The purpose of this experimental research study was to determine if artistic screens (screens that employ accepted principles of visual design) influence the learning process. The independent variable was screen design: the dependent variables were recall learning, lesson completion time, and completion rate. Fifty-two adult subjects loom a research university in Western Canada participated in this study. Comparisons of the two groups showed that there was no difference in achievement scores between subjects who used the lesson with good design principles and those who used the lesson with poor design principles. However, it was found that subjects who used the lesson with good design principles completed the lesson in less time (21%) and had a higher completion rate (74%, vs. 45%) than those who used the lesson with poor design principles. Possible explanations focused on automaticity of control processes while learning and complexity of cognitive processing as a function of complexity of visuals.

The worst thing that can happen to an artist is to create a visual image that does not interest the viewer. Should the same also hold true for the instructional technologist who creates computer screens? Heroes (1984) claims poorly designed computer screens can hinder communication. Can visually pleasing computer screens enhance communication? Much of the literature in computer based instruction offers guidelines based on the empirical research available regarding the use of text, color, and graphics (Aspillaga, 1991; Baek & Layne, 1988; Duin, 1988; Gullingham, 1988; Heroes, 1984; Livingston, 1991; Rubens & Krull, 1985; Soulier, 1938; Steinberg, 1991; Szabo & Poohkay, 1994). This includes such areas as: text density, text size, line length, margins, columns, location of information, color choices and the use of graphics (in motion or static). If a visually pleasing screen is important, as much of the research states (Misanchuk & Schwier, 1995; Yang & Moore, 1996), why are there not similar guidelines based on
empirical research on how to design a computer screen that is visually pleasing? How do we know when a screen is visually pleasing? Are there certain characteristics that we can use to judge whether a computer screen is visually pleasing?

One possible reason for the lack of research-based information on how to create a visually pleasing computer screen may originate from the assumption that a good visual design and a work of art are the same thing and, in turn, only an artist can produce a good visual design. Another is that many of us believe this aspect of computer design falls into an area where we must use `judgment, common sense, and a refined connoisseurial sensitivity" (Misanchuk & Schwier, 1995, p. 20). Put another way, this area of computer screen design is soft information and cannot be empirically tested. In fact, neither of these assumptions are correct.

In regard to the first reason, art and design are not interchangeable terms. The difference between a work of art and a good visual design has to do with function (Dickie, 1975; Janson, 1977; Smith & Smith, 1974). Specifically, a design serves a purpose (Beittel & Lockhart, 1969). An artist's aim, on the other hand, is to create a visual statement that expresses a feeling, mood, sentiment and emotional attitude Arnstine, 1974; (Dickie, 1977; Ducasse, 1955; Townsend, 1997). Thus, although the design of a visual image may be visually pleasing, it is not necessarily a work of art. Moreover, one does not need to be an artist to create a technically good visual design. An example is a graphic designer. We know that a skilled graphic designer can create visually pleasing images that are not generally considered to be works of art. To create visually pleasing images, graphic artists use design principles. Regarding the second assumption, the principles of design (such as unity, focal point, balance, and color) are most often used to create visually pleasing images that can be empirically tested. Generally, when designing a visual image that is pleasing, the principles of design are used; contrary to the claim of Misanchuk and Schwier (1995) that "judgment, common sense, and a refined connoisseurial sensitivity" (p. 20).

Upon a closer look at the goals of the graphic designer and the goals of the instructional technologist it becomes evident that both have much in common. In addition to creating visually pleasing layouts, the goals of graphic designers include: (a) attracting and holding the viewer's attention, and; (b) communicating easily understood information that aims to have the viewer remember the information. To achieve these goals, most graphic designers use the principles of design. Is it possible for instructional technologists to apply these same design principles to achieve the same goals and enhance instructional effectiveness at the same time?

