School of Technology

Hypertext or Hypermedia: A comparative study in computer graphics.

In partial fulfillment of the requirements for the
Degree of Master of Science in Technology

Chad M. Blessinger

April 2004

Committee Member	Approval Signature	Date
Dr. Nathan W. Hartman, Chair **Technology**	_____	_____
Professor Susan G. Miller **Technology**	_____	_____
Professor Carlos R. Morales **Technology**	_____	_____
Professor Erik L. Malewski **Curriculum & Instruction**	_____	_____

Hypertext or Hypermedia: A comparative study in computer graphics.

by
Chad M. Blessinger

In Partial Fulfillment of the
Requirements for the Degree

of

Master of Science

April 2004

TABLE OF CONTENTS

INTRODUCTION

Instruction using computers is becoming more prevalent in educational institutions (Boles, Pillay, & Raj, 1999). With an increase in technology comes an increase in the challenges presented to educators to use these technologies and to researchers to validate these technologies (Dastbaz & Kalafatis, 2003). Before instruction can be considered good, it needs to be evaluated (Smith & Ragan, 1999). Before an instructional technology can be considered good, it too should be evaluated. One way to evaluate an instructional technology is to compare it to an existing technology that has been shown to have value (Farhat, Instone, Laventhal, Mynatt, and Rohlman, 1992).

Hypermedia is being used over hypertext as an instructional technology at an increasing rate (Hailey & Hailey, 1998; Klein & Koroghlanian, 2004; Kotze, 1998). Is this trend because we can or because we should? At this point there has been little research conducted to answer this question (Klein & Koroghlanian 2004). It appears that an assumption may be made by some instructors that since there has been evidence to support that hypertext technology has improved the learning experience (Farhat et al., 1992; Moore, 1995), hypermedia will improve it even more (Klein & Koroghlanian 2004). This assumption might be correct, but that does not mean that it does not need to be supported by research.

This study has tested the validity of the belief that hypermedia technology is more effective when used in instruction than hypertext technology. It has done this by comparing two instructional applications, one created using each technology, for the instruction of the *anatomy of type* as it is defined by Baines & Haslam (2002), Carter, Day, and Meggs (2002), Clair (1999), and Faiola (2000).

The term hypertext has many different meanings depending on which scholar you are addressing (Wardrip-Fruin, 2004). For the purposes of this study, traditional hypertext was defined as “non-linear, organized and accessed screens of text and static diagrams, pictures, and tables” (Kotze, 1998). The word traditional is essential here because some scholars are now using the term hypertext with regard to the application of multimedia in general (Wardrip-Fruin, 2004). For the purpose of this study the terms hypertext and traditional hypertext were used interchangeably to mean the same thing. Hypermedia, as it was used in the context of this study, is “a computer-based system allowing for non-linear traversal

through a maze of interactive, linked, multiple format information, including text, still or animated graphics, movie segments, video, and audio" (Kotze, 1998).

PROBLEM STATEMENT

The use of traditional hypertext as an instructional technology can be problematic in that there are limitations in the available modes of communication inherent to the use of hypertext that suggest the use of other technologies to assist learners.

RESEARCH QUESTION

How effective is traditional hypertext as an instructional technology, when compared with hypermedia, to teach the *anatomy of type* to CGT undergraduate students?

SIGNIFICNACE OF THE PROBLEM

Hypertext is considered to be a valuable means of representing and organizing information by many educators (Moore, 1995). Hammon, McKendree, and Reader (1995) identify that some educators have misconceptions about the value of hypertext as an instructional technology. They state that educators often fail to take into consideration that learners could become distracted by low level links and miss pertinent information relative to main content (Hammon et al., 1995). Hypertext primarily focuses on the use of two means of communication, text and still images. Much like a textbook, hypertext still focuses on learning in a two-dimensional learning environment (Kotze, 1998). A small amount of attention is devoted to haptic communication, but mainly for the purpose of "flipping pages" in a body of text (Farhat et al., 1992). Farhat et al. (1992) found in a study they conducted comparing nonlinear hypertext to a linear textbook that hypertext can equal or surpass conventional books as an information-seeking medium. This does not necessarily determine whether we should be using hypertext or just nonlinear

instructional technologies. This study is concerned with a second technology to be considered for use in instruction.

Hypermedia has the ability to communicate using text, still images, animation, video, and audio (Doube, 1998; Kotze, 1998). It allows the learner to interact with information in two-dimensional, three-dimensional, and four-dimensional learning environments. Howell (2001) states that learners have a variety of learning styles, and that for electronic instruction to be effective it must reflect this variety. However, the disadvantage of hypermedia can be the quantity of time required to produce it (Ess, 1991).

PURPOSE OF THE STUDY

It was the purpose of this study to determine if there is a difference between the effectiveness of using hypertext and hypermedia in the instruction of the *anatomy of type* to CGT students within Purdue University by comparing a hypertext HTML web instructional application with a hypermedia instructional application designed using Flash. It was also to determine if there was difference in production time needed between developing an instructional tool using the two technologies. This data is now available for instructors to consider when deciding between using hypertext or hypermedia to create and administer instruction.

Effectiveness, for the purpose of this study, was measured by determining two factors. These factors were the ability of learners to retain knowledge and the development time required for production of a teaching tool using each technology. Retention of learner knowledge was defined as the improvement made by learners in correctly answering questions on a test after receiving instruction on its content using a teaching tool representing one of the two already defined technologies, hypertext or hypermedia. According to Klein and Koroghlanian (2004, pg. 24), “little research exists to support the notion that adding multimedia (hypermedia) features to instruction improves learning and performance.” The context in which they make this statement suggests that not much research has been done in support of or contrary to the use of hypermedia. It was the intent of the author that this study adds to any existing research on this subject.

ASSUMPTIONS

The following assumptions were inherent in the pursuit of this project:

1. The students have had some exposure to computer-based learning environments.
2. The students participated honestly in evaluation of the unit of instruction created.
3. The students performed to the best of their ability on evaluations of individual performance.
4. The author had equal competency in developing instructional applications in both Dreamweaver and Flash.
5. No participants who had completed participation in this study divulged information about testing or lesson content to other participants who had not yet participated before testing was completed.
6. The Smith and Ragan (1999) Instructional Design Model was adequate for use during the development of instruction when teaching the *anatomy of type* to CGT students.

DELIMITATIONS

The following delimitations were inherent in the pursuit of this project:

1. This unit of instruction was taught within the Department of Computer Graphics at Purdue University.
2. The implementation of this project occurred within Purdue University's computing network.
3. The implementation of this project was limited by the student interest in the *anatomy of type* at the time of this project. This may have been influenced by each student's area of interest within computer graphics.
4. Results showed their greatest significance in the instruction of the *anatomy of type* in the Department of Computer Graphics at Purdue University. Generalizability is currently limited.
5. The instructional tools compared focused on the anatomy of type in the English language. Letterforms in Asian cultures such as China, Korea, and Japan or any other cultures were not discussed.

DEFINITION OF TERMS

The following terms are defined to assist the reader:

Advanced Technological Knowledge: a thorough understanding of the technology specific to a course (Perrin & Mayhew, 2000). This would include but is not limited to software specific skills, computer networking, and the installation of applications.

Anatomy of Type: various parts of and geometry of a letterform (Faiola, 2000).

Constructivism: belief that learning is an active process and that learning is determined by the complex interlay among learners' existing knowledge, the social context, and the problem to be solved (Sahin, 2003).

Subject Matter Expert: one who has acquired extensive knowledge in a specific area that affects what they notice and how they organize, represent, and interpret information in their environment (Bransford, Brown, & Cocking, 2000).

Hypermedia: computer-based system allowing for non-linear traversal through a maze of interactive, linked, multiple format information, including text, still or animated graphics, movie segments, video, and audio (Kotze, 1998).

Hypertext: non-linear, organized, and accessed screens of text and diagrams, pictures, and tables (Kotze, 1998).

Legibility: refers to the ability of the reader to distinguish letters or characters from each other. This is achieved by controlling the qualities and attributes inherent in typography that make type readable (Carter et al., 2002).

Objectivism: belief that knowledge is acquired through experience and is generally singular (Smith & Ragan, 1999).

Readability: how easy it is for a reader to comprehend a body of text (Clair, 1999). This is contingent on a variety of factors; the point size, leading, tracking, and length of a line can all effect readability.

Scaffolding: the cognitive processing support that the instruction provides the learners, allowing them to learn complex ideas that would be beyond their grasp if they depended solely on their own cognitive resources, selectively aiding the learners where needed (Greenfield, 1984).

Type: individual letterforms.

Typography: originally the composition of printed matter from movable type; now the art and process of typesetting by any system or method (Carter et al., 2002).

REVIEW OF LITERATURE

This literature review pertains to computer-based instruction (CBI) in general, hypertext and hypermedia, instructional design, and typography. Literature on CBI is reviewed to help understand the significance of computer-based learning today. Hypertext and hypermedia are defined, and then some context is given for how and why they are used. A definition of instructional design is given and the Smith and Ragan (1999) instructional design model is explained with its relevance to this study. A brief history of type is outlined and the *anatomy of type* is described based upon four textbooks (Baines & Haslam, 2002; Carter et al., 2002; Clair, 1999; Faiola, 2000).

Computer-Based Instruction (CBI)

Boles et al. (1999), claim that "CBI is becoming an integral part of our teaching and learning process and a dominant educational delivery system in many parts of the world." This technology is being promoted for use in education by the government through grants (Adams, Carswell, Ellis, Hall, Kumar, Meyer, & Motil, 1996). According to Klein and Koroghlanian (2004), CBI containing hypermedia is increasingly being used as an adjunct to instruction in the traditional classroom. Development of these learning tools has become more challenging as it requires expertise in technology, learning, and in content (Dastbaz & Kalafatis, 2003).

CBI which includes hypertext and hypermedia attracts learning professionals because of its demonstrated and potential capability for enhancing the experience of learners (Ess, 1991). It has the ability to use simultaneous modalities to communicate information (Doube, 1998). For CBI to be effective, it should be designed with the consideration of effective learning, instruction, communication of content, and use of technology. It should be simple, clear, and unambiguous (Adams et al., 1996). "Careful planning, designing, and evaluating of computer-based learning can yield results for you and for your students beyond your (and their) wildest imaginations" (Opitz, 1998).

According to Kotze (1998, pg. 150), "Controlling the flow of a presentation is central to any CBI system." She claims that links in CBI systems can sometimes distract learners from important information. When students begin using CBI, they are forced to make an internal switch from a regular

mode of work to computer work (Bracey, 1989) Bracey (1989) claims that this can be very stressful for some learners. Boles et al. (1999) assert that there is a gap in understanding the relationship between CBI and learning.

Hypertext & Hypermedia Technology

There is often confusion between the use of the terms hypertext and hypermedia. They do however have different meanings (Chen & Dwyer, 2003; Hailey & Hailey, 1998; Klein & Koroghlanian, 2004; Kotze, 1998). The term hypertext was coined by Theodore Nelson in the 1960's (Bevilicqua, 1989; Vrasidas, 2002; Wardrip-Fruin, 2004). He defined hypertext as meaning non-sequential multidimensional writing (Vrasidas, 2002). Still images, in addition to text, are generally accepted as a part of hypertext (Bevilicqua, 1989; Chen & Dwyer, 2003; Hailey & Hailey, 1998; Klein & Koroghlanian, 2004; Kotze, 1998; Vrasidas, 2002). Hypermedia on the other hand, can include media in addition to text and still images. Hypermedia might include sound, animation, video, and/or virtual reality environments (Hailey & Hailey, 1998). Common traits between the two technologies are that they are both non-linear and learner directed (Schroeder, 1991; Vrasidas, 2002).

According to Hailey and Hailey (1998) and Chen and Dwyer (2003), instructional technologists, technical writing instructors, and developers of CBI have increasingly claimed that the non-linear structure of hypertext and hypermedia mimic the thought process of the human brain and therefore are ideal for teaching and learning. "It parallels the way the human brain and memory work" (Vrasidas, 2002). These two technologies, by their user oriented nature, are aligned with the constructivist paradigm (Dastbaz & Kalafatis, 2003).

Schnackenberg and Sullivan (2000, pg. 19) claim that "popular argument states that learner control is intrinsically appealing because it allows learners to tailor elements of instruction to their individual needs and preferences." A drawback of learner controlled technologies such as hypertext and hypermedia is that when learners have been left to regulate learning on their own, they often inadequately monitor the level of their learning (Song, 2002). Learners will sometimes not push themselves as hard as they can or possibly should. These systems can also be confusing and disorienting to less able students.

Some of this confusion often comes from poorly designed interfaces and inconsistency across systems (Schroeder, 1991). Schroeder (1991) suggests that some standardization may help solve this problem.

It has not yet been determined whether hypertext can appropriately simulate different learning environments to facilitate learning for different types of learners (Chen & Dwyer, 2003). According to Moore (1995), there are limitations in using hypertext that suggest the use of other technologies during instruction.

With the use of hypertext, the scope of a topic is defined by the reader, not the editor or author as it has been in the past (Bevilacqua, 1989). One of the biggest concerns with hypertext is that it may cause cognitive overloading (Clibbon, 1995). Cognitive overloading occurs when individuals attempt to comprehend too much information in one way at one time (Klein & Koroghlanian, 2004). The majority of studies indicate that physically including text in an illustration improves learning and can reduce cognitive overloading (Klein & Koroghlanian, 2004).

Hypermedia systems are generally designed so that they carry the entire burden of instruction (Vrasidas, 2002). An advantage of hypermedia systems is that they are multimodal. Visual, verbal, and auditory information can be used for communication (Vrasidas, 2002). Vrasidas (2002) gives an example, stating that if the same piece of information is given using both text and sound, the likelihood that it will be learned will be increased. Klein and Koroghlanian (2004) discuss a study validating this where redundant audio-print instruction was more effective than either audio or print alone. Song (2002) claims that “individuals learn differently and that when a learner is in an environment appropriate to his/her type, learning will be improved.” The way that hypermedia environments cater to students’ individual differences, make them ideal for instruction (Song, 2002).

