higher achievement levels on identification, terminology and comprehension tests compared with verbal testing. The methodology most applicable for this type of research was experimentation. The experimental aspect of the study investigated the effects of two levels of the independent variable, (i.e., presence or absence of visual testing) on the three dependent variables, (i.e., learning as defined by student performance on identification, terminology and comprehension tests).

Population

The population for this study is all students involved in basic Emergency Prehospital Medical Care training within Alberta. The students are primarily being trained to be Emergency Medical Responders (EMR). The size of the target population is about 800 students per annum. It is composed of adult learners whose ages range from 18 - 40 years. There is a higher number of males to females. The education level of the population varies. The minimum level is the completion of grade eleven high school. Some students will have additional post secondary education. Currently, several EMR training programs are being provided in the provinces of Alberta. These training programs run anywhere between six months to one year and are composed of didactic and laboratory sessions. This training is offered in a full-time and part-time capacity.

Sample Data

The study's sample was EMR students enrolled in Health Science programs at a post secondary technological institute in Alberta. There were four classes (n = 62) of EMR students used as subjects. Of these students, about sixty percent (n= 37) were male and forty percent (n= 25) were female.

The students' participation in the instruction was mandatory because the content of the IMM lesson was a mandatory component of the EMR curriculum. The students were randomly assigned to the treatment groups. The students signed a consent form which allowed the results of their

performance to be used for research purposes (a copy of the consent form can be found in Appendix A.)

Although the sample was not randomly selected from the population, it is still considered to be representative of the population because of the following factors. The role and duties of an EMR have been clearly defined by the Provincial Government of Alberta and the EMR Professional Association. The entrance requirements and final competencies for EMR training were developed by a collaborative project involving the Alberta Government, other EMR training institutes and the researcher's institute. The subjects within the sample were required to have the same entrance requirements and trained to ensure that all EMR competencies were learned. In addition, the EMR Professional Association requires that all EMR students pass a provincial certification examination before they can be registered and practice within the province. Previous EMR graduates of the researcher's institute and all the individuals of the sample have passed the provincial certification exam.

Treatment Conditions

The subjects were randomly assigned by the researcher into one of two research groups. As each subject entered the computer lab they were handed a numbered package that contained an answer card and the consent form. The number on the package corresponded to a specific computer in the lab and the students proceeded to them accordingly. The computers in the lab

were divided into two sections, one for verbal testing and the other for visual testing. The computers were arranged in the lab so that each group faced the other.

After a brief introduction presented by the researcher the subjects were allowed to complete the IMM lesson at their own pace. The majority of the students completed the IMM lesson in about one and a half hours.

The students then received the first evaluation (immediate) of their learning. The evaluation was presented by the personal computer in one of the two treatments. Research group number one received evaluation by visual testing and research group number two received evaluation by verbal testing only. On the answer card, the students wrote their name and marked their responses to the test questions. On completion of the evaluation the students returned the package to the researcher.

Two to seven days later, the students received a second evaluation (delayed) of their learning. The students were assigned a computer based on their original research grouping from the first evaluation. In the second evaluation the testing modes were reversed for the groups. Students who initially received evaluation by visual testing were re-evaluated by verbal testing and those students who initially received evaluation by verbal testing were re-evaluated by visual testing (see Table 1). The students' final grade awarded for the IMM lesson was derived from the best score of the two evaluations.

Table 1

Treatment Conditions

Research Group	Instructional Delivery Method	First Evaluation (immediate)	Second Evaluation (delayed)
Group 1	Interactive Multimedia	Visual testing administered by the computer	Verbal testing administered by the computer
Group 2	Interactive Multimedia	Verbal testing administered by the computer	Visual testing administered by the computer

Instructional content

The instructional content of the IMM lesson was anatomy and physiology of the pregnant female, the stages of labour and delivery and the procedures to prepare for an imminent delivery. The content was selected because it allowed the evaluation of learning objectives that involved identification, terminology and comprehension. The IMM lesson was designed and developed by the researcher and an IMM development team. The IMM program was beta tested and reviewed by EMRs, paramedics, and EMR and paramedic instructors. Formative feedback provided by the reviewers influenced the modification of the IMM lesson to its next version.

The IMM lesson was presented to the students by multimedia capable personal computers on an individual basis. The multimedia capable personal computers used to create the lesson were Macintoshes and to deliver them were IBM compatibles. The personal computers were operating as stand

alone units, i.e., they were not networked. The technical specifications of the personal computers are:

- Intel Pentium running at 75 MHz.,
- VGA monitor,
- 16 MB of RAM,
- 1.2 GB hard drive,
- 4X CD-ROM player,
- Sound Blaster audio card, and
- headphones for audio out.

The IMM lesson was delivered from the hard drives of each personal computer.

The IMM lesson content was program directed and the students' progression through the IMM lesson was self paced. The IMM lesson content was divided into small learning sections as per the learning objectives. The content was presented to the students using both text and fifty-three color visual displays. The visual displays designed and used were to present information that was identical to the text information. Color was used in the visual displays in one of two ways. The first method was to present the actual color scheme of an anatomical structure, photograph or illustration. In the second method, color was used to highlight or differentiate various components of a graphic illustration. Audio segments were used in situations where sounds or pronunciation was to be learned by the student. Dynamic visual displays were used to show sequential processes or demonstrate psychomotor skills. At the end of the content presentations, the students

completed some rehearsal activities such as completing a review quiz or labeling a diagram. Corrective feedback was provided to the students in all the rehearsal activities.

Data Collection Instruments

The data collection instruments used in this study were three achievement tests. They were developed from the lesson's learning objectives as per the identification, terminology and comprehension criteria defined by Dwyer & De Melo (1983). Each evaluation contained nine items which were administered to the students as a single twenty-seven item composite evaluation at the end of their IMM lesson as per their treatment groups. The visuals used in the visual tests were a subset of those used in the IMM instructional lesson and there were no new visuals introduced in the visual testing.