Hypermedia can be effective at catering to multiple types of learning styles (Pillay, 1998). Three different learning styles listed by Lemire (2002), include visual, auditory and haptic/kinesthetic. Visual learners retain information dominantly by what they see (Lemire, 2002). Auditory learners tend to benefit the greatest from lectures (Howell, 2001). Haptic/kinesthetic learners learn best by interacting with learning material (Lemire, 2002).

Klein and Koroghlanian (2004) claim that an advantage that hypermedia has over hypertext is that in hypermedia, modes such as audio can be used to reduce the amount of text needed on screen. This is an advantage because "reducing the amount of text on a screen leaves more area available for graphics and labeled illustrations, which are necessary tools for teaching certain types of concepts" (Klein & Koroghlanian, 2004, pg. 25).

Defining Instructional Design

In its most basic form, the term instruction means the action, practice, or profession of a teacher (Merriam-Webster, 1995). In the words of Hannafin & Hill (2002), "instruction involves the deliberate arrangement of learning conditions to promote the attainment of some intended goal." Instruction is defined by Smith & Ragan (1999, p. 2) as "the intentional facilitation of learning toward identified learning goals." Instruction can take place in different settings as Ertmer and Quinn (2003) demonstrate through a series of case studies in both academic and industry settings. Instruction can and does take place in both of these arenas without any formal design effort. The process of planning instruction should be viewed as a system which requires the consideration of learners, the instructor, instructional materials, and the learning environment (Dick & Carey, 1996). This statement suggests there is more to good instruction than just good teaching.

Design is defined by Merriam-Webster (1995) as deliberate planning. Another definition of design is that it is a disciplined inquiry engaged in for the purpose of creating some new thing of practical utility (Rowland, 1993). According to Cross (1982) design is a goal-directed process where something new is conceived and realized. During the design process one continues to learn (Rowland, 1993). Also, design problems must be found as well as solved (Lawson, 1980).

When combined together to form the term instructional design, these two words can take on a much more specific meaning. Exactly what this meaning is depends on which scholars are listened to. A list of popular definitions is a follows:

- The systematic and reflective process of translating principles of learning and instruction into plans for instructional materials, activities, information resources, and evaluation (Smith & Ragan, 1999).
- A systematic process involving analysis, design, development, implementation and evaluation are used to design instruction. Every component (i.e., teacher, students, materials, and learning environment) is crucial to successful learning (Dick & Carey, 1996).
- A linking of science; a body of knowledge that prescribes instructional actions to optimize desired instructional outcomes, such as achievement and affect (Reigeluth, 1983).

Application of the Instructional Design Process (Systematic Approach)

"Instructional design professionals use systematic processes to design, develop, and implement methods and materials" (Hannafin & Hill, 2002, pg. 73). According to Hanafin & Hill (2002), the systems approach enables designers to provide generalizable processes that aid in focusing, organizing, and managing available resources across diverse learning problems and needs. A system cannot properly function without clear communication between its individual parts, and it depends on feedback to define if its goal has been reached (Dick & Carey, 1996). Instruction using hypertext and hypermedia is no different than other modes of instruction in that its structure needs to be based on instructional design (Doube, 1998).

The instructional design process, as defined by Smith and Ragan (1999), consists of three major stages. The first of these is Analysis. During the analysis stage of instructional design, a designer needs to analyze the learning environment, the learners themselves, the task or objectives that the learners need to complete, and begin creating the instrument which will be used in evaluation of the learners (Smith & Ragan, 1999). According to Dick and Carey (1996), information collected during analysis is crucial in shaping a number of succeeding steps in design, particularly strategy. Strategy is where the instructional designer considers the approach they will take when instructing the learners. Hypertext and hypermedia

technology are considered two similar but different computer-based tools for approaching different instructional strategies (Vrasidas, 2002). The final stage of the instructional design process is Evaluation. During evaluation, instruction is tested to determine how it can be improved and for its overall value (Smith & Ragan, 1999).

As mentioned above, there are four phases to the analysis stage according to the Smith and Ragan (1999) instructional design model. The first of these four phases, the analysis of the learning environment, has two steps within itself: the substantiation of a need for instruction to help learners reach learning goals and a description of the learning environment in which the instruction will be used (Smith & Ragan, 1999). After it has been determined that instruction is needed, the characteristics of the teachers, associated curricula, available hardware or software, facilities, school system or organization, and community policies are analyzed (Smith & Ragan, 1999). Using digital hypertext or hypermedia will define the environment as computer-based.

The second phase of the analysis stage is to analyze the learners themselves (Smith & Ragan, 1999). Learners have differences, created by the environment they have been exposed to and inheritance from their parents (Liben, 1981). By defining and understanding these differences, it is much easier for one to deliberately plan the actions a teacher needs to take for effective instruction. Instructional designers need to identify the sensory capacities of the learners, the way they process information, the type of learner they are, their intelligence quotient, their cognitive style, and their gender, ethnicity, or racial group (Smith & Ragan, 1999). According to Smith & Ragan (1999), specific prior learning is the most important factor for a designer to consider about the audience. Dick and Carey (1996) claim that it is important to determine the knowledge and skills, or "entry behaviors," of learners before instruction can begin.

The third phase of analysis is task analysis (Smith & Ragan, 1999). Smith and Ragan (1999) identify five steps in performing a learning task analysis. These include: write a learning goal, determine the types of learning of that goal, conduct an information-processing analysis of that goal, conduct a prerequisite analysis and determine the type of learning of the prerequisites, and finally write learning

objectives for the learning goal and each of the prerequisites. A learning objective is a central component of virtually all instructional design approaches (Hannafin & Hill, 2002). However, perception of what a learning objective is changes dependent upon the school of thought one subscribes to. Objectivists believe that a learning objective is concrete while constructivists do not (Falance, 2001). Hypertext and hypermedia instruction has objectives, but has the potential to be aligned with the constructivist paradigm (Dastbaz & Kalafatis, 2003).

The final phase within the analysis stage of the Smith and Ragan's (1999) instructional design model is to write test items. The philosophy here is much like the quote from Covey (1989), "Begin with the end in mind." By determining the type of assessment and what it will assess early on, it is easier to design the instruction to meet this assessment (Smith & Ragan, 1999). Two of the most popular forms of assessment include performance assessment and pencil-and-paper tests. Other forms of assessment exist and should be considered for their appropriateness. Dick and Carey (1996) state the importance of relating test items and the objectives that have already been determined. Validity and reliability are two very important factors that need to be considered when choosing or generating assessment tools (Smith & Ragan, 1999).

The next stage in the instructional design process as defined by Smith and Ragan (1999) is to determine instructional strategies. Within this stage, Reigeluth (1983) says that, organizational strategy, delivery strategy, and management strategy should be defined before the production of the instruction itself.

The first of these, organizational strategy, determines what content, how it should be presented, and in what order it should be presented (Smith & Ragan, 1999). At this point in the design of instruction, it should be decided how much scaffolding should be used. The organization of instruction should usually take place in a series of four events: an introduction, the presentation of body, a conclusion, and assessment. Dick and Carey (1996) also mention that this is where the designer should consider preinstructional activities and any follow-through activities. It is during the organizational strategy phase where an instructional designer should consider the generativity of instruction. According to Wittrock

(1974), generative strategies exist when learners are encouraged to construct their own meanings from instruction. Smith and Ragan (1999, pg. 126) state that "an optimal instructional strategy goes as far toward the generative pole as possible while still providing sufficient support for learners to achieve learning in the time possible, with a limited and acceptable amount of frustration, anxiety, and danger."

There are numerous delivery strategies that can be considered when designing instruction. Two of the most common of these are problem solving and declarative strategies. Others include concept learning, principle learning, learning procedures, cognitive strategy instruction, attitude and motivational instruction, and psychomotor skill learning (Smith & Ragan, 1999). Declarative knowledge learning is often associated with the memorization or "knowing" of facts and information. Hypertext and hypermedia are two delivery methods that can be used with most of these delivery strategies (Vrasidas, 2002). Some methods used to help learn declarative knowledge include linking with existing knowledge, organizing or clumping knowledge, and elaborating (Smith & Ragan, 1999).

The production process for instructional materials, as explained by Smith and Ragan (1999), differs based upon the medium that has been chosen for delivery. In most cases, production includes a planning stage, the creation of a draft or prototype, evaluation, and revision. These stages are still appropriate when designing hypertext and hypermedia instructional tools (Doube, 1998). The time and cost of production can some times be large. According to Lee and Zemke (1987), each hour of instruction takes 40 hours of development time.

The final stage of Smith & Ragan's (1999) instructional design model is the evaluation of instructional materials. This takes place in two different forms. These are formative evaluation and summative evaluation, both of which should be planned early in the design process.

Formative evaluation is where the designer evaluates the materials and methods used to determine the weakness in the instruction so that revisions can be made (Smith & Ragan, 1999). Dick and Carey (1996) define formative evaluation as evaluation used to identify how to improve the instruction. There are four phases of formative evaluation defined by Smith and Ragan (1999). They are design reviews, expert reviews, learner validation, and ongoing evaluation. Design reviews can be done after the

completion of any phase of the design. Expert reviews are done with content experts, instructional design experts, content-specific educational specialists, or experts on the learners (Smith & Ragan, 1999). Learner validation is where instruction is tested with actual portions of the learners to identify problems they have with it. The last phase of formative evaluation, ongoing evaluation, is where teachers or trainers using the instructional materials continue to gather data from learners. Long term this will constantly help to improve the quality of instruction. It will also help in adapting instructional materials for changing groups of learners (Smith & Ragan, 1999). During formative evaluation, seeing as it never really ends, revisions are made to instruction.

The final stage of evaluation is summative evaluation. Smith and Ragan (1999) state this is where data is collected, analyzed, and summarized to present to decision makers so that they can make judgments regarding the effectiveness of instruction.

Brief History of Type and its Anatomy

The codex, bound text with left and right margins, was known to be used for the first time in the first century. However, this new form of medium did not become the norm until about 300 years later (Faiola, 1999). According to Faiola (2000), early reproduction of manuscripts was done almost entirely by monks or similar religious icons in non-western cultures. Therefore, these monks maintained control over the accuracy and style of letterforms. This stayed the case for around a thousand years throughout the medieval era (Carter et al., 2002). As recorded by Faiola (2000), through the spread of Christianity, Celtic influence eventually brought many changes to existing Latin lettering styles. Three significant aspects of this can be noted. The first of these is the addition of more rounded uncials resembling our modern text. Second, the use of upper and lower case letters became common practice. This greatly improved readability and saved valuable space on expensive parchment. Third, space was introduced in between words increasing readability even more. Over time, mostly thanks to Charlemagne in the eighth century, standardization was introduced for the training of monks in their craft (Clair, 1999).

A great revolution in the use of type came about during the Renaissance. Much of this is attributed to Johann Gutenberg and his invention of the printing press in 1450 (Carter et al., 2002).

Regardless of who invented movable type, typography as it is defined in modern dictionaries was formed (Merriam-Webster, 1995). At this point, the evolution of terminology related to the *anatomy of type* became crucial to printers (Clair, 1999). As stated by Baines & Haslam (2002), "typography is the mechanical notation and arrangement of language that is used to make multiple copies, whether by printed or electronic means." Clair (1999) explains that writing out a full-length text was a lengthy and imprecise process. With Gutenberg's new invention, the time it took to reproduce a book was cut to a small fraction. Language, spoken or written, can affect our perception of reality (Clair, 1999). Being able to manipulate the appearance and function of type can give one control over that reality (Clair, 1999). At the end of the Renaissance, standards for printable fonts had become well developed and increased to a high level of readability (Carter et al., 2002).

During the early portion of the 18th century, an international standard was created for the proportion of type by Fournier. His system of points and picas is still used today in English-based desktop publishing systems. Fournier also began the categorizing of type into families. He described how different combinations of type are more compatible than others (Clair, 1999). The industrial revolution began in the latter portion of the 19th century changing type close to the way it is seen today (Carter et al., 2002). Sans serif fonts showed up, taking their place in the world of advertising. It became widely recognized that different fonts were better suited for different purposes (Carter et al, 2002).

Type Today

Jury (2004, pg. 8) claims that "the historical development of type design has been inseparable from the developments of the tools, equipment and materials used to make and print type." Computer technology, including hypertext and hypermedia, poses interesting challenges to creating type (Clair, 1999). Since the advent of desktop publishing, creating type has become much easier (Faiola, 1999). Baines and Haslam (2002) believe that the conventions of typography are changing with changes in technology. This is allowing for innovative approaches in design to be taken toward both the printed page and the audiovisual screen. The basic rules of typography must still play a dominant role in the design and use of type (Faiola, 1999).

As noted by Carter et al. (2002), the internet is a challenging environment for creating good type. The main cause of this is the current limitation of display quality. This impacts both hypertext and hypermedia instructional tools in both readability and legibility. Most computer monitors display at less than 100 pixels per inch. “When type is rendered on a screen, details such as stroke weight, subtle curves, and serif detail are reduced to a coarse approximation of the refined forms found in the original design” (Carter et al., 2002). It is also not possible for the typographer to know at exactly what quality their work will be viewed. They must design for various quality displays, often times limiting their freedom. This makes issues surrounding legibility difficult to control (Carlson et al., 1999). This can be an instructional design problem relating to learners with hindered vision. In contrast, computers have also brought flexibility to typography that had never been considered before. A greater freedom to modify size, shape, and complexity of type exists now than in the past (Baines & Haslam, 2002). In hypermedia less text is necessary, so the text that is used can be more prominent on a page (Klein & Koroghlanian, 2004).

Anatomy of Type

Type at a basic level consists of letterforms. Letterforms can have innumerable variations in their size, proportion, weight, and complexity. They must however always maintain the same basic form (Carter et al., 2002). These letterforms are made up of various different components that all have a purpose. Type has different properties including size, width, and letterspace (Faiola, 2000). These properties help to divide type into different categories called fonts. They are also a determining factor in the quality of type defined by legibility and readability (Jury, 2004). According to Clair (1999), it is essential for a designer to know the names of the parts of characters.

Most of the various components of type anatomy are illustrated below in Figure 1. The names of the different components and related terms with their definitions follow. Most of these definitions have been referenced from the same source to maintain consistent language, but four different textbooks on typography were consulted, all containing very similar definitions (Baines & Haslam, 2002; Carter et al., 2002; Clair, 1999; Faiola, 2000).

Figure 1 (Baines & Haslam, 2002)

Ascender: the part of lowercase letters, “b, d, f, h, k, l, and t” extending above the x-height line (Clair, 1999).

Ascender height line: the horizontal rule that aligns along the top of the lowercase letters that extends above the waist line (Clair, 1999).

Baseline: the horizontal rule on which all the bottom serifs or terminals of letters align (Clair, 1999).

Bowl: the curved stroke that makes an enclosed space within a character. In an open bowl, the stroke does not meet with the stem completely: a closed bowl stroke meets the stem (Clair, 1999).

Bracketed serif: a serif in which the transition from the stem stroke to the serif stroke is one continuous curve. Serifs may have differing degrees of bracketing (Clair, 1999).

Cap Height: the typesetting term referring to the size of a typeface (Clair, 1999).

Cap-height line: headline measured from the baseline to the top of the capital letters, determines the height of a typeface (Clair, 1999).

Counter: the white space enclosed by a letterform, whether wholly enclosed or partially (Faiola, 2000).
Cross Bar: the horizontal bar connecting two strokes of a letterform as in “H” and “A”, the ends are not free (Clair, 1999).

Cross Stroke: the horizontal stroke cutting across the stem of a letter, as in “t” and “f”, where both ends of the stroke are free (Clair, 1999).

Cursive: typefaces that are joined and slanted; when typeset, referred to as scripts (Clair, 1999)

Descender: the part of the lowercase letters “g, j, p, q, and y” and capital “J,” extending below the baseline (Clair, 1999).

Descender Line: the horizontal rule that aligns along the bottom edge of the lowercase letters that extend below the baseline (Clair, 1999).

Ear: the small stroke (sometimes rounded) projecting from the top of lowercase Roman “g, r, f, and a” (Clair, 1999).

Eye: the counter (enclosed) area at the top of the lowercase e (Faiola, 2000).

Foot serif: a serif residing at the baseline of a letterform (Baines & Haslam, 2002).

Hairline stroke: the secondary stroke of a letter; usually thinner than the stem (Clair, 1999).

Head serif: a serif residing at the x-height, cap-height, or ascender height of a letterform (Baines & Haslam, 2002).

Hook: curving top portion of a letterform such as in “f” and “r” (Faiola, 2000).

Lining figures: numerals that align along the baseline of the font and are the same height as the uppercase characters, unlike Old Style figures, which have ascenders and descenders (Clair, 1999).

Loop: the lower portion of the Roman lowercase “g” added as a flourish rather than an essential part of the letter (Clair, 1999).

Lowercase: small letterforms, originating from the semi-uncial lettering style; includes ascenders and descenders. The name comes from the placement of the letters in the lower of the two wooden type cases used by hand compositors; placed so that they were within hands’ reach; also called lc or miniscule (Clair, 1999).

Non-lining figures: numerals that do not align along the baseline of the font (Clair, 1999).

Roman Face: denotes the upright vertical position of a letter, as opposed to a slanted, italic form (Clair, 1999).

Small caps: smaller capital letters; designed with many fonts; usually about 75% the height of the uppercase characters; can be specified to be set instead of lowercase (Clair, 1999).

Stem stroke: the main vertical, diagonal, or curved stroke of a character (Clair, 1999).

Stroke: any line necessary to the basic form of a letter; not serif or swash, etc. (Clair, 1999).

Tail: a downward sloping stroke or arc of a character starting from the ending free-stroke on an uppercase “R, K, and the Q” (Clair, 1999).

Terminal: the free end of a stroke. Different types: sheared, ball, straight, acute, horizontal, convex, concave, flared, hooked, and tapered and pointed terminals (Clair, 1999).

Uppercase: capital letters, historically placed in the upper of the two drawers used in hand composition (Clair, 1999).

Waist Line: and imaginary horizontal rule that aligns on the body of the lowercase alphabet; also called the x-height line (Clair, 1999).

X-height Line: the height of the body of the small or lowercase letters; does not include ascenders or descenders; measured from baseline to waist line (Clair, 1999).

By understanding the different components of type, one can make more educated design decisions (Baines & Haslam, 2002). Along with anatomy, understanding how type is measured is important to a designer (Clair, 1999). The size of type is described in points (Jury, 2004). According to Clair (1999), a point is equal to 1/72 of an inch. Jury (2004) defines the height of type as the height of the body of type, which should not be confused with the visible printed area of a typeface. The body is illustrated by Faiola (2000), as the distance from the baseline to the top of a lowercase letter, excluding an ascender or descender. The width of a typeface is determined by the "thickness" of its stroke (Faiola, 2000). Different typefaces are also designed with varying amounts of space to exist between characters.

Summary

The preceding literature discussed CBI and its relevance to the modern learning environment. A deeper look was then taken into hypertext and hypermedia. Their definitions were examined, their differences were explained, and some context was given for how and why they are used. Instructional design was then defined and the Smith and Ragan (1999) instructional design model was explained with its relevance to this study. Finally, a brief history of type was outlined and the *anatomy of type* was described.

PROCEDURE

Introduction

A study was conducted comparing two instructional technologies, hypertext and hypermedia. This section outlines the process that was used to conduct this study. The choice of content used in instruction, the testing and instructional environment, the sampling methodology used, and issues surrounding human subjects are addressed.

The systematic design of instruction as it is explained in the literature review was not strictly adhered to due to time constraints, but it was seriously considered during the design of instructional materials. Since it was the goal of this study to test for a difference in effectiveness between two instructional technologies, and not to validate the individual instructional tools created using these technologies as good, adherence to the formal instructional design process was secondary. An understanding of the instructional design process is important when designing instruction regardless of whether the process is completely followed (Smith & Ragan, 1999).

Instructional Content

The content for this study, the *anatomy of type*, was chosen due to the consideration of multiple factors. The first of these was that typography is an area in which the author has a large interest. Secondly, there is a fundamentals course within the Department of Computer Graphics Technology, CGT 111, which covers this content. Its coordinator was accessible for consultation. Therefore, a subject matter expert in the *anatomy of type* was available during the creation of the instructional tools to assist with their design and to make sure that their content was represented appropriately. Another factor was the desire of the author to have content that was objective, reducing the number of extraneous variables within the study. Much about typography can be considered subjective (Jury, 2004). The *anatomy of type* is one area within typography that most scholars in the field seem to agree upon as having correct and incorrect interpretations (Baines & Haslam, 2002; Carter et al., 2002; Clair, 1999; Faiola, 2000).

Testing & Instructional Environment

The *anatomy of type* was researched and a list of objectives that the learners needed to complete was created. After defining these specific objectives, a pretest was created in pencil-and-paper form to determine learner knowledge with regard to the *anatomy of type*. A pencil-and-paper format was used in order to reduce any variables created by user experience with technology (Rouet, 1992). The same test was then used after instruction as a posttest to measure what new information the learner has retained. There were also two open-ended questions added to the posttest to gain insight from the participants on what they thought about the study. The validity of actual posttest scores is reduced by testing effect, but all treatments used the same test to remove testing effect's impact on the validity of comparisons between them.

Based upon the list of learner objectives created, two instructional tools were generated using different instructional technologies. The first instructional tool was made with hypertext technology. It was produced using Macromedia Dreamweaver MX 2004. The second instructional tool was made using hypermedia technology. It was produced using Macromedia Flash MX 2004. These two applications were chosen because they allow for instructional tools to be created fitting within the definitions of hypertext and hypermedia given above. Also, the author has never had formal instruction in either of them and has spent approximately the same amount of time developing in each. This should reduce variables caused by the development experience of the author exceeding in one application over the other.

It was not a goal of this study to show that Flash is the best technology for the delivery of computer-based instruction. Flash was used only as an example of a hypermedia application. The use of Flash was chosen over the use of other hypermedia applications due to its popular availability on user machines. A plug-in for Flash is standard on all major internet browsers such as Internet Explorer (IE) and Netscape. This negated the need for users to download or install any extraneous applications. The decision was made not to include any advanced functions in the hypermedia application to reduce potential user complications. The intent was to not place test subjects in an environment dependent upon their advanced technological knowledge. Advanced technological knowledge was defined for the purpose

of this study as any knowledge about technology that it is expected that students learn during their time as an undergraduate in the CGT Department at Purdue University. Rouet (1992) determined that the technical ability of users can greatly impact their ability to learn using computer technology. It was desired to keep this variable to a minimum. To maintain further control over the experiment, there were no user customization options in either testing tool. For example, a user could not turn off the sound in the hypermedia version. All testing and instruction took place within a computer lab in the Computer Graphics Technology department on Purdue University's campus.

Test Population and Sampling Methodology

Undergraduate students within CGT were the population. In this study, the author was more concerned with providing internal validity within the context of CGT at Purdue University than with generalizing the results of this study to the computer graphics community. It was felt that if success could be shown at comparing the two technologies, further study could then be done using this established methodology to better generalize this research. All data was collected within the Department of Computer Graphics Technology at Purdue University. Observations made were with regard to this context. The computer graphics community can benefit from the results of this study, but without further research done in other contexts a high confidence in the generalizability of the results of this study will not exist.

A group of 200 students was randomly sampled from the Computer Graphics Technology Department. An email list for this sample was assembled by a third party to initially protect the identity of the individual students in order to avoid coercion. This sample was then sent a recruitment letter asking if they would be willing to participate in the study. According to Sekaran (2003), a minimum of 30 subjects is needed for each cluster in a sample. Therefore 100 subjects were allotted for each treatment to allow for non-response. This also allowed for some non-performance of those who did volunteer to participate. It was expected by the author that some subjects would not participate in the study as they had agreed to. Out of the original sample of 200, 71 positively responded. As students responded with a willingness to participate, they were given a number and alternately designated with a T or M. For example, participant

identification numbers looked like T-01, M-02, T-03, and so on. This created two separate treatments. Table 1 is presented below for clarification.

Table 1

Division of Sample within Corresponding Groups

	Treatments	
Group	Hypertext Instruction (Group A)	Hypermedia Instruction (Group B)
CGT Test Subjects	36	35

The study began by establishing a baseline competency of the test subjects. The subjects were asked to take a pretest including 25 questions to determine their prior knowledge of the *anatomy of type*. The results of this pretest provided data in the form of the number of questions answered correctly out of the 25 possible by each test subject. After taking the pretest, subjects were then asked to accept instruction using a tool created with either hypertext or hypermedia technology depending on which group they were in. After receiving instruction, subjects were asked to take a posttest matching the original pretest. There were also two open-ended questions added at the end of the posttest providing data about user opinions on the tests taken and the lesson they were assigned. Again, data in the form of a number of items answered correctly by the test subjects out of the 25 possible was collected. There were 69 subjects who actually participated in the study. Out of these, 36 were in the hypertext treatment and 33 were in the hypermedia treatment.

Testing Environment

Testing of the instructional tools took place over a period of three days in a computer lab within the Department of Computer Graphics Technology. This testing was all done in the same computer lab in the evenings with two sessions on each of the first two days and one session on the final day. All test

sessions were allotted the same amount of time, one hour, with most subjects completing the pretest, the lesson, and the posttest in approximately forty to forty-five minutes. The original schedule for testing included approximately 15 students per session. Due to some minor scheduling conflicts a small number of subjects were shuffled from one session time to another. Every session was made up of approximately half hypertext subjects and half hypermedia subjects to avoid influence on results from an unbalanced session being impacted due to unforeseen extraneous conditions.

The lessons were delivered over the internet through a webpage linking to each of them. This link was not made available to subjects until after they had been given the pretest. All subjects were asked multiple times during each testing session not to divulge anything to anyone about the content of the tests or lessons until after all of the testing was over on the final day. The author was aware that there was not a way to grantee that no information was leaked. It was the intent of the author to control this issue by keeping all sessions balanced with participants in both treatments.

Hypothesis

It was hypothesized that test subjects who were instructed by the hypertext tool would retain the same amount as the test subjects instructed by the hypermedia tool. Therefore, the null hypothesis, with regard to hypertext compared to hypermedia, was that subjects instructed by the hypertext tool would improve the same amount as the subjects using the hypermedia tool. The alternate hypothesis was that the test subjects using the two different instructional technologies would retain different amounts of content. These are represented in Figure 2. It was the intent of the author to test with a .05 p-value.

$$H_0 : \mu_D = 0$$

$$H_a : \mu_D \neq 0$$

Figure 2

Human Subjects

As the comparative effectiveness of hypertext technology and hypermedia technology was studied, the author had to consider issues of confidentiality and the welfare of any test subjects. An

explanation of this study along with a copy of any testing tools that were used were submitted to and approved for exemption by the Purdue University Committee on the Use of Human Research Subjects before any testing was done on human subjects. Before participating in this study, all test subjects were made aware of the purpose of the data being collected and any potential risk that could have incurred. It was made clear during solicitation that they were under no obligation and that they were free to back out if they became uncomfortable with the study at any time. No subject has been or will be identified by name in any presentation of the results of this study. Once the study was completed, the author was able to make sure that test subjects participated in the correct treatment, and it was confirmed that no subject participated more than once, records of what subject was assigned to what number were destroyed. The author maintained the only copies of this data to assure that any identification of individual subjects was properly removed.