Identification test

The objective of this test was to evaluate the students' ability to identify parts or positions of an object (Dwyer & De Melo, 1983). This multiple-choice test required the students to identify the numbered parts on a detailed diagram of the pregnant female and fetus. The name, location and function of the structures of the pregnant female and fetus were presented and discussed in the IMM program. An example of one of the static computer screens with an identification test question is shown in Figure 1.

Figure 1.

A Static Computer Screen of a Verbal Identification Test Question

1. The fetus obtains oxygen and nourishment from the mother's blood through which of the following anatomical structures?

    a) Uterus

    b) Placenta

    c) Amniotic sac

    d) Cervix

Terminology test

The objective of this test was to measure the students' knowledge of specific facts, terms, and definitions. The objectives measured by this type of test were appropriate to all content areas that required an understanding of the basic elements required for learning more complex concepts, rules, and principles inherent to the discipline. An example of one of the static computer screens with a terminology test question is shown in Figure 2.

Figure 2.

A Static Computer Screen of a Verbal Terminology Test Question

11. The stage of labour that covers the time from when the baby is in the birth canal until it is born is the

    a) First stage

    b) Second stage

    c) Third stage

    d) Fourth stage

Comprehension test

The objective of this test was to measure a type of understanding that occurs when an individual can use the information to explain some other phenomenon occurring simultaneously (Dwyer & De Melo, 1983), e.g., students were given a specific point in the process of labour and delivery and then asked to identify what other activities are occurring at the same time or in the next step. This test required the students to have a thorough understanding of anatomy and physiology of the pregnant female and the stages of labour and delivery. An example of one of the static computer screens with a Comprehension test question is shown in Figure 3.

Figure 3.

A Static Computer Screen of a Verbal Comprehension Test Question

27. Which of the following positions could cause hypotension in the pregnant female?

    a) lying in the knee-chest position

    b) lying supine

    c) lying on her right lateral side

    d) lying on her left lateral side

Two versions of the data collection instrument were developed. i.e., verbal and visual. The verbal version contained only text in the questions and answer choices. A copy of the verbal version of the tests can be found in Appendix B. The visual version had text information complemented with visuals within the question or the answer choices. The visuals used in the

tests were a subset of those used to present the IMM lesson content and rehearsal activities. For both instruments, seventy percent of the exam items were taken from the Professional Association's registration examination for EMRs. The remaining thirty percent were developed by the researcher.

The validity of these instruments was established by:

- a review by Emergency Medical Responder and Paramedic instructors
- pilot testing with four first year Health Sciences students and subsequent revision.

The reliability of this instrument was determined by Cronbach's Coefficient Alpha test.

Data Analysis

To test the hypothesis of this study a one way repeated measures analysis of variance (ANOVRM) test was performed on the standard scores of the combined immediate and delayed tests. The data analysis focused on determining significant differences between: the research groups, the testing modes and interaction effects (i.e., research group by testing mode). If an F-value indicating a significant interaction effect was found, then the scores were subjected to further pairwise analysis, i.e., a Scheffé test of significance. The SPSS computer program for the Macintosh was used to perform the ANOVRM test and the Scheffé test of significance. For this research study, any statistic with a probability of occurrence below 95% ($p \leq 0.05$) was deemed significant.

CHAPTER IV

PRESENTATION OF RESULTS

Introduction

The purpose of this research was to investigate selected effects of visual testing upon learning from an interactive multimedia program. This chapter presents the results of this study in the following order: descriptive statistics, reliability, identification, terminology, comprehension and the composite tests.

Descriptive Statistics

These are provided here to present an overview of the outcomes of the study. Table 2 shows the means and standard deviation of achievement scores for the combined immediate and delayed visual and verbal tests. Table 3 shows the means and SD of achievement scores for the immediate visual and verbal tests. Table 4 shows the means and SD of achievement

scores for the delayed visual and verbal tests. The mean scores for both the verbal and visual tests in all cases were very high when compared to the total number of items tested. The mean scores on the visual forms of the criterion tests were not generally deviant from those on the verbal forms.

Table 2

Data for Combined Immediate and Delayed Tests

Type of test	Test format	Number of cases	Number of test items	Mean score	SD
identification	visual	62	9	8.08	.84
identification	verbal	62	9	7.35	.89
terminology	visual	62	9	7.94	1.05
terminology	verbal	62	9	7.89	1.38
comprehension	visual	62	9	8.10	.94
comprehension	verbal	62	9	8.08	1.5
composite	visual	62	27	24.15	1.87
composite	verbal	62	27	23.32	2.34

Table 3

Data for the Immediate Visual and Verbal Tests

Research Group	Type of test	Test format	Number of cases	Number of test items	Mean score	SD
1	identification	visual	31	9	8.00	0.96
2	identification	verbal	31	9	7.65	0.98
1	terminology	visual	31	9	7.84	1.00
2	terminology	verbal	31	9	8.09	1.18
1	comprehension	visual	31	9	8.16	0.93
2	comprehension	verbal	31	9	8.19	0.87
1	composite	visual	31	27	24.03	2.15
2	composite	verbal	31	27	23.35	1.60

Table 4

Data for the Delayed Visual and Verbal tests

Research Group	Type of test	Test format	Number of cases	Number of test items	Mean score	SD
1	identification	verbal	31	9	7.71	0.94
2	identification	visual	31	9	8.16	0.69
1	terminology	verbal	31	9	7.68	1.56
2	terminology	visual	31	9	8.03	1.11
1	comprehension	verbal	31	9	7.93	1.36
2	comprehension	visual	31	9	8.03	0.95
1	composite	verbal	31	27	23.29	2.96
2	composite	visual	31	27	24.26	1.60

Test Reliability

Reliability analysis was done on the all the criterion test scores and the composite test scores using the Cronbach's Coefficient Alpha test followed by an application of the Spearman-Brown prophecy formula. The Cronbach's Coefficient Alpha test of reliability uses a split half method calculation that may produce low reliability scores for testing instruments that are short in length. The Spearman-Brown prophecy formula was used because the criterion tests in this study are short in length, (nine items for each criterion and twenty seven items for the composite test). The Spearman-Brown prophecy formula is a statistic that estimates test reliability if the test was of identical composition but is twice the length. The results of the reliability tests are found in Table 5a and 5b.

Table 5a

Reliability Coefficients for Criterion Measures before Application of Spearman Brown Prophecy Formula*

	Identification[1]	Terminology[1]	Comprehension[1]	Composite[2]
Verbal test	.26	.45	.56	.69
Visual test	.61	.26	.26	.61

* Cronbach's Coefficient Alpha test

[1] 9 items

[2] 27 items

Table 5b

Reliability Coefficients for Criterion Measures after Application of Spearman Brown Prophecy Formula*

	Identification[1]	Terminology[1]	Comprehension[1]	Composite[2]
Verbal test	.42	.61	.72	.81
Visual test	.76	.42	.41	.76

* Cronbach's Coefficient Alpha test

[1] 9 items

[2] 27 items

The reliability coefficient for the composite verbal (0.81) and visual (0.76) tests indicate that they as a whole are reliable. The reliability coefficient for the individual criterion tests generate some concern because three of the six tests obtained reliability coefficient lower than .60. This finding generates some questions on the validity of the results but it does not invalidate the study as a whole. Low reliability coefficients , (i.e., less than .60) have been reported by both Dwyer (1985) and McNeal (1994) for their criterion tests.

Data Analysis Process

A one way repeated measures analysis of variance (ANOVRM) repeated measures test was performed on the standard scores of the combined immediate and delayed tests. The data analysis focused on determining significant differences between: the research groups, the testing modes and interaction effects (i.e., research group by testing mode). If an F-

value indicated a significant interaction effect, then those scores were subjected to further pairwise analysis, i.e., a Scheffé test of significance. The SPSS computer program for the Macintosh was used to perform the ANOVRM and the Scheffé test of significance. For this research study, any statistic with a probability of occurrence below 95% ($p \leq 0.05$) was deemed significant.

Results of the Identification Test

A summary of the ANOVRM test for the identification test is presented in Table 6. The ANOVRM test indicated that there was no significant difference between the two research groups. The ANOVRM test did yield an $F(1,60) = 32.77$, $p \leq 0.05$ for testing mode which was statistically significant. The ANOVRM test also yields an $F(1,60) = 8.56$, $p \leq 0.05$ for interaction effects (i.e., research group by testing mode), which was statistically significant. The visual testing mode had a higher mean score than the verbal testing mode for the identification test.

Table 6

Analysis of Variance Repeated Measures- Scores for Identification Tests

Source of variation	Sum of square	D. F.	Mean Square	F ratio	F Prob.
Between subjects					
Research Group	168.26	1	168.26	1.48	.23
Within + Residual	6821	60	113.7		
Within subjects					
Testing mode	2016.13	1	2016.13	32.77*	.00
Research Group by Testing mode	526.68	1	526.68	8.56*	.01
Within + Residual	3691.76	60	61.53		

*$p \leq 0.05$

A post-hoc Scheffé test of significance was performed to determine whether the difference between the testing modes for the identification tests were statistically significant. This analysis can be found in Table 7.

Table 7

Scheffé Test of Significance - Identification Test Scores

Mean	Label		G1Ve	G2Ve	G1Vi	G2Vi
7.65	Group 1 verbal test	G1Ve				
7.06	Group 2 verbal test	G2Ve				
8.00	Group 1 visual test	G1Vi		*		
8.16	Group 2 visual test	G2Vi		*		

(*) Indicates significant differences which are shown in the lower triangle

The Scheffé test showed Group 1 and Group 2 visual tests scores were greater than Groups 2's verbal test scores. These findings are consistent with part of the Hypothesis that predicted group 1 and 2 to score higher on the visual tests than the verbal tests.

Results of the Terminology Test

A summary of the ANOVRM test for the terminology test is presented in Table 8. The ANOVRM test indicated that there was no significant difference between the two research groups, the testing mode and the interaction effect.

Table 8

Analysis of Variance Repeated Measures- Scores for Terminology Tests

Source of variation	Sum of squares	D. F.	Mean Square	F ratio	F Prob.
Between subjects					
Research Group	359.42	1	359.42	1.20	.28
Within + Residual	17976.90	60	299.62		
Within subjects					
Testing mode	8.96	1	8.96	.12	.73
Research Group by Testing mode	48.79	1	48.79	.68	.41
Within + Residual	4324.97	60	72.08		

*$p \leq 0.05$

Results of the Comprehension Test

A summary of the ANOVRM test for the comprehension test is presented in Table 9. The ANOVRM test indicated that there was no significant difference between the two groups, the testing mode and the interaction effect.

Table 9

Analysis of Variance Repeated Measures- Scores for Comprehension Tests

Source of variation	Sum of squares	D. F.	Mean Square	F ratio	F Prob.
Between subjects					
Research Group	24.89	1	24.89	.12	.73
Within + Residual	12138.59	60	202.31		
Within subjects					
Testing mode	1.00	1	1.00	.01	.91
Research Group X Testing mode	168.26	1	168.26	2.40	.13
Within + Residual	4213.46	60	70.22		

*$p \leq 0.05$

Results of the Composite test

A summary of the ANOVRM test for the identification test is presented in Table 10. The ANOVRM test indicated that there was no significant difference between the two research groups and interaction effect. The

ANOVRM test did yield an $F(1,60)=9.88$, $p \leq 0.05$, for testing mode which was statistically significant.