Summary

Instructional applications using examples of two different instructional technologies were created to teach the same content. The instructional technologies being used were hypertext and hypermedia. These two technologies were compared by observing development time and by testing CGT students to see if there was a significant difference in learner retention of knowledge using one of these treatments over the other. This test was conducted by giving a pretest to establish what the student competency already was and then giving a posttest to check for improvement in performance using each technology. Data gathered was then analyzed and presented for instructors within CGT to consider when deciding what instructional technologies they wish to use in their courses.

LIMITATIONS

The following limitations were inherent in the pursuit of this project:

1. Confidentiality with regard to the content of the testing tools and lesson material was dependant upon the integrity of test subjects.

2. The author was unable to procure the quality of text to speech audio desired for the multimedia lesson. Therefore, the voice used was mechanical in nature and lowered the overall ability of subjects to understand the audio.
3. Due to a relatively small sample size the author was unable to run comparative testing between lower and upper division computer graphics students as was originally desired.
4. There was not enough time in the duration of this study for the author to run a paired-observation comparison of the two lessons. Different samples of the defined population took each of the two lessons.

RESULTS

How effective is traditional hypertext as an instructional technology, when compared with hypermedia, to teach the *anatomy of type* to CGT undergraduate students? The answer to this question proved to be more complex than was originally anticipated. In short, the answer is that it depends upon the circumstance. As the following findings support, it appears that if hypertext and hypermedia are both used in a non-customizable state, in the same setting, and with the same basic population, there is little overall difference between the mean user retention of information. This does not prove however that the two technologies produced an equal result. What was observed about the two technologies in this study was an extreme contrast in range of difference in pretest to posttest scores, not a significant difference in their averages. It seems that user preference may play a bigger role in hypermedia educational applications than in hypertext educational applications. A more detailed explanation of this will be given in the following section.

Analysis of Data

A difference in means analysis was done using a t-test comparing the mean difference in scores of Group A before and after instruction to the mean difference in scores of Group B before and after instruction. The results of this test can be found in Table 2 and Table 3 below.

Table 2

	Descriptive Statistics			
	N	Mean	Stdev	Var
Hypertext Difference	36	5.17	2.30	5.29
Hypermedia Difference	33	4.39	3.99	15.93

Table 3

T-Test of difference = 0		
Difference = μ_1 (Hypertext Difference (Post - Pre)) - μ_2 (Hypermedia Difference (Post - Pre))		
Significance Level (α):	5% (.05)	
Estimate for difference:	0.773	
95% CI for difference:	(-0.821, 2.367)	
p-Value:	0.335	**Cannot reject H_0 at an α of .05**

What this data says is that there is not significant evidence to reject the H_0 that using hypertext and hypermedia instructional technology to teach the anatomy of type within the CGT department at Purdue University will provide an equal mean level of improvement. With such a low p-value, there is however only approximately a 34% chance that this H_0 is true, despite the evidence.

As mentioned above, there was a large difference in the range of change in test scores from pretest to posttest between the group taking the hypertext lesson and the group taking the hypermedia lesson. Everyone taking the hypertext lesson showed some improvement. All 36 of these participants answered between 2 and 10 more questions correctly on the posttest than they did on the pretest. This was not the case within the hypermedia test group. Not everyone in this group showed improvement. It was observed that 5 of the 33 did not improve. The members of this group answered between 5 less correct to 13 more correct on the posttest. This is better illustrated in Figure 3.

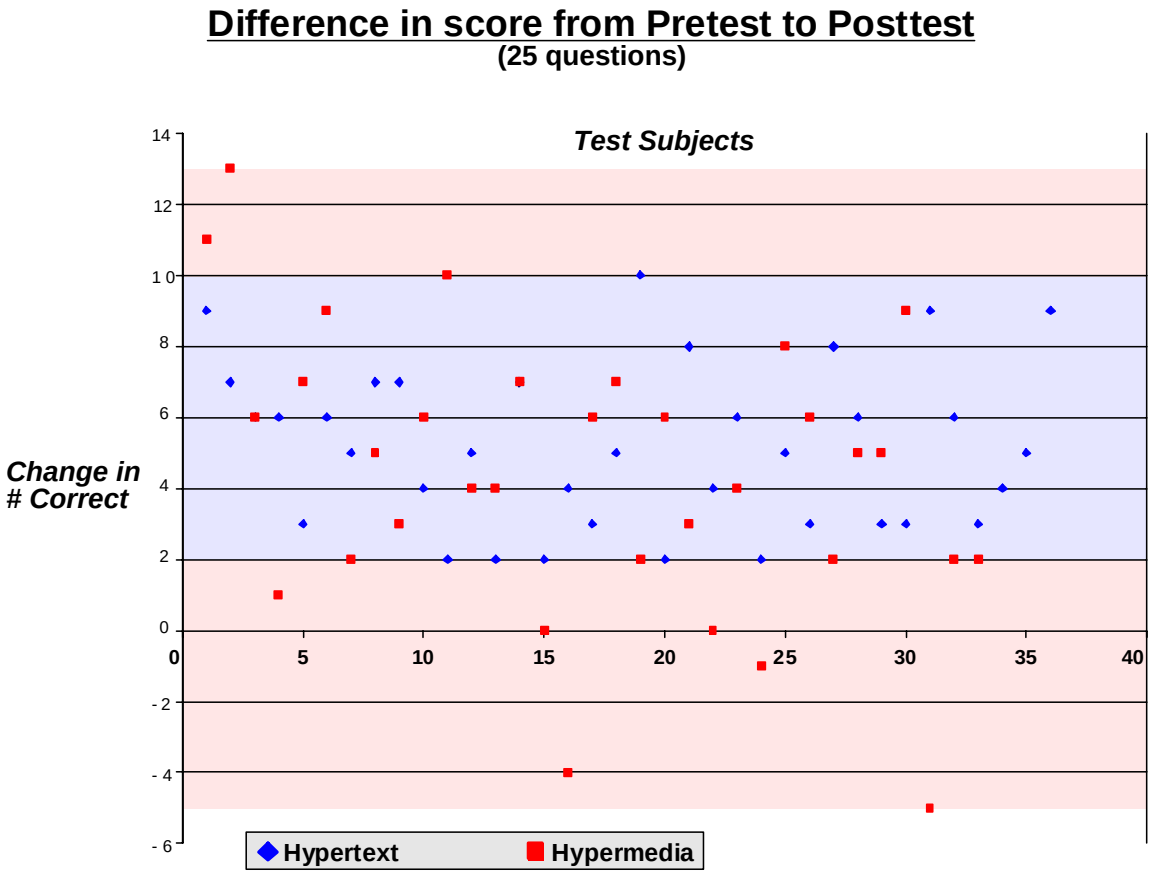


Figure 3 (see Appendix B for a larger version)

When the open-ended responses were reviewed to try and establish why this phenomenon existed in the data, a possible explanation was found. Most of the subjects taking the hypertext lesson seemed to generally feel that the lesson met their expectations. Some expressed a desire for more interactivity and modes of instruction, but overall felt that the lesson was good. When reviewing the hypermedia responses there was not such a consensus. This is particularly true with regard to user attitude toward the audio function of the hypermedia lesson. Many felt that it was helpful to have the audio and others found it to be an extreme hindrance. A few example statements showing these contradicting opinions can be seen below in Table 4. All user responses can be found in Appendix C.

Table 4

User Attitude Toward Audio in Hypermedia Lesson

	Positive	Negative
Student Response	"Overall, the voice helps you concentrate more and allows you to follow along."	"The voice slowed my reading down a little and was a little annoying."
	"Spoken text helps to hold interest in the subject matter."	"The audio was more distracting than helpful."
	"I think the sound helped me to pay more attention to what I was taught & possibly retain more."	"The computer voice was disruptive."

This varying user reaction suggests that for hypermedia to show its full potential when used to instruct a diverse group of learners it should be customizable. Some users may actually find added instructional delivery methods, such as audio, to be disruptive to their learning. If functionality is added to a hypermedia application that allows a user to turn on and off options, many of the disruptions that seem to have accounted for the low outliers in this study may be alleviated.

Production Time

It was noted during the production of the two instructional tools that it took approximately twice as long to create the hypermedia lesson as it did to create the hypertext lesson. Time that was spent on any

assets or basic interface design applied to both lessons is not included in this statement. It was expected by the author that the hypermedia version would take longer to create due to it requiring more assets. In an attempt to balance the amount that this bias affected the length of development time of the two different tools, the hypertext version was created first. Delays caused by the author's novice understanding of the content matter affected the production time of the hypertext version more than the production time of the hypermedia version. Regardless, the hypertext version took much longer to create. This outcome is supported as being a common result in the review of literature (Ess, 1991).

Recommendations to Instructors

After reviewing the results of this study, the author recommends to any instructor that intends to create a computer based learning application to consider the time they are willing to commit to the endeavor. Although the potential for hypermedia instructional applications appears high, they come with a price. If instructors are unable to devote the time necessary to analyze their audience and design a hypermedia application specifically for that audience, or to create a hypermedia application that is customizable by the learner, the author would recommend that they use a hypertext application in its stead.

RECOMMENDATIONS FOR FURTHER STUDY

The author feels that the results of this study have raised enough questions to warrant further inquiry into the comparison of hypertext and hypermedia instructional technologies. To begin with, repeating this study under a series of varying conditions will likely strengthen the claims made in the results section of this report as well as provide further insight into the advantages and disadvantages of each technology under these diverse conditions. A recommended list of varying trial conditions resides below.

- Repeat experiment with a larger sample size.
- Repeat experiment with a variety of different populations.
- Repeat experiment using a paired-observation comparison in the experimental design to improve the strength of the data collected.
- Repeat the experiment with a variety of content matter to improve its generalizability.
- Repeat the experiment with a hypermedia application including customization options to see if they affect the quantity of low outliers in the final data.

The recommendation to use a larger sample size stems from the desire of the author to have a higher level of confidence in the data that has been collected. A reasonable sample size was collected for the initial trial, 69 participants, but the larger the sample size the more confident a researcher can be that their sample represents the population (Sekaran, 2003). Having a larger sample size could help in understanding the significance of outliers. The five participants in the hypermedia test group who showed no improvement represent approximately 15% of that group. If the number of participants is increased to 200 for instance, and there is not an increase in the number of low-level outliers, the low-level outliers would only represent 2.5% of that group. This is likely an extreme, but it would be interesting to see if a trend in this direction presents itself and decreases the significance of this observation.

At the present time, inferences can only be made from this data with regard to undergraduate computer graphics technology students at Purdue University. It would be interesting to first see how

results vary in computer graphics students in other locations. Then it would be intriguing to find out how results vary in university students from other departments and schools of study. Finally the study should be repeated within populations at differing levels within their education such as K-12 students, graduate students, vocational students, and on-the-job training personnel.

A weakness in this study, as is noted in the limitations, is that two completely different groups of students sampled from the same population took each of the two lessons. Although there was a strong effort made by the author to keep the two samples as normal as possible, it is probable that one sample differed in factors such as experience with computer based instruction, prior knowledge of content, attitude, and physical or mental limitations. The risk of this differentiation could be removed by incorporating a paired-observation comparison into the experimental design. In doing this, the entire sample would be evaluated using both technologies. To describe this in relation to this study, if the entire experiment were to be run again with exactly the same participants, this time using a different content matter and reversing which students used the hypertext and hypermedia lessons, a stronger set of data could be collected. This would likely help explain if the outliers in the data exist because of the instructional tools or extraneous variables surrounding a few individual participants in the study. It is strongly recommended by the author that this be done in future trials.

As mentioned before, statements can currently only be made within the small context of the Department of Computer Graphics at Purdue University. In addition to this, significant claims about the use of the two technologies can only be made at this time with regard to the study of the *anatomy of type*. This is useful to a small group of individuals in the field of computer graphics, but it would be ideal to have data that could be generalized to other fields of study. Repeating this experiment with other content matter in place of the *anatomy of type* could provide data that is useful to instructors in many fields who are interested in introducing computer based instruction into their curriculum.

The final recommendation I have for the continuation of this research is to introduce customization options into the hypermedia application before the experiment. In review of the open-end responses from participants, as was mentioned earlier, there appeared to be strong opinion one way or the

other as to if the audio was helpful or a hindrance. It would be interesting to discover whether or not giving users the ability to turn on and off options improves their scores from pretest to posttest more than when extra channels of communication are forced upon them.

REFERENCES

Adams, E. S., Carswell, L., Ellis, A., Hall, P., Kumar, A., Meyer, J, & Motil, J. (1996). Interactive Multimedia Pedagogies. *Proceedings of the conference on Integrating technology into computer science education, USA, 1*, 182-191.

Ausubel, D. P. (1963). *Educational Psychology: A Cognitive View.* New York: Holt, Rinehart and Winston, Inc.

Baines, P. & Haslam A. (2002). *Type & typography.* New York, NY: Watson-Guptill Publications.

Bevilacqua, A. F., (1989). Hypertext: Behind the Hype. *ERIC Digest*, 4p. Retrieved December 17, 2004, from http://www2.lib.purdue.edu:2923/gw2/ovidweb.cgi

Boles, W. W., Pillay, H., & Raj, L. (1999). Matching Cognitive Styles to Computer-based Instruction: An approach for enhanced learning in electrical engineering. *European Journal of Engineering Education, 24(4),* 371-383.

Bracey, B. Individual Learning Styles Disregarded by Computer-Based Instruction. *Electronic Learning, 8(7),* 16-17.

Carter, R., Day, B., & Meggs, P. (2002). *Typographic Design: From and Communication (3rd ed.).* Hoboken, NJ: John Wiley & Sons, Inc.

Clair, K. (1999). *A Typographic Workbook: A primer to history, techniques, and artistry.* New York: John Wiley & Sons, Inc.

Clibbon, K. (1995). Conceptually Adapted Hypertext for Learning. *Conference companion on Human factors in computing systems, USA*, 224-225.

Covey, S. R. (1989). *The Seven Habits of Highly Effective People: Restoring the character ethic.* New York, NY: Simon & Schuster Inc.

Cross, N. (1982). Designerly ways of knowing. *Design Studies, 3(4),* 221-227.

Dastbaz, M. & Kalfatis, S. P. (2003). Can hypermedia aided learning (HAL) Deliver? *International Journal of Instructional Media, 30(2),* 162.

Dick, W. & Carey, L. (1996). *The systematic design of instruction (4th ed.).* New York: HarperCollins.

Doube, W. (1998). Multimedia delivery of computer programming subjects: basing structure on instructional design. *Proceedings of the Australasian conference on Computer science education, Australia, 3,* 85-93.

Dwyer, F. & Chen, W. (2003). Hypermedia Research: Present and future. *International Journal of Instructional Media, 30(2),* 143-148.

Ertmer, P. A. & Quinn, J. (2003). *The ID Casebook: Case studies in instructional design (2nd ed.).* Upper Saddle River, NJ: Prentice-Hall, Inc.

Ess, C. (1991). The Pedagogy of Computing: Hypermedia in the classroom. *Proceedings of the ACM conference on Hypertext, USA, 3,* 277-289.

Faiola, A. (1999). *Survey of Visual Language: The Evolution of Typographic Design & Style.* West Lafayette, IN: Crown Press.

Faiola, A. (2000). *Typography Primer.* Sewickley, PA: GAFT Press.

Falance, T. (2001). Constructivism. In K. L. Medsker & K. M. Holdsworth (Eds.), *Models and strategies for training design* (pp. 213-233). Silver Spring, MD: International Society for Performance Improvement.

Farhat, J., Instone, K., Laventhal, L. M., Mynatt, B. T., & Rohlman, S., Diane (1992). Hypertext or book: Which is better for answering questions? *Proceedings of the SIGCHI conference on Human factors in computing systems, USA,* 19-25.

Gagne, R. M. , Briggs, L. J., & Wagner, W. W. (1988). Principles of instructional design (3rd ed.). In Smith, P. L. & Ragan, T. J. (1999). *Instructional Design, Second Edition.* Hoboken, NJ: John Wiley & Sons, Inc.

Hailey, C. & Hailey, D. E. (1998). Hypermedia, Multimedia, and Reader Cognition: An empirical study. *Technical Communication, 45(3),* 330-342.

Hammon, N., McKendree, J., & Reader, W. (1995). The "Homeopathic Fallacy" in learning from Hypertext. *Interactions, 2(3),* 74-82.

Hannafin, M. J., & Hill, J. R. (2002). Epistemology and the design of learning environments. In R. A. Reiser & J. V. Dempsey (Eds.), *Trends and issues in instructional design and technology* (pp. 71-82). Upper Saddle River, NJ: Pearson Education.

Howell, D. (2001). Elements of effective E-learning: Three design methods to minimize side effects of online courses. College Teaching 49(3), 87-90.

Jury, D. (2004). *About Face: Reviving the rules of typography.* Switzerland: RotoVision.

Klein, J. D. & Koroghlanian, C. (2004). The Effect of Audio and Animation in Multimedia Instruction. *Journal of Educational Multimedia and Hypermedia, 13(1),* 23-46.

Kotze, P. (1998). Why the Hypermedia Model is Inadequate for Computer-Based Instruction. *Proceedings of the conference on the teaching of computing and on integrating technology into computer science education: Changing the delivery of computer science education, USA, 6, 3,* 148-152.

Lawson, B. (1980). *How designers think.* Westfield, NJ: Eastview Editions.

Lee, C., & Zemke, R. (1987). How long does it take? *Training, 24(6),* 75-80.

Lemire, D. (2002). Brief report: What developmental educators should know about learning styles and cognitive styles. Journal of College Reading and Learning 32(2), 177-182.

Liben, L. (1981). Spatial representation and behavior: multiple perspectives. In L. S. Liben, A. Patterson, & N. Newcombe (Eds.), *Spatial representation and behavior across the life span.* New York: Academic Press.

Mager, R. F. (1962). *Preparing instructional objectives.* Palo Alto, CA: Fearon.

Merriam-Webster dictionary (Ed.). (1995). Springfield, MS: Merriam-Webster.

Moore, T. (1995). Active use of Hypertext to Aid Learning and Classroom Instruction. *Proceedings of the SIGCSE technical symposium on Computer science education, USA, 26,* 297-301.

Opitz, M. (1998). What's New in Computer-Based Instruction? *The Clearing House, 72(1),* 4-5.

Perrin, K., & Mayhew, D. (2000). The Reality of Designing and Implementing an Internet-based Course, *Online Journal of Distance Learning Administration, 3(4),* URL: http://www.westga.edu/distance/ojdla/winter34/mayhew34.html

Reigeluth, C. M. (1983). *Instructional-design theories and models: And overview of their current status.* Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Robinson, D. G., & Robinson, J. C. (1996) *Performance Consulting: Moving beyond training.* San Francisco, CA: Berrett-Koehler Publishers, Inc.

Rouet, J. F. (1993). Cognitive Processing of Hyperdocuments: When does nonlinearity help? *Proceedings of the ACM conference on Hypertext, USA,* 131-140.

Rowland, G. (1993). Designing and Instructional Design. Educational Technology Research and Development 41(1), 80-91.

Schnackenberg, H. L. & Sullivan, H. J. (2000). Learner Control Over Full and Lean Computer-Based Instruction Under Differing Ability Levels. *Educational Technology, Research and Development, 48(2),* 19-35.

Schroeder, E. E. (1991). Interactive Multimedia Computer Systems. *ERIC Digest*, 4p., Retrieved December 17, 2004, from http://www2.lib.purdue.edu:2923/gw2/ovidweb.cgi

Sekaran, U. (2003). *Research Methods for Business: Skill Building Methods (4th ed.).* New York, NY: John Wiley & Sons, Inc.

Smith, P. L. & Ragan, T. J. (1999). *Instructional Design, Second Edition.* Hoboken, NJ: John Wiley & Sons, Inc.

Song, C. (2002). The branching structure for individual learning skills differences in instructional hypermedia. *Online Information Review, 26(2),* 73-78.

Vrasidas, C. (2002). Systematic Approach for Designing Hypermedia Environments for Teaching and Learning. *International Journal of Instructional Media, 29(1),* 13-25.

Wardrip-Fruin, N. (2004). What Hypertext Is. *Proceedings of the ACM conference on Hypertext & Hypermedia, USA, 15,* 126-127.

West, C. K., Farmer, J. A., & Wolf, P. M. (1991). *Instructional design: Implications from cognitive science.* Upper Saddle River, NJ: Prentice-Hall.

Wittrock, M. C. (1974). Learning as a generative process. In Smith, P.L. & Ragan, T.J. (1999). *Instructional Design, Second Edition.* Hoboken, NJ: John Wiley & Sons, Inc.

APPENDIX A

PRETEST & POSTTEST

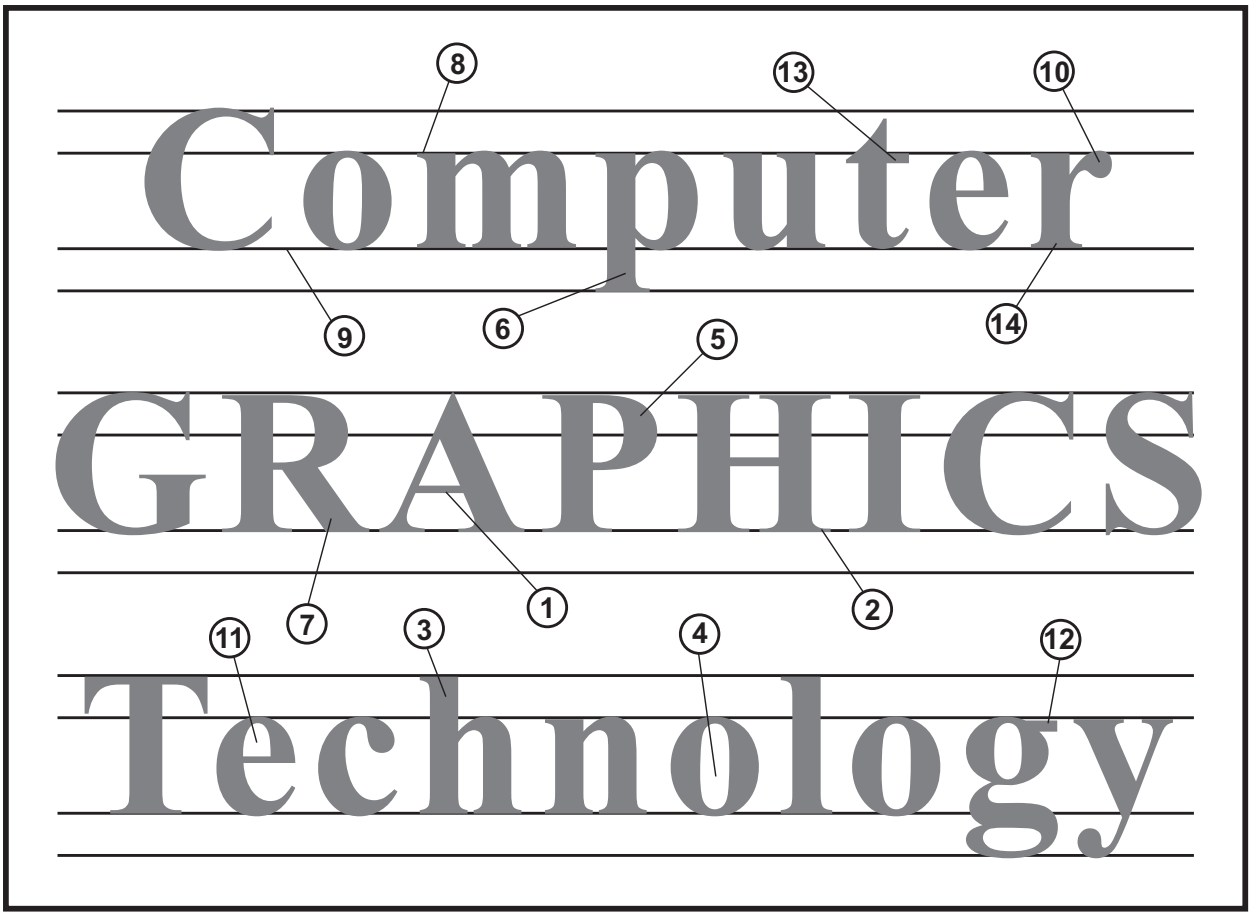
Participant ID #	

Anatomy of Type Pretest

Instructions:

At any point during this test, the lesson that will follow, or the posttest if you begin to feel uncomfortable with participating in this study please do not hesitate to stop. You are under no obligation to complete this test.

This test consists of two sections. In the first section, you will be asked to use terms within a list relating to the anatomy of type to fill in the blank corresponding to the number tags on a diagram. In the second section, you will be asked to answer a series of true or false questions. Please insert your participant ID number in the box at the top of this sheet and then begin whenever you feel ready. Thank you for your participation.



Match the terms in this list with their corresponding numbers in the image above.

Ascender	Crossbar	Foot serif	Baseline
Descender	Cross stroke	Head serif	Ear
Terminal	Bowl	Tail	
Hook	Eye	Counter	

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____

For the following statements answer true or false in the space provided.

_____ 15. The ends of a crossbar do not have to make contact with any other portion of a letterform.

_____ 16. The x-height is the height of an upper-case “X” within a font.

_____ 17. The baseline defines the lowermost point of a letterform.

_____ 18. The cap-height line determines the height of a typeface.

_____ 19. Not all letterforms have a terminal.

_____ 20. A serif would classify as a stroke on a letterform.

_____ 21. Cursive and italic are synonymous.

_____ 22. All counters are enclosed.

_____ 23. What makes a bracketed serif “bracketed” is that the transition from the stem stroke to the serif makes one continuous curve.