Table 10

Analysis of Variance Repeated Measures- Scores for Composite Tests

Source of variation	Sum of squares	D. F.	Mean Square	F ratio	F Prob.
Between subjects					
Research Group	8.96	1	8.96	.09	.76
Within + Residual	5748.48	60	95.81		
Within subjects					
Testing mode	287.73	1	287.73	9.88*	.00
Research Group X Testing mode	2.77	1	2.77	.10	.76
Within + Residual	1746.54	60	29.11		

*$p \leq 0.05$

Summary of the Results

This chapter presented the results of the analysis of students' performance on the combined immediate and delayed tests, the immediate tests, delayed tests, reliability scores for the tests and the statistical analysis of the identification tests, terminology tests, comprehension tests and composite tests. All the tests except for the verbal identification, visual terminology and visual comprehension tests obtained reliability scores greater than .60. ANOVRM tests yielded F-values that were statistically significant for the visual testing mode for the identification tests and

composite tests. A post-hoc Scheffé test of significance revealed that only the visual testing mode for the identification tests was statistically significant. There was no significant difference found in the remaining F values between and within the treatment group, but in 8 of the 12 statistical analysis the mean scores for visual format of testing were higher than the verbal testing format.

CHAPTER V

DISCUSSION OF RESULTS

Introduction

The purpose of this research was to investigate selected effects of visual testing upon learning from an interactive multimedia program. The hypothesis tested was that after completing an IMM program, students who receive visual testing will obtain higher achievement levels on identification, terminology and comprehension tests than students who receive non visual versions of the tests. The methodology used for the study was experimental in nature. The experimental aspect of the study investigated the effects of the independent variable, (i.e., presence or absence of visual testing) on the dependent variables, (i.e., learning as defined by student performance on identification, terminology and comprehension tests). There was a total of sixty-two students involved in the study.

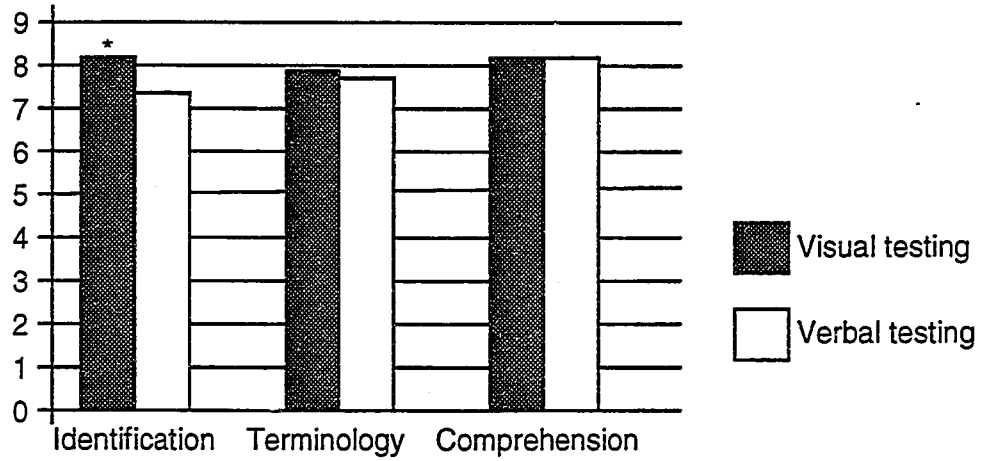
This chapter will present a summary of the study's findings, discussion of whether it supports the study's research hypothesis, comparison of the study's findings to previous research, an explanation for the study's findings, the study's conclusion and recommendation for application and further research.

Summary of Research Findings

Figure 4 presents a summary of the study's findings for the combined immediate and delayed visual and verbal tests. Figure 5 presents a summary of the study's findings for immediate visual and verbal tests. Figure 6 presents a summary of the study's findings for the delayed visual and verbal tests. Figure 7 presents a summary of the study's findings for the composite tests. The study did find statistical significance for only the visual testing mode for the identification tests. There was no significant difference found in the remaining 12 statistical analysis of test scores between and within the treatment group, but in 8 of the 12 statistical analysis the mean scores for visual format of testing were higher than the verbal testing format.