_____ 24. A hairline stroke is considered to be a primary stroke.

_____ 25. The ends of a crossbar do not have to make contact with any other portion of the letterform.

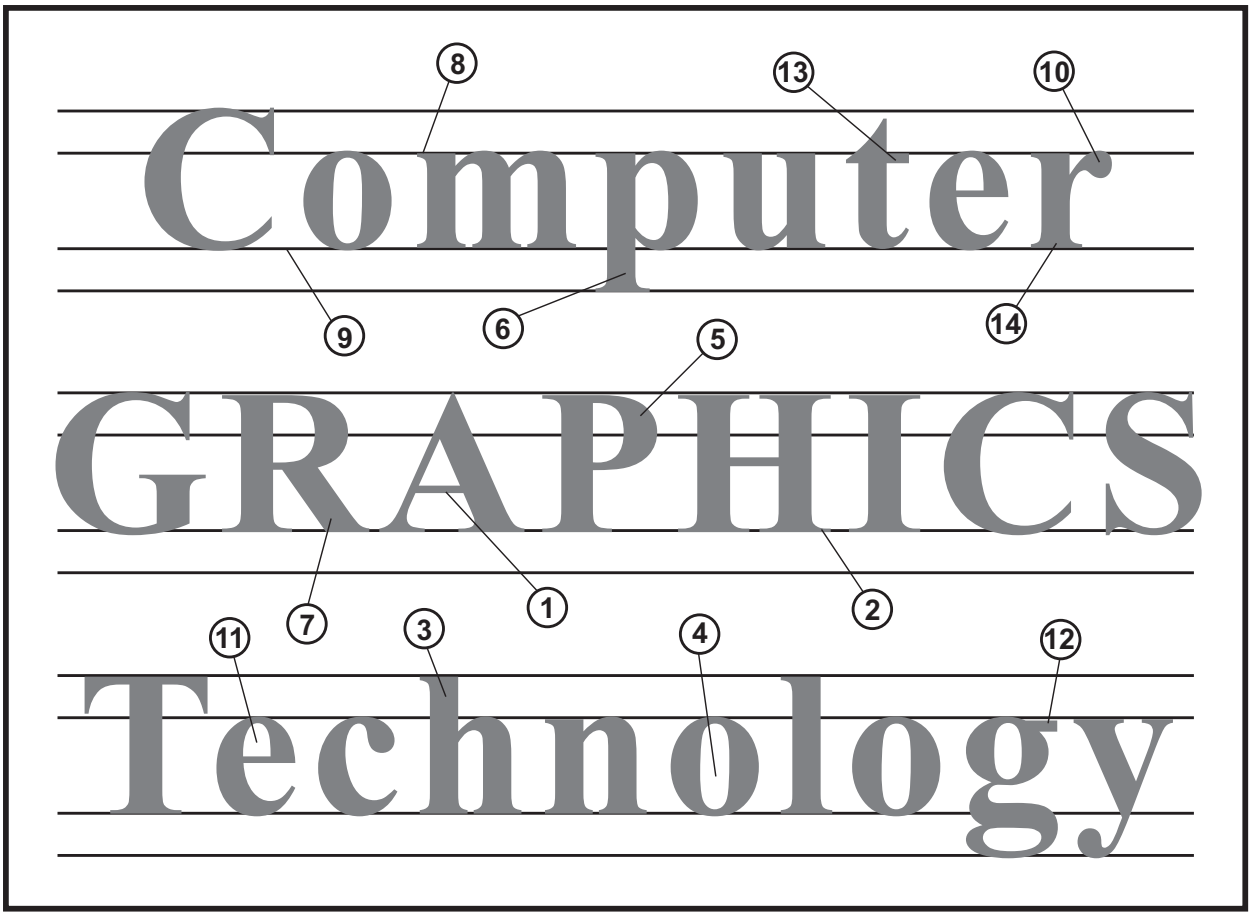
Participant ID #	

Anatomy of Type Posttest

Instructions:

At any point during this posttest if you begin to feel uncomfortable with participating in this study please do not hesitate to stop. You are under no obligation to complete this test.

This test consists of three sections. In the first section, you will be asked to use terms within a list relating to the anatomy of type to fill in the blank corresponding to the number tags on a diagram. In the second section, you will be asked to answer a series of true or false questions. Then you will be asked to answer a couple of questions regarding your perceptions of this test and the lesson you received. Please insert your participant ID number in the box at the top of this sheet and then begin whenever you feel ready. Thank you for your participation.



Match the terms in this list with their corresponding numbers in the image above.

Ascender	Crossbar	Foot serif	Baseline
Descender	Cross stroke	Head serif	Ear
Terminal	Bowl	Tail	
Hook	Eye	Counter	

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____

For the following statements answer true or false in the space provided.

_____ 15. The ends of a crossbar do not have to make contact with any other portion of a letterform.

_____ 16. The x-height is the height of an upper-case “X” within a font.

_____ 17. The baseline defines the lowermost point of a letterform.

_____ 18. The cap-height line determines the height of a typeface.

_____ 19. Not all letterforms have a terminal.

_____ 20. A serif would classify as a stroke on a letterform.

_____ 21. Cursive and italic are synonymous.

_____ 22. All counters are enclosed.

_____ 23. What makes a bracketed serif “bracketed” is that the transition from the stem stroke to the serif makes one continuous curve.

_____ 24. A hairline stroke is considered to be a primary stroke.

_____ 25. The ends of a crossbar do not have to make contact with any other portion of the letterform.

26. Please offer your opinion on the fairness and accuracy of this test with regard to your knowledge of the *anatomy of type*. If you need more space, please use the back of this page.

27. In your opinion, to what extent does this lesson effectively teach the *anatomy of type*? What, if anything, could be done to improve this lesson? What, if anything, made this lesson effective? If you need more space, please use the back of this page.

APPENDIX B

COLLECTED DATA & CHARTS

Hypertext

	Participant	Pretest Score	Posttest	Difference (Post - Pre)
1	T - 01	14	23	9
2	T - 03	16	23	7
3	T - 05	16	22	6
4	T - 07	14	20	6
5	T - 09	16	19	3
6	T - 11	17	23	6
7	T - 13	15	20	5
8	T - 15	14	21	7
9	T - 17	17	24	7
10	T - 19	18	22	4
11	T - 21	18	20	2
12	T - 23	17	22	5
13	T - 25	21	23	2
14	T - 27	14	21	7
15	T - 29	19	21	2
16	T - 31	19	23	4
17	T - 33	21	24	3
18	T - 35	17	22	5
19	T - 37	14	24	10
20	T - 39	21	23	2
21	T - 41	15	23	8
22	T - 43	16	20	4
23	T - 45	17	23	6
24	T - 47	14	16	2
25	T - 49	19	24	5
26	T - 51	18	21	3
27	T - 53	13	21	8
28	T - 55	19	25	6
29	T - 57	19	22	3
30	T - 59	14	17	3
31	T - 61	14	23	9
32	T - 63	15	21	6
33	T - 65	22	25	3
34	T - 67	17	21	4
35	T - 69	15	20	5
36	T - 71	13	22	9

Mean =	16.61	21.78	5.17

Stdev	2.299
Var	5.286
Mode	6

Hypermedia

	Participant	Pretest Score	Posttest	Difference (Post - Pre)
1	M - 02	11	22	11
2	M - 04	11	24	13
3	M - 06	17	23	6
4	M - 08	21	22	1
5	M - 12	15	22	7
6	M - 14	12	21	9
7	M - 16	21	23	2
8	M - 18	17	22	5
9	M - 20	17	20	3
10	M - 22	14	20	6
11	M - 24	13	23	10
12	M - 26	17	21	4
13	M - 30	16	20	4
14	M - 32	17	24	7
15	M - 34	18	18	0
16	M - 36	20	16	-4
17	M - 38	17	23	6
18	M - 40	12	19	7
19	M - 42	16	18	2
20	M - 44	16	22	6
21	M - 46	22	25	3
22	M - 48	19	19	0
23	M - 50	18	22	4
24	M - 52	18	17	-1
25	M - 54	16	24	8
26	M - 56	17	23	6
27	M - 58	20	22	2
28	M - 60	19	24	5
29	M - 62	17	22	5
30	M - 64	13	22	9
31	M - 66	22	17	-5
32	M - 68	18	20	2
33	M - 70	22	24	2

Mean =	16.94	21.33	4.39

Stdev	3.992
Var	15.934
Mode	6

Descriptive Statistics:

```
Variable           N  N*    Mean  SE Mean  Stdev  Variance  Minimum      Q1
Hypertext Pre     36   0  16.611    0.413  2.476     6.130   13.000  14.000
Hypertext Post    36   0  21.778    0.331  1.987     3.949   16.000  21.000
Htext Difference  36   0   5.167    0.383  2.299     5.286    2.000   3.000
Hypermedia Pre    33   0  16.939    0.540  3.102     9.621   11.000  15.500
Hypermedia Post   33   0  21.333    0.405  2.327     5.417   16.000  20.000
Hmedia Difference 33   0   4.394    0.695  3.992    15.934   -5.000   2.000

Variable          Median  Q3      Maximum
Hypertext Pre     16.500  18.750  22.000
Hypertext Post    22.000  23.000  25.000
Htext Difference  5.000   7.000   10.000
Hypermedia Pre    17.000  19.000  22.000
Hypermedia Post   22.000  23.000  25.000
Hmedia Difference 5.000   7.000   13.000
```

Two-Sample T-Test and CI: Htext Difference, Hmedia Difference

```
Two-sample T for Htext Difference (Post - Pre) vs. Hmedia Difference (Post -
     Pre)

                   N  Mean  Stdev  SE Mean
Htext Difference  36  5.17   2.30     0.38
Hmedia Difference 33  4.39   3.99     0.69


Difference = mu (Hypertext Difference (Post - Pre)) - mu (Hypermedia Difference (Post
- Pre))
Estimate for difference:  0.772727
95% CI for difference:  (-0.821093, 2.366548)
T-Test of difference = 0 (vs. not =): T-Value = 0.97  P-Value = 0.335  DF = 50
```

Correlations: Hypertext Pre, Hypertext Post

```
Pearson correlation of Hypertext Pre and Hypertext Post = 0.487
P-Value = 0.003
```

Correlations: Hypermedia Pre, Hypermedia Post

```
Pearson correlation of Hypermedia Pre and Hypermedia Post = -0.062
P-Value = 0.732
```

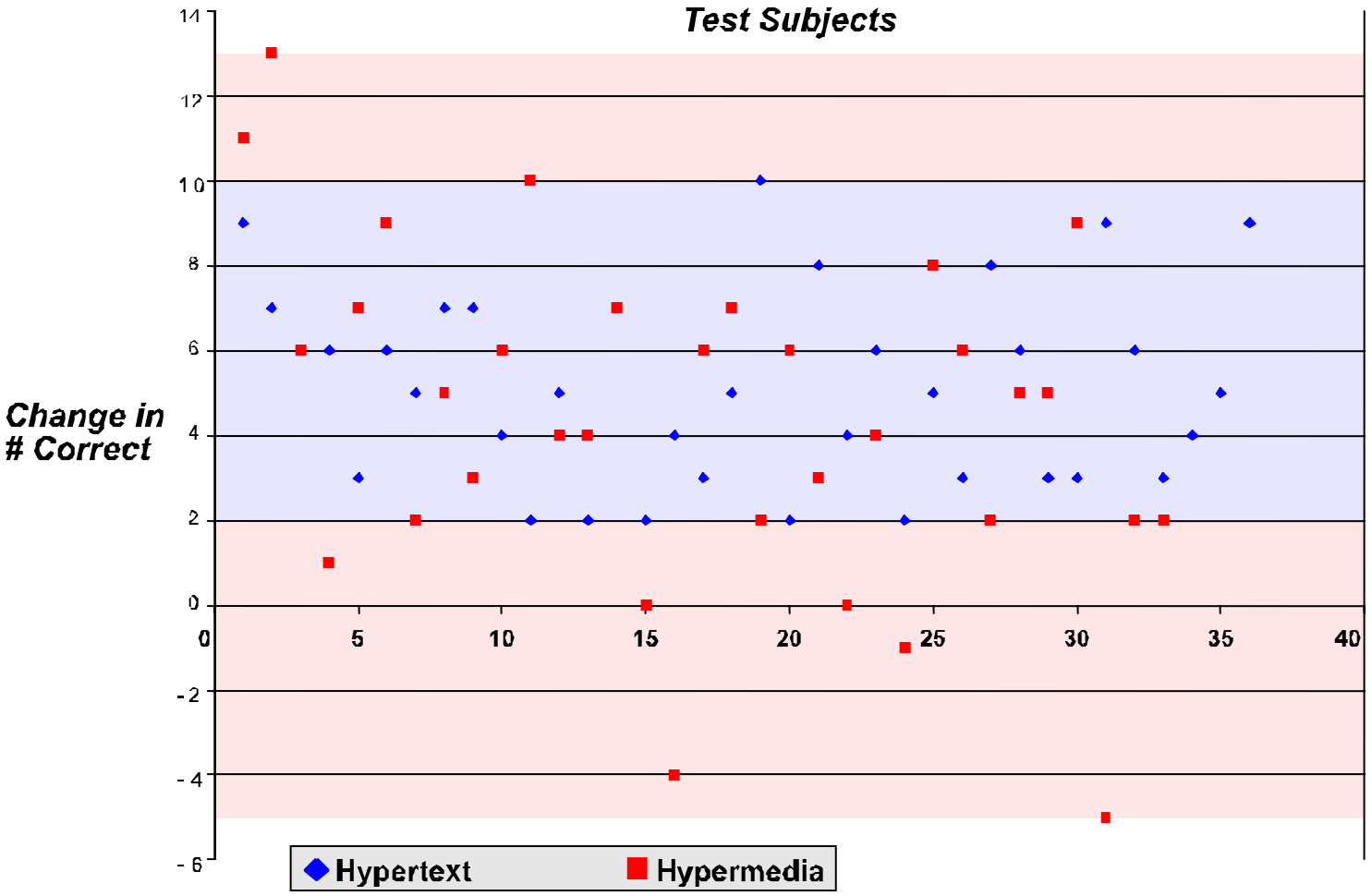
Correlations: Hypertext Pre, Htext Differnece (Post - Pre)