Figure 4

Summary of Mean Scores for Combined Immediate and Delayed Tests



* - Denotes significant difference found, p<0.05

Figure 5

Summary of the Mean Scores for Immediate Visual and Verbal Tests

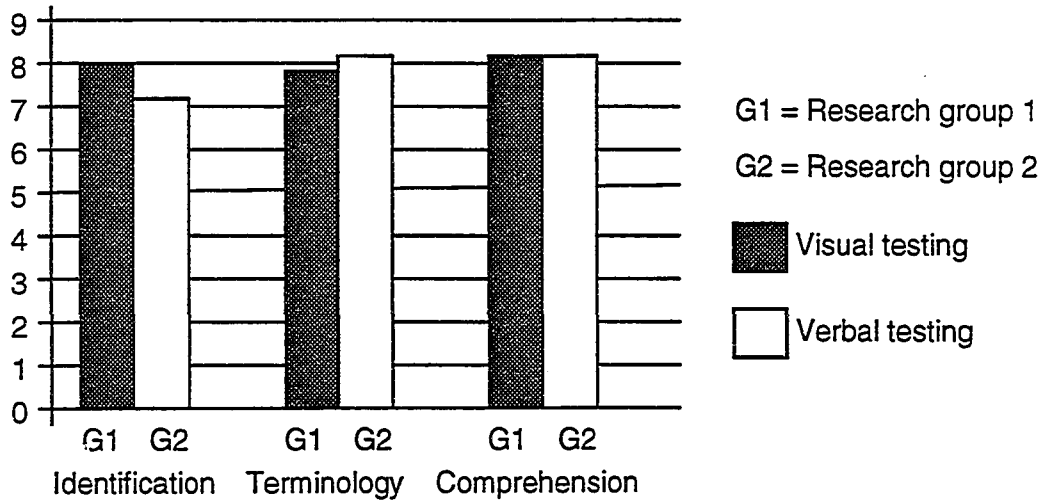


Figure 6

Summary of the Mean Scores for Delayed Visual and Verbal Tests

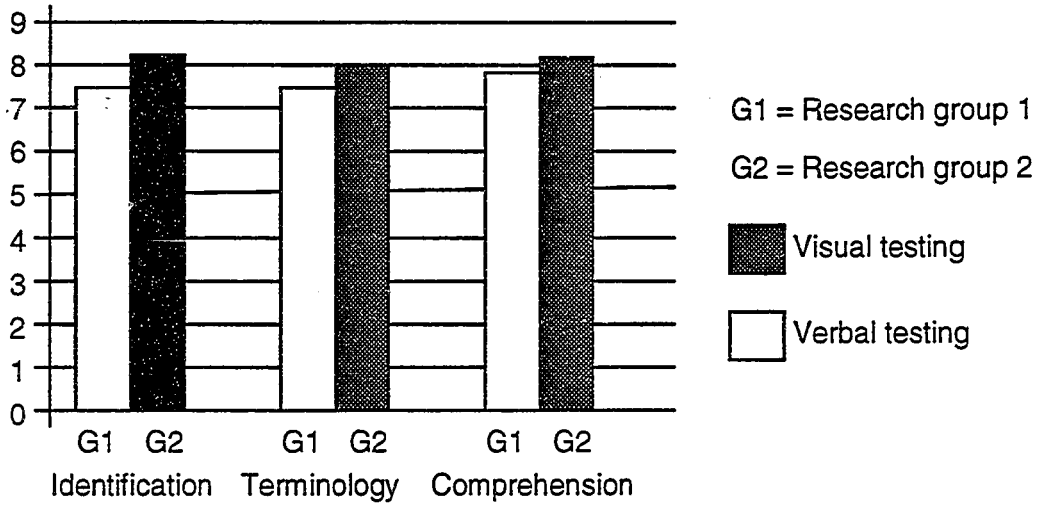
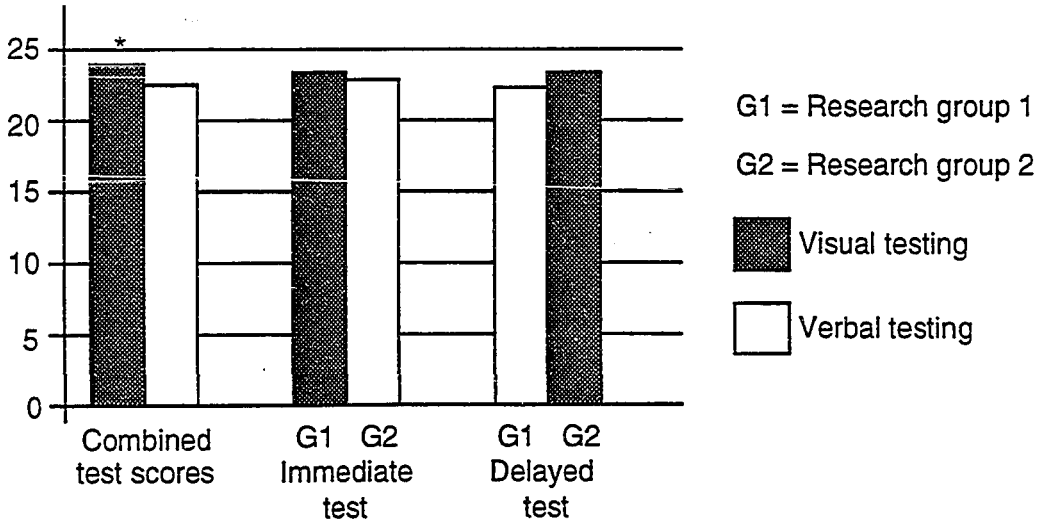


Figure 7

Summary of the Mean Scores for Composite Tests



* - Denotes significant difference found, $p<0.05$

The Study's Findings and its Hypothesis

The results of this study show statistical significance to support part of the study's hypothesis, i.e., students who receive visual testing will obtain higher achievement levels on identification tests. There was no statistical significance found to support the balance of the study's hypothesis, i.e., visual testing increases achievement for terminology and comprehension tests. It is important to note that although no significant difference was found, the mean test scores for all the delayed visual tests were higher than the delayed verbal tests mean scores.

The Study's Findings in Comparison to Past Research

It is very fortunate that several studies have used the criterion tests formats developed by Dwyer & De Melo (1983). This section will compare the study's findings to those past studies. The study only found significant difference for the visual criterion identification test. The study's findings are congruent to only one previous study, i.e., Szabo et al (1981). The balance of the past research is incongruent to the findings of this study. Dwyer & De Melo (1983) and Dwyer (1986) found significant difference for visual testing in all of the three criterion tests. Dwyer (1985) found significant difference for only the visual comprehension criterion test. Dwyer & De Melo (1984); Richards (1987); Pimolbunyong (1988); Mayton (1991); and McNeal (1994) found no significant difference between verbal and

visual test modes for any of the criterion tests. See Table 11 for a summary of the current and past research findings for visual testing.

Table 11

Comparison of this Study's Findings to Past Research Findings Comparing Visual and Verbal Testing.

Research	Identification test	Terminology test	Comprehension test
Study's findings	Visual > Verbal	NSD	NSD
Szabo et al (1981)	Visual > Verbal	NSD	NSD
Dwyer & De Melo (1983)	Visual > Verbal	Visual > Verbal	Visual > Verbal
Dwyer & De Melo (1984)	NSD	NSD	NSD
Dwyer (1985)	NSD	NSD	Visual > Verbal
Dwyer (1986)	Visual > Verbal	Visual > Verbal	Visual > Verbal
Richards (1987)	NSD	NSD	NSD
Pimolbunyong (1988)	NSD	NSD	NSD
Mayton (1991)	NSD	NSD	NSD
McNeal (1994)	NSD	NSD	NSD

NSD = No Significant Difference

Alternative Plausible Hypotheses for the Study's Findings

The study's hypothesis stated that there would be increased student performance as measured by achievement on identification, terminology and comprehension tests. Reasons for the lack of significant difference for the terminology and comprehension criterion tests found in this study are suggested by several possible effects and factors. These include the type of rehearsal activities used in the IMM lesson, the students' lack of familiarity with visual testing, the way the visuals were used for visual testing, the types of visuals used for visual testing, the novelty of learning by IMM and the high competency requirements of the IMM lesson content.