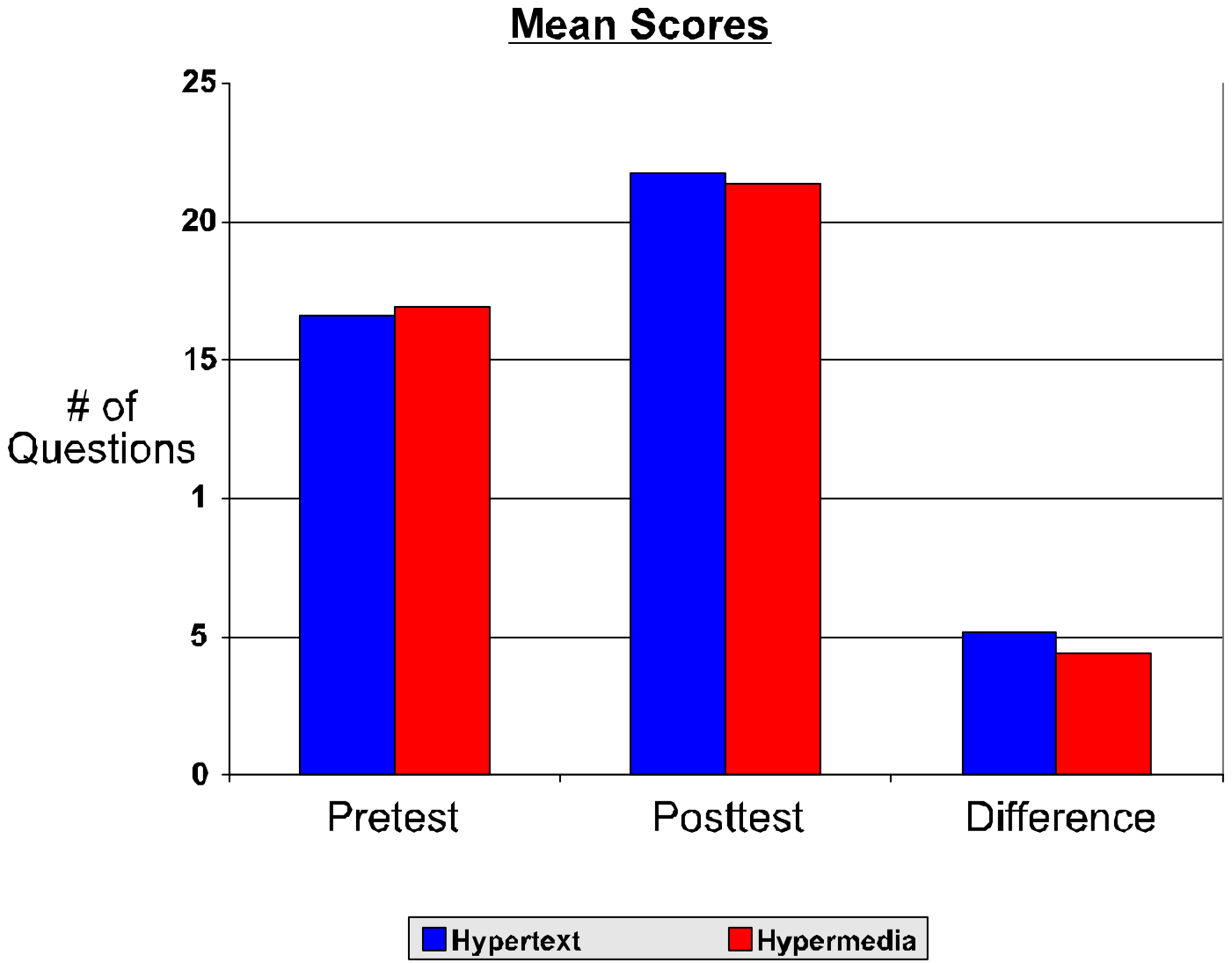
```
Pearson correlation of Hypertext Pre and Hypertext Differnece (Post - Pre) = -0.656
P-Value = 0.000
```

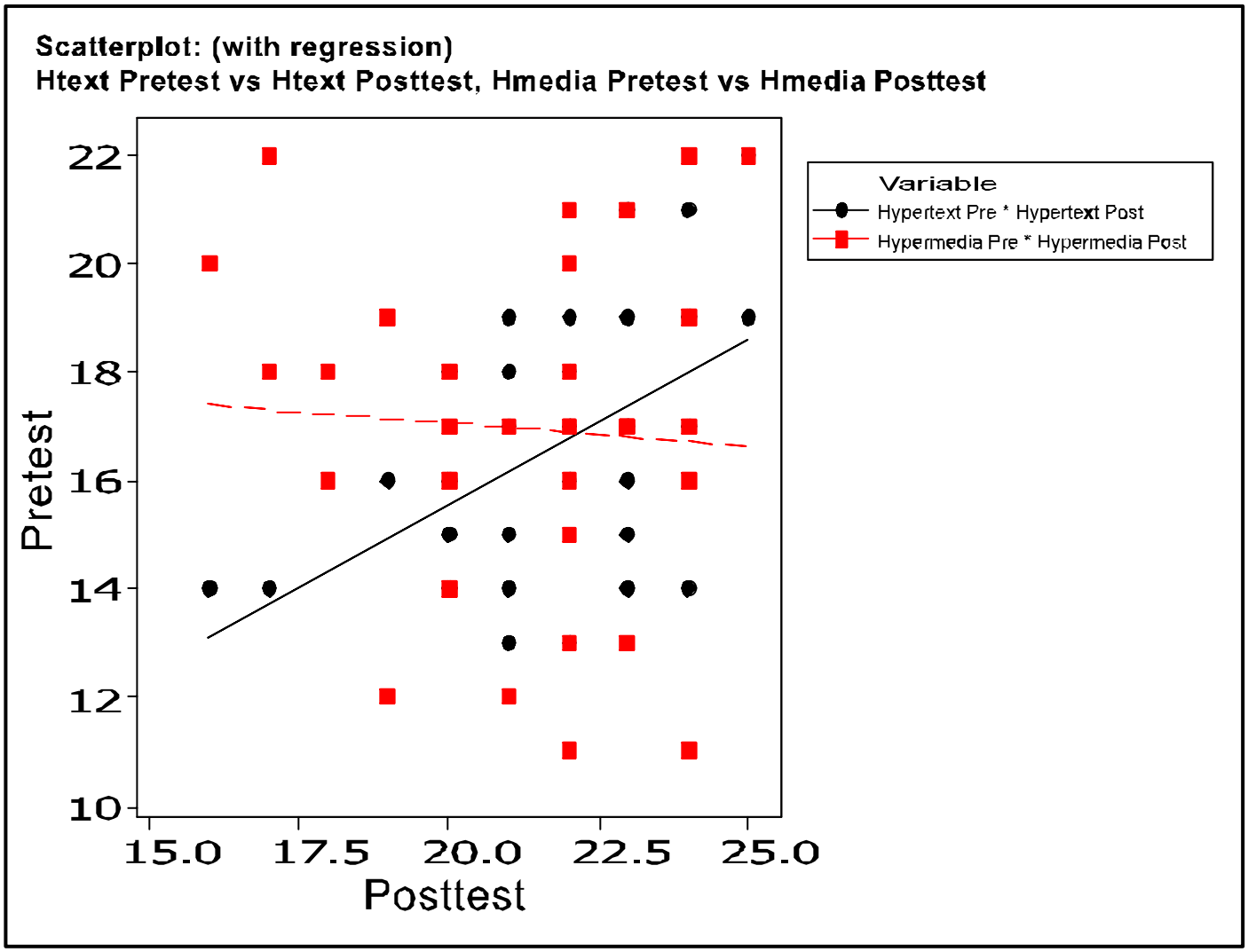
Correlations: Hypermedia Pre, Hmedia Differnece (Post - Pre)

```
Pearson correlation of Hypermedia Pre and Hmedia Differnece (Post - Pre) = -0.813
P-Value = 0.000
```

Difference in score from Pretest to Posttest
(25 questions)




Mean Scores
25
20
15
1
5
0
# of Questions
Pretest
Posttest
Difference
Hypertext
Hypermedia


Scatterplot: (with regression)
Htext Pretest vs Htext Posttest, Hmedia Pretest vs Hmedia Posttest
Variable
Hypertext Pre * Hypertext Post
Hypermedia Pre * Hypermedia Post
Pretest
Posttest
22
20
18
16
14
12
10
15.0
17.5
20.0
22.5
25.0

APPENDIX C

PARTICIPANT OPEN RESPONSES

QUESTION # 26

Please offer your opinion on the fairness and accuracy of this test with regard to you knowledge of the anatomy of type.

Hypertext

- Overall, the test was pretty fair, although lines pointing to the part that is supposed to be labeled can be deceiving, Maybe highlight the area (like on the site lesson) to better represent what should be named.
- In general it is good. Question 18 needs to be reworded a little I think because while the cap-height line is used to determine the height of a typeface the baseline is also used.
- We've been taught this material so I see it fair to test us.
- It seems totally fair and pretty accurate. My only comment is on the graphic, the numbering as to what's where made it difficult finding things.
- This test was good, although the numbers on the page were hard to follow (i.e. I would be at the bottom, 14 would be in the middle, etc.). This test seemed to test the idea of typefaces pretty well overall, the T & F was easy to understand.
- I believe this test was very fair and accurate with what I've been taught in 111. I did find it odd that # 15 and # 25 were the same question though.
- It was fair for me. I can never remember the parts of letters.
- Perhaps to better estimate what a student learned from this, you could take account what CG classes he or she has already completed.
- I was able to correct my earlier mistakes after reading the web pages.
- After I read through everything, all off my typology knowledge came back to me. I believe everything is accurate. A couple of things I don't remember but I wouldn't chalk that up to inaccuracy.
- The test is fair, but some of the matching could be more clearly labeled. Also, why was one question repeated almost verbatim?
- Completely fair, I am assuming the information is accurate only because that's what I learned in class.
- Pretty good, but some of the answers were not expressly stated in the reading. Also #18 was a bit ambiguous; yes it mostly does determine the low point, unless there is a descender. I suggest using "always" in there.
- The test is pretty fair and accurate with all basic information about typography that we have learned or forgot.
- As a senior, I haven't used type for 2 years so it is a refresher. Test is fair as compared to previous type exposure.
- The test was fair.
- I thought the test was good, accurate, and fair. It has been a while since I was taught this material, but I remembered it quick.

- The test is fair. I didn't remember the proper names of the anatomy of type, I still forgot some after going through the material, but overall it refreshed my memory back to CGT 111.

- On the previous page I am pretty sure what a terminal is but I am not sure whether 13 or 14 are pointing more closely to the edge of the stroke.

- I think it was fair. Although, I couldn't really remember what I learned in 111 on the anatomy of type, I feel I had a better understanding once I went to the website, and the website answered many questions I had when taking the pretest, for instance, it clearly explained that the hairline stroke is a secondary stroke.

- This test was so fair & accurate I want to cry.

- This test would mostly only be fair to people who have previous knowledge of anatomy of type. This test is very accurate, it is straightforward and to the point.

- The test was unfair in how the test asked questions on the true & false, a mild understanding of type also did not help.

- I think it's pretty fair, but the pretest help the test taker to remember the terms more if the questions are repeated.

- As stated in the beginning, it seems to be assumed that one already knows typography but needs a 'refresher' from the learning tool provided.

- I think it's a fair test.

- This test seems to accurately assess one's knowledge of type the many different type elements are there. I think it would be slightly more effective to offer the different characteristics of type term on the exam such as having to label the counter on an "o" and on a "c".

- I would say the test of fair for the most part, though there were some questions that I don't remember being mentioned in the presentation, such as # 21, but that could be because of a memory lapse.

- This was a very fair test, but the detail of where the lines could have been more detailed or put on more specific letters.

- Seemed fair enough, I forgot what some of the terms meant when I took the pre-test, but remembered most of them. I think that the test was fairly comprehensive but there were some concepts in the lesson not on the test.

- No opinion.

- Seems to be fair, well designed. General – add directions like "submit test when completed" (instead of waiting).

- The test seemed very fair. Although it did seem like a lot to learn in one setting. The size of the text on screen was very small. Hard to read. Took more time. May have hindered learning.

- At first I thought some of the questions were tricky but then after the lesson I realized by understanding / knowledge left room for confusion.

- It seemed completely fair. The main page said points are measured from lowercase letters, the guides page said it was measured from uppercase.

Hypermedia

- I would say that the test was very fair, and was quite accurate with testing my knowledge.
- I think it was a good test. Does not make me miss 111 though.
- This is great research. I found it much easier to take the post test after using the website.
- It seemed fair to me, I'm not sure how it could be made more fair.
- It was very fair, although a little difficult to distinguish between the foot serifs and terminal choices.
- Although I was probably supposed to, I don't remember much discussion about the anatomy of type so I know I didn't do very well on the pretest.
- From what I remember of anatomy of type, the test was accurate.
- This test is quite accurate and fair due to the fact that the program taught you what you needed to know.
- The test was fair. I forgot much of the material since 111, but from what I recall it was also accurate.
- The information was well presented. The type's anatomy highlighted in red helped me remember the information better, especially when combined with the parts' names being spoken with it.
- I think it was fair. I think it was mostly accurate.
- I thought the computer voice actually hindered my ability to retain the information, and after the voice has finished, I had to reread the information. This test was fair and accurate, though my knowledge of type anatomy is limited.
- Test was both fair and accurate considering I had not thought about this information in two years.
- I think the fairness of the test is accurate because we are given plenty of time, however the accuracy may be swayed if we did not give ourselves enough time to study the material.
- I thought it was very well done, but the voice had a tendency to slur some words.
- I think it was extremely fair & accurate.
- Test seemed fair and accurate. Knew some things coming in, but definitely learned more after watching the images.
- I think the test was very fair, and I think the lessons do a very good job at teaching the anatomy. Only a few T/F questions were tricky.
- This test was extremely fair and accurate in my opinion. No one knew what we were going to be tested on which prevented anyone from "preparation". The only variables I can think of are that some people have taken 111 more recently than others and people's specializations within CGT might factor into the test somehow.
- This test is very fair & accurate to testing the basic knowledge of the anatomy of type. I didn't encounter any errors with the questioning.

- I had forgotten many of the parts of the type, but after using the program the test seemed fair.
- I think this was a fair test.
- I believe this is the basic need-to-know info you should know when dealing with type. I think it is fair.
- Fairness is fine. As far as accuracy, I think there is a problem with numbers 14 and 2 on the previous page – they both look like foot serifs; however the placement of the line helped distinguish that one was also a terminal. Color would help differentiate foot serif from terminal.
- I think it was fair and accurate. I thought that the "sound" was annoying however.
- I thought it was very fair. I knew a little about type from classes, but the lesson really helped to explain what made each different part, rather than just point to it.
- This test was very fair and accurate. I found nothing out of place except #15 and 25 were the same questions above.
- I think it was fair. I noticed that I didn't know as much as I thought I did after taking the lesson.
- I rather liked the small test, because I forgot much of what I learned many semesters prior. This was a nice little refresher & would be great to review from time to time.
- Repeating Q. # 15 (#25) kind of seems unfair, but the rest is cool.
- This test seems to have been administered to a range of students. The material comes from a required CGT course, but can create some of a bias because not all of the students surveyed are focusing on multimedia.
- I felt like after doing the interactive program I learned more about the letters. I felt that it was fair & accurate.