Rehearsal activities

Rehearsal activities of the instructional lesson are a possible factor that may have created the study's results. The instructional strategy used in the IMM program involved content being presented in small segments by the most appropriate media format followed by some rehearsal activities, e.g., complete a review quiz or practice labeling a diagram. Corrective feedback was provided to the students in all the rehearsal activities.

Rehearsal activities can be classified as either overt or covert. Covert rehearsal generally requires minimal information processing activity on the part of the learners. Examples of covert rehearsal include: reading prose passages, reading summary statements, reading questions and answering them mentally before checking with a given answer, and following mentally

the completed solution of a problem. Overt rehearsal provides some physical activity where the learners are required to interact with the content material, ensure that they attend to the information and spend more time interacting with and encoding the information. Writing answers to questions, note taking, and drawing diagrams may be considered to be examples of overt rehearsal (Dwyer, 1985). The effectiveness of covert versus overt learning strategies has produced somewhat mixed results in the literature but there are some indications that overt is more effective in increasing learning (Richards, 1987). Dwyer (1985) in her study found that the use of overt visual rehearsal activities with visual testing produced a significant difference in student achievement. The overt visual rehearsal activity required the students to shade and label part of a diagram of the human heart.

A retrospective analysis of the rehearsal activities used in the IMM lesson of this study revealed the following findings. There were two overt rehearsal activities used for the identification learning objectives, i.e., 1. drag the anatomical name to the appropriate part of a diagram of the pregnant female and 2. drag the anatomical name to its appropriate physiological function on a chart. The terminology learning objectives had two covert rehearsal activities, i.e., two short multiple choice answer quizzes. The comprehension learning objectives had one covert rehearsal activity i.e., one short multiple choice answer quiz. In the initial design of the instructional lesson, the selection of the types of rehearsal activities was based on the content and there was no consideration given to whether it was

overt or covert. It is possible that the significant difference found only for the identification exam was the result of overt rehearsal being only used for the identification learning objectives.

Students' lack of familiarity with visual tests

The students' performance on the terminology and comprehension visual tests may have been also influenced by the fact that EMR students are most familiar with verbal tests. In EMR and prehospital emergency medical care education the typical evaluation used is a verbal multiple choice exam. The EMR students' lack of familiarity with visual testing may have hindered their performance. McNeal (1994) stated that her study's subjects were adult learners who were part time learners with other life roles and may not have had learning strategies that could benefit from visualized testing. She indicated that in Dwyer & De Melo (1983) and Dwyer's (1986) studies the subjects were full time college students who had learning strategies that could have allowed them to benefit from visual testing. McNeal's sample profile is very similar to the profile of the EMR students used in this study.

The research of Szabo & Schlender (1996) noted that the lack of familiarity with visual testing was a factor in producing no significant difference in their study. They stated that most school based learning occurs in a textual form and appeals to the left hemisphere of the brain. The use of visuals, which appeals to the right hemisphere, will not only change what is learned but how it is learned. In addition, they noted that a student's confidence in the use of computers is a trait built up over prolonged periods of

time and exposure. In their study, students were provided a one time class exposure to instruction and evaluation by a CBI program with static and dynamic visual displays. This limited exposure may have been insufficient to bring a measurable change in the students' confidence and ability to learn and be evaluated by static and dynamic visuals.

The way the visuals were used

Another possible factor affecting this study is the way the visuals were used in the terminology and comprehension visual tests. In the majority of the visual terminology questions and some of the comprehension questions, the visuals were used to either complement or be redundant to the questions stem or answer choices. Dwyer & De Melo (1984) indicated in their study that this type of redundancy may have simply provided an alternative iconic base from which students can interact and compound complex content material. They also indicated that their reasoning does appear to coincide with Glanzer & Clark's (1963a, 1963b and 1964) verbal-loop hypothesis. The verbal-loop hypothesis states that a stimulus (illustrations or objects) viewed by a learner is translated into a series of words, is held in memory and is recalled by the learner in making a covert or overt response. Holliday (1977) have disputed that displays of visuals in text may result in some readers paying more attention to one cue and less to others. The students in this study may have mentally translated the visuals into less important textual information or merely treated them as icons thus reducing their effectiveness

for conveying information. These effects would have been also enhanced by the students' unfamiliarity with visual testing.

The type of visuals used

The another possible factor affecting this study is the type of visuals used in the comprehension test. The use of static visuals may have been a limiting factor in testing the students' level of information retention. In the initial design of the visual comprehension test, static visuals and no textual information were to be used in the question stems and/or answers. In many cases a static visual could not encapsulate all the information or concepts presented by the question stem and/or answer choices of the verbal comprehension test. This limitation of the static visuals resulted in the inclusion of a verbal description to enable the question stem or answer to provide sufficient information to the students to comprehend and develop a response. This factor may have reduced the effectiveness of the visual comprehension test. Dwyer & De Melo (1984, p. 93) stated that they experienced the same problem in their study:

> The intentional design of the visual distracters in the visual test format (so that they were congruent with the verbal distracters of the verbal items) imposed a severe limitation; the investigators, had they not been restricted by an attempt to make congruent distracters, might have been able to design visual distracters that could have assessed more validly the students' level of information retention.

In the IMM lesson both static and dynamic visuals were used to present content, yet in the final evaluations only static visuals were used. It is probable that the use of static visual displays is not the most appropriate

form for evaluating comprehension learning. Mayton (1991); Rieber (1991); Poohkay (1994); and Szabo & Poohkay (1995) found that the use of dynamic visual displays, i.e., animation, in computer based instruction (CAI) did increase student learning when compared to students who learned from CAIs that only used static visual displays. The instructional material in Mayton's (1991); Rieber's (1991); Poohkay's (1994) and Szabo & Poohkay's (1995) studies were concepts and processes. In these studies the dynamic visuals were only used in the instructional lesson and not in the evaluation of learning. Chien (1991) found that students who received computer graphic instruction and were tested by video significantly outperformed students who received computer graphic instruction and were tested by computer graphics. Chien (1991) evaluated students' attitudes and abilities to discriminate performance of fast-moving objects. The findings of these studies do suggest that the use of dynamic visuals may be more appropriate for assessing comprehension learning objectives. The role of dynamic visuals in the evaluation of learning is a subject that does warrant further investigation.