QUESTION # 27

In your opinion, to what extent does this lesson effectively teach the *anatomy of type*? What, if anything, could be done to improve this lesson? What, if anything, made this lesson effective?

Hypertext

- I believe the site did a fairly good job, especially with the contrast and color of "the parts," to define.
- The lesson fit the test well because the same letters were used to display the different letter components. The main page of the lesson says that point size of a font is determined by the height of the lower-case letters then the "Guides" page says the height of a font is determined by the cap-height line; this was confusing. Also, the link on the "Guides" page that is supposed to take you to the "Components" page didn't work for me: this is just a minor technical thing, but it's something you might want to fix if you have a minute.
- I believe it accurately portrays the information in a fast and simple fashion. I see nothing to improve.
- The second page with the pictures was the most helpful. Maybe group the terms to be more similar rather than alphabetical.

- It does a pretty good job. However, on the opening (main) page, you may want to put your information in bullet points since it would make it easier to find such concepts as 1 inch = 72 points. This lesson is done very well since the ideas are outlined on the letters in red. The content is VERY simple and to-the-point, so I was able to pick up the info quickly.

- If a person has a slight grasp on the type anatomy to begin with, this test will easily strengthen that grasp. The ability to see examples and jump about freely made it effective for me.

- I thought it was effective short term. I don't know how much I'll retain long-term.

- The lesson effectively teaches anatomy of type, I believe, but could be improved upon with examples of multiple typeface elements simultaneously. Also, the COMPONENTS button does not work from the GUIDES page.

- This lesson did everything right when it comes to teaching the anatomy of type. I think the lesson has nothing missing.

- I think it does and excellent job. Hands on is always my learning preference. So, I would say… take this one step farther in interactivity and allow people to click on different parts of the letters to see what they are. The more options there are, the more interesting it is to me and I may learn more in the meantime.

- It would be more effective to explain the differences between some of the various parts or include the definitions in some logical order in the lesson.

- It did well for me, but I had a decent background coming into it.

- Make all links work. On the guides pages, put in all the guides for, say, half of the picture so we can get an overall view of proportion.

- The use of visual pictures to help aid what a term means help the student to learn effectively. None, the test does well in teaching what we know visually compared to what we know by definition. This separation made very effective in knowing which areas a student is able to learn better in visually or by reading.

- I thought the lesson was straight forward – possibly audio would help.

- I am still unclear on the term, tail. I was looking for this part of an e or c. An example of a tail on another letter may help to clarify this for me. Also, and example of an unbracketed vs. bracketed serif may be more explanatory.

- I think it was good with all the pixs and examples it helped, maybe some voice.

- This lesson covers all the terms of type – more than most people would ever know about it. What was effective about this test is being able to learn at my own pace and click the links when I was ready.

- This lesson does a good job teaching the fundamental lessons of type for the short term, but event though the info is important I'm not sure how long I will retain the info in the years to come with this simple test. Nothing can be made to improve it.

- The most effective part was the visuals used to accompany the definitions. I'm a visual learner so that was very helpful in my understanding. I thought the website did an adequate job in teaching the anatomy of type – it was very clear & easy to use. As for improvement, I have no ideas on how to make it better.

- This makes me want to learn more about the anatomy of type. It has changed my life. Thank you.

- Again, it is straight forward & to the point as well as being well thought up. I is very effective in determining if a computer lesson on something really works to teach students new material. I'm drawn back to the 411 test research we did for that 411 construction group. It is just as effective as that was.

- It is effective in teaching the components of type but ineffective a small rules of type. The use of red highlights was the most helpful, but associating the part with the name wasn't as simple.

- I just read it a couple of times, and I'm still confused when I try to remember it. If there are more examples, including interesting graphic, it will improve this lesson.

- I think it is much too brief to be a primary learning tool. I did not find any basic material (such as the difference between serif and sans-serif) providing a context for the material displayed.

- The lesson teaches everything well. There are a few questions on the T/F that I am unsure about though after going though the lesson. I am not sure if they were not addressed or not like – 16, 20, and 23. I'm not sure if there was anything on bracketed serifs.

- This lesson is fairly effective. It is similar to the standard studies from textbooks that students have done for years, so it is easy enough to know how to study it. I is also a comfortable method of studying. To improve it I would recommend some interactivity. People learn best by doing.

- I think this taught me the anatomy of type fairly well. The pictures were the best part though, because without them I would have been lost.

- This lesson teaches the anatomy of type quite well. It could have maybe provided a little more info on terms. It was effective because I did better the 2nd time.

- I felt that I learned whatever I had forgotten or didn't know from going through the lesson. I think that the lesson was effective because it allowed me to go between each of the concepts (parts of type) quickly, but also allowed me to focus on one at a time and I could quiz myself easily by guessing what each term referred to before clicking the link to the definition. One thing I can think of to improve the lesson is to provide multiple examples of each part of type rather than only one with the definition (for example showing the terminal on another letterform along with the letterform 'c').

- The lesson is effective in the fact that I knew what everything was in the posttest having no clue what I was doing in the pretest. As far as long term. I don't know if the lesson is effective. Making it more interactive would be a definite plus.

- Link from 2nd to 1st section broken. Multiple examples of each term might have helped, especially for some. For lines, display all and highlight selected one. For components, must click multiple ones to know orange = selected and black = deselected.

- It is a good review or index of type face anatomy. A little more direction and maybe interaction would help with the lesson.

- Like I said before, increase the font size. Use black & yellow, with the text that is to be read. I seem to pick up a lot of more vibration (appears to move) with black and white small text making it difficult to read and understand. When you talk about "white" space between strokes, the image on screen should have "white" space not a different color.

- Instead of just showing one letter for each term show multiple letters. I thought the lesson was very effective. The images definitely helped with my understanding.

- It's very effective. In the guides section, you should show all of the lines and highlight the one being focused on instead of only showing one line at a time.

Hypermedia

- Overall, the voice helps you concentrate more and allows you to follow along. There were several times where the voice was very hard to understand.

- It teaches it very well. The only thing I could see making this better is to give a diagram with all of the terms on it, showing what each looked like. The ability to view them one at a time, and the changing color helped.

- The lesson was just as effective if not even more than when I had 111. If any improvements are needed it could be the voice used.

- Change the voice, add a quiz. It helped having the areas being talked about highlight.

- It was effective in defining the anatomy. The voice slowed my reading down a little and was a little annoying. It probably would have been better with multiple examples to make the definitions a little more clear.

- I thought it was very helpful. I feel like I actually learned it. I do however wish that there was a way to turn the sound off. Although it was helpful, when I wanted to go back through the stuff quickly as a refresher, the talking was annoying. There were also times when the speaker was hard to understand.

- Spoken text helps to hold interest in the subject matter.

- I thought the lesson was very effective except for the voice. Something more pleasant might keep me more interested.

- I think it does an excellent job. Hands on is always my learning preference. So, I would say … take this one step farther in interactivity and allow people to click on different parts of the letters to see what they are. The more options there are, the more interesting it is to me and I may learn more in the meantime.

- The audio was more distracting than helpful. It also doesn't give examples for each character. For example, a bowl is common in only some characters, but not all are shown to give a better view of a bowl.

- I think it might be even more effective with some kind of interactivity. Perhaps a matching game or a quiz game. As a visual learner, I found the visualization of the information the most helpful.

- The lesson is clear and engaging. If possible, more interaction would make a greater difference. I lets the student isolate what he has most trouble with.

- The computer voice was disruptive, and yet the lesson is effective and extensive.

- The only thing I would change is the voice narrating; it's slightly obnoxious and distracting. I found the pictures along with the text descriptions were enough.

- I think the sound helped me to pay more attention to what I was taught & possibly retain more. Maybe a play & stop button for the sound could improve the lesson. The Flash (interactive) portion & the sound made the lesson effective.

- I thought this lesson did an excellent job of teaching the anatomy of type. If anything, getting a better voice might make some portions clearer.

- I think it teaches it pretty effectively. I think the thing that hurt it the most is having the computer voice. If it would have been an actual person's voice, I think it would have been more effective.

- The test was pretty simple once you went through the lesson. I am a visual learner so just seeing the pictures and labels was enough for me to remember what was what.

- I thought the lesson was effective, but at first I was wondering why you did not have the option to turning the voice off from reading the text. Sometimes it got annoying, but thinking about it, it was probably beneficial because while I as looking at the illustration, the lady was pumping the exact definition into my head.

- I think the lesson was very effective due to the graphical representations and images. The only thing I am undecided on is if the audio really helped or harmed the lesson. Personally I would rather read at my own pace than be read to; but I guess that really depends upon students' learning styles.

- This lesson was effective in that it visually highlighted the stroke that it was referring to. A better voiceover could have made the lesson better.

- It is extremely effective. I felt I knew a lot more after going though the lesson. Improvements – A more interesting narrator instead of the robotic voice. Effective – I think the colored portions of the graphics (rather than an arrow) to show the parts of letters, was effective. I also think that the sound helped. Not only could I read the text, but I could see & hear what the different parts of type are. Learning info in more ways than one helps it to stick more, and its easier to remember.

- When you have to manipulate type or make a symbol for a company. I think I remembered a decent amount from 111, but I needed to be reminded of a few. This was effective.

- I think listening while I can look at the pictures helped & if I had questions, I can re-read it myself to better understand. I don't know how to improve – maybe a real voice speaking consistently.

- To improve the lesson I would recommend giving an option to turn off the sound. The voice over got really distracting. The lesson was pretty effective., and the diagrams really helped.

- I think this is and effective teaching tool, particularly with the sound – I believe it adds to comprehension. Clearly it seems this study went through several iterations, and this seems generally complete and accurate.

- The lesson worked well. The #'s 15 and 25 are the same question.

- I think it did a great job. While doing the lesson I saw a mistake that I had made and it explained what each part was. I really liked how each part glowed when you clicked on it, that way I knew all that was part of that specific part of the type.

- This is helpful in teaching typography … especially the details on type. This could even go further in depth by asking the user to create a crossbar for example – more interactive. (or enter a letter that contains a crossbar)

- I think it clearly teaches most of the things I learned in 111, but quicker, and pretty effectively. If anything, I would substitute the robotic voice in the lesson, to a more smooth human voice. I think I paid more attention, and absorbed more info by listening and reading at the same time rather than just reading.

- It gives the basics for the anatomy of type. For me the talking was a bit distracting when I was following along with the text.

- It is pretty effective. Listening to the lesson as well as reading it was good. The interaction on the computer voice, however, was sometimes distracting. A recorded reading of each might be less distracting.

- The lesson is effective in that it provides audio & visual stimulation at the same time. The problem with this lesson was the monotone computer voice.

- It really teaches type well. I had a problem at first determining where the arrows pointed on the letters but was able to figure it out by elimination.

APPENDIX D

STUDY ANNOUNCEMENT & RECRUITMENT LETTERS

Student Announcement:

CGT Student,

A study will be conducted in these next few weeks comparing the educational value of hypertext and hypermedia technology. Some of you may be randomly selected from the department to participate. **If selected, you are under no obligation to participate. Assisting as a subject for this study is completely voluntary.** If you choose to participate, $1000 Cogent (CGT 490 extra credit) will be offered as compensation. If at any point during the study if you feel uncomfortable with what you are doing, you will still receive the Cogent. I as the investigator will be unaware if you have been randomly selected. I will only know that you have been asked to participate if you choose to respond at that time.

If selected to participate in this study, you will take a short pretest on CGT related content. You will then be given a lesson using one of two tools created using either hypertext or hypermedia technology. After completing the lesson you will then take a short posttest. The results of your scores on both tests will be averaged with all other participants and then studied.

Potential Benefits – The results of this study have the potential to benefit you as a student by affecting the way that you receive a portion of your education within CGT courses. It is the hope of the researcher to discover knowledge about the comparative value of hypertext and hypermedia technology in a normal educational setting. This knowledge will then be shared with faculty within the Department of Computer Graphics Technology.

Potential Danger – Although very slight, any time there is data collected about individual test performance there is the chance for a breach of confidentiality. After the study is completed, information attaching you as a subject to any test scores will be destroyed to minimize this chance. It is not possible to eliminate this risk entirely.

Thank you for your time and any assistance you are willing to provide with this study.

Sincerely,

Chad M. Blessinger
Graduate Student
Computer Graphics Technology

Recruitment Email:

CGT Student,

You were recently sent an email informing you of a study to be conducted regarding hypertext and hypermedia technology. You have been selected as a potential participant. **You are under no obligation to participate. Your assistance is completely voluntary.** If you choose to participate, $1000 Cogent (CGT 490 extra credit) will be offered as compensation. If at any point during the study if you feel uncomfortable with what you are doing, you will still receive the Cogent.

If you choose to participate in this study, you will be asked to take a short pretest on CGT related content. You will then be given a lesson using one of two tools created using either hypertext or hypermedia technology. After completing the lesson, you will then be asked take a short posttest. The results of your scores on both tests will be averaged with all other participants and then studied.

Potential Benefits – The results of this study have the potential to benefit you as a student by affecting the way that you receive a portion of your education within CGT courses. It is the hope of the researcher to discover knowledge about the comparative value of hypertext and hypermedia technology in a normal educational setting. This knowledge will then be shared with faculty within the Department of Computer Graphics Technology.

Potential Danger – Although very slight, any time there is data collected about individual test performance there is the chance for a breach of confidentiality. After the study is completed, information attaching you as a subject to any test scores will be destroyed to minimize this chance. It is not possible to eliminate this risk entirely.

If you are willing to assist with this study please contact Chad M. Blessinger at blessinc@purdue.edu within the next 7 days. Only if you choose to make contact will I be aware you have been asked to participate in this study. Upon contact, you will be given a participant number that will be used for the rest of the duration of the study to project your identity.

Thank you,

Sincerely,

Chad M. Blessinger
Graduate Student
Computer Graphics Technology