Competency requirements

The competency requirements of the IMM lesson is another possible factor for creating the study's findings. Emergency medical training demands a high level of competency from its practitioners because the undesirable consequences of poor performance. The pass mark for the EMR course was set at 80% by the school and the Professional Association for

EMRs. Students enrolled in EMR training are fully aware of the high expectation for competency placed on them and they will devote more effort into their learning to obtain competency. The mean scores for all the criterion tests in this study were very high. The high level of mastery required has created a ceiling effect in the mark distribution of the data. This ceiling effect may have resulted in a restricted range of scores which could have mask the actual differences for the terminology and comprehension tests.

The novelty of learning by IMM

The use of IMM is a fairly new instructional method for the EMR students and also for teaching the subject content. It is possible that the EMR students found learning by IMM to be a very novel experience. This novelty could have increased their attention and interest in the learning activity and subsequently could have increased their level of learning. Gagné (1985) noted that gaining attention and motivation is key to a successful learning process. The effects of novelty are considered by the study's researcher to be small but in combination with some of the alternative hypotheses presented, their total effect could be responsible for the no significant difference findings for the comprehension and terminology tests. Unfortunately, no data was collected to assess the participants' attitudes of learning activity. This data could have been analyzed to determine if there is any correlation between student performance and attitudes.

Study's Conclusion

The conclusion of this research study is that students who learn by a visually rich IMM program do obtain significantly higher achievement scores for identification criterion learning objectives when evaluated by visual testing than verbal testing. The study also found that the use of visual testing is just as adequate and appropriate as verbal testing for evaluating terminology and comprehension learning objectives.

The results of this study also lend further support to the Morris, Bransford, & Franks (1977), transfer appropriate principle, Tulving & Thompson's (1973) encoding specificity principle and Paivio's (1986) dual coding theory. Morris, Bransford, & Franks' (1977), transfer appropriate principle implies that information processing must be appropriate to the intended use of the information. EMRs must identify the anatomical structures and positions of the pregnant female as part of their assessment and treatment duties. This study has shown statistically that the use of visual learning and testing is the most appropriate information processing activity for identification learning objectives. Tulving & Thompson's (1973) encoding specificity principle includes the assumption the recognition memory is better if the cues used in the original instruction/acquisition environment are used in the testing/retrieval environment. The content for the identification learning objectives were presented in a visually rich IMM program and the students did score significantly higher on the visual identification tests over the verbal identification tests. The fundamental principle of Paivio's (1986) dual coding theory is that recall and recognition is

enhanced by presenting information in both visual and verbal forms. In this study, the visual identification tests contained both visual and verbal information and the students do significantly obtain higher scores on the visual identification test compared to the verbal identification test.

Recommendations for Application

The results of this study recommend the use of visuals in the evaluation of student learning from an IMM program, especially in situations where the learner is required to obtain a high level of competence in identifying parts or positions of an object, e.g., human anatomy in medical education.

Recommendations for Further Investigation

Based on the results of this study and the literature on the field of visual testing further research in to this area is recommended.

First, research of this type should be replicated with a sample and instruction content that do not require a high level of competency. The sample should be polled to determine preferences and familiarity to verbal and visual testing and this data should be analyzed to determine if there is a correlation to their final performance. The data should also be collected mid-way of a course delivered totally by IMM, (this will reduce a possible effect created by the novelty of learning by IMM). The knowledge gained from this

research will either verify or disprove some of the hypotheses postulated for creating the findings of this study

Secondly, research should be conducted to determine the role of rehearsal within an IMM lesson. Rehearsal is key to increasing the learning of any subject matter. The ever increasing capabilities and power of personal computers to convey information via IMM can also foster more elaborate and meaningful forms of rehearsal. The knowledge gained by this research will help direct instructional designers and IMM developers to increase the value of IMM as a learning tool

A third suggestion for further research is to investigate the differences in student performance when evaluated in simulated and real situations after learning from IMM. Morris, Bransford, & Franks' (1977), transfer appropriate principle does provide some theoretical basis for this inquiry. The findings of this study indicate that students who learn by a visually rich IMM program do obtain significantly higher achievement scores for identification criterion learning objectives when evaluated by visual testing. The ultimate visual test for EMRs are real situations where they have to identify the anatomical structures and positions of the pregnant female as part of their assessment and treatment duties.

Finally, research should be conducted to investigate the role of dynamic visuals in evaluating learning from an IMM instructional program. The results of this study do point out the limitations of the use static visuals within the evaluation phase. Research has shown that the use of dynamic visuals in the instructional phase of MCBI is beneficial, (Mayton, 1991; Rieber, 1991; and Poohkay, 1994). The subsequent question raised is

whether dynamic visuals are beneficial in evaluating learning? This body of knowledge will help direct instructional designers and IMM developers to determine if they are truly evaluating what is learned in an IMM lesson

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APPENDIX

A. CONSENT FORM

Thesis Title: The role of visual testing when learning from instructional multimedia.

Researcher: Richard Daniel Poon
University of Alberta
Faculty of Education
Department of Adult Career and Technology

This is to certify that I agree to have the results of my performance in this EMR course used for research purposes by the Northern Alberta Institute of Technology and the University of Alberta. Having been contacted by the researcher, a graduate student in the Department of Adult Career and Technology, I understand that:

1. The purpose of this study is to investigate selected effects of visual testing upon learning from an interactive multimedia program.
2. My name will not be disclosed at any time during this study or used in the resulting thesis.
3. Any information I provide to the researcher will be kept confidential and used solely for the purposes of this research study.
4. The results of the study will be made available to me if I so request.
5. I have been fully informed as to the nature of the study and my involvement in it.
6. The thesis this study leads to will be available for examination at the University of Alberta Library.

Signature of participant _____ **Date** _____

APPENDIX

B. VERBAL EXAM

This is a compilation of the twenty seven questions used in the verbal exam. In the study each question was individually presented on a single computer screen to the student.

1. The fetus obtains oxygen and nourishment from the mother's blood through which of the following anatomical structures?

a) Uterus

b) Placenta

c) Amniotic sac

d) Cervix

2. Just before delivery, the fetus enters which anatomical structure?

a) Placenta

b) Amniotic sac

c) Cervix

d) Vagina

3. Which organ does the fetus develops inside?

a) Uterus

b) Placenta

c) Amniotic sac

d) Vagina

4. What structure prevents bacteria and other foreign substances from entering the uterus during pregnancy?

a) Placenta

b) Cervix

c) Mucus Plug

d) Vagina

5. Measurements of what structure is used to determine the week of pregnancy?

a) fundus

b) placenta

c) cervix

d) perineum

6. What anatomical structure is called the birth canal and also acts as a receptacle for semen during intercourse.

a) uterus

b) Cervix

c) Vagina

d) perineum

7. For a baby to be consider term, it must be born at what weeks of pregnancy?

a) 36 to 37 weeks of the pregnancy

b) 38 to 40 weeks of the pregnancy

c) 41 to 42 weeks of the pregnancy

d) 43 to 44 weeks of the pregnancy.

8. What structure will dilate to 10 cm. in diameter during the first stage of labour?

a) fundus

b) uterus

c) cervix

d) vagina

9. What structure transfers oxygen and nourishment between the fetus and the placenta?

a) Uterus

b) umbilical cord

c) amniotic sac

d) amniotic fluid

10. What anatomical structure is also known as the bag of waters?

a) Uterus

b) Placenta

c) amniotic sac

d) amniotic fluid

11. The stage of labour that covers the time from when the baby is in the birth canal
until it is born is the

a) First stage

b) Second stage

c) Third stage

d) Fourth stage

12. Choose the statement that describes the third stage of labour.

a) From the beginning of contractions until the cervix is fully dilated

b) From when the baby is in the birth canal until it is born

c) From the beginning of contractions until the fetus is delivered

d) From when the baby is born until the afterbirth is delivered

13 The interval between contractions is measured from

a) The end of one contraction until the beginning of the next

b) The beginning of one contraction until the beginning of the next

c) The beginning to the end of a single contraction

d) End of one contraction until the end of the next

14. In true labour, the initial contractions are felt normally where in the mother?

a) the fundus

b) mid abdomen

c) the lower abdomen

d) the lower back

15. Which of the following statements best describes false labour?

a) a series of regular contractions that increase in strength, time and interval.

b) a series of regular contractions that increase in strength and time and have a decreasing interval.

c) a series of irregular contractions that vary in length, time and interval and are not relieved by activity such as walking.

d. a series of irregular contractions that vary in length, time and interval are relieved by activity such as walking.

16. During your assessment of a patient in labour, you notice that her vaginal discharge is green stained. How would you define this finding?

a) This is normal discharge and there is no need for concern.

b) This is meconium staining and there is no need for concern.

c) This is normal discharge and it is an indication of fetal distress.

d) This is meconium staining and it is an indication of fetal distress.

17. What statement is the correct in describing the second stage of labour.

a) It will last about 2 hours in all pregnant woman regardless of the number of times they have been pregnant.

b) It is very short, even as short as 4 minutes in all pregnant woman regardless of the number of times they have been pregnant.

c) In a woman who's having her first pregnancy it can last up to 2 hours, and for women in their second or subsequent pregnancy t is much less, it could be even as short as 4 min.

d) For women in their second or subsequent pregnancy it can last up to 2 hours. For women having their first pregnancy the length of time of it is much less and can be as short as 4 min.

18. What is the proper way to transport a pregnant female?

a) knee-chest

b) supine

c) on her right lateral side

d) on her left lateral side

19. Normally, how long is the third stage of labour?

a) 1 hour in all women

b) 1 hours in first time mothers and 20 to 30 minutes in woman who have give birth before.

c) 20 to 30 minutes in all women

b) 20 to 30 minutes in first time mothers and 10 minutes in mothers who have given birth before.

20. What vaginal discharge is known as the "show"?

a) the placenta

b) the fetus

c) the amniotic fluid

d) the mucus plug

21. Appropriate questions to evaluate the status on a pregnant patient in labour include all of the following except

a) If this is her first pregnancy

b) If she feels the need to move her bowels

c) If she knows the sex of the fetus

d) If she has been seeing a physician

22. Choose the action that is not acceptable when preparing a mother for delivery at the scene.

a) Have the mother lie on her back

b) Feel for contractions if time allows

c) Check the cervix to see if it's fully dilated

d) Look to see if the baby is visible at the vaginal opening

23. Which of the following signs and symptoms is not an indication of eminent delivery?

a) the mother feels like the baby is moving out through her vaginal opening,

b) the mother has the urge to push the baby out,

c) the mother has the urge to have a bowel movement,

d) the contractions are about 4 minutes apart and strong

24. Which of the following steps is needed for preparing for delivery?

a) selecting an area for delivery and examination of the baby.

b) breaking open and setting out the obstetric kit.

c) positioning and visually examining the mother

d) establishing a clean field for delivery.

e) all of the above

25. What is the proper order for draping a mother with sheets and towels in order to form a clean field for delivery?

a) abdomen, legging, and then vaginal opening

b) abdomen, vaginal opening and than leggings

c) vaginal opening, abdomen, and then leggings

d) vaginal opening, leggings and then abdomen

26. You are called to a house for a 18 year old pregnant female who's having labour pains. She is full term, having her first child and is confused and scared. She tells you that her bags of water have not broken. The contractions are very strong and about 2 minutes apart. On visual exam of the perineum you see that it is bulging. What is your assessment of the situation?

a) Delivery is imminent and you should prepare for it.

b) This is true labour and you should transport the patient.

c) This is probably false labour but you should still transport.

d) This is probably false labour and you do not transport.

27. Which of the following positions could cause hypotension in the pregnant female?

a) lying in the knee-chest position

b) lying supine

c) lying on her right lateral side

d) lying on her left lateral side