Bunderson (1981) observed that creators of mediated instruction tend to use one of three guiding principles in their work; logical (plan carefully using the best available knowledge and execute once), empirical (develop quickly in a lean format and iteratively test and revise), or artistic (create an outstanding graphic design of work of art). Guidelines and suggestion on how to implement the third-or artistic-approach abound (Alesandrini. 1987; Baek & Layne, 1988; Dolsky, 1993; Dumas, 1988; Heroes, 1984; Peterson, 1996; Steinberg, 1991). However, the researchers were unable to find studies that attempt to quantify relationships between the artistic aspects of instruction and measurable student performance outcomes. If instructional technologists apply these design principles to computer screens layouts, how might this influence achievement, completion rate, and lesson time?
LITERATURE REVIEW

Visual Cognition

Visual cognition is the process of how we perceive and remember visual information (Pinker in Rieber & Kini, 1991). Research has confirmed that as humans we seem to be exceptionally good visual learners (Kobayashi, 1986) and that visuals may enhance the learning process (Adams and Hamm, 1989; Alesandrini, 1987; Benson, 1989; Considine & Haley, 1992; Dwyer, 1978; Duin, 1988; Soulier, 1988). A reasonable question to ask next is, why? Presently, according to Steinberg (1991), there are two conflicting theories about how information is stored in our memory. One of these theories provides an explanation of why we remember information better when it is presented with a visual image.

The first theory contends that information is stored in our memory, based on its meaning, in complete and logical statements. This is referred as propositions or propositional forms (Pylyshyn in Rieber & Kini, 1991; Steinberg, 1991). According to this view, "...pictures are stored in memory in terms of their meanings rather than as images" (Steinberg, 1991, p. 145). This view does not provide an explanation of why visual images enhance the learning process.

The second theory suggests that we perceive and store words and visual images in two systems: one verbal and the other perceptual (Steinberg, 1991). This is referred to as the dual coding theory (Paivio, 1991). In this theory, it is believed that visual perception is different from verbal perception. Perception, according to Levie (1987) and Steinberg (1991), is the process of selectively attending to and scanning a stimulus, interpreting important details, and perceiving meaning. According to this theory, visuals are remembered better than words because visuals are more likely to be encoded redundantly than words (Paivio, 1967; Paivio, 1991). Thus, the likelihood of recall is extended due to the accessibility of two mental representations instead of just one. If one memory trace is absent (whether a visual or words), the other remains accessible (Paivio & Caspo, 1973). In addition, when the content is highly imageable, dual-coding is more likely to occur (Paivio & Caspo. 1973). Specifically, research shows that "words, sentences, and paragraphs that are highly imageable are recalled better than those which are not and that the learning of concrete concepts precedes the learning of abstract concepts-concrete concepts are stored as images whereas abstract concepts are stored as verbal representations" (Reiber & Kini, 1991, p. 85)

The dual coding theory, then, may explain why the use of visuals enhances the learning process. According to Molitor, Ballstaedt, and Mandl, in Mandl and Levin (1989), "when learning from texts and pictures occurs, pictures can always be retrieved from both memory systems" (p. 7). Bagui (1998) concurs with Molitor, et al. and concludes that dual coding enhances memory in terms of allowing a person to absorb information from the environment using both the verbal and visual processes. In addition, Bagui claims that dual coding may help in reducing the cognitive load in a person's working memory. Further support for this assumption can also be found from the research of Szabo, DeMelto and Dwyer (1981), who found that achievement scores were significantly higher when testing includes the same visuals that were used during instruction.

The dual coding theory is not without its critics: "Above all, representatives of research in artificial intelligence maintain that all of our knowledge is stored in a unique memory
system in a propositional format independently of whether it was decoded as linguistic or visual information" (Molitor, Ballstaedt, & Mandl in Mandl & Levin, 1989, p. 7). To support this proposition, studies by Baggett and Ehrenfeucht (cited in Mandl & Levin, 1989) found that...

in some situations visual stimuli as input can provide better cues than their equivalent verbal counterparts, for certain responses; but the study also shows that verbal cueing is also quite successful, demonstrating that cueing is not medium dependent. This fording bears on the question of single- versus dual-code memory. If one postulates that information from different media is stored separately, one would expect that cues to access the information be medium dependent. That has never been confirmed, however. (n. 105-106)

Visual Literacy

Visual literacy is an acquired competency in visual expression and communication that involves, according to Thiel (1981, p. 12), "insights and skills no less disciplined than those required for proficiency in engineering and construction." When multimedia designers are visually literate, multimedia learners are capable of making better choices and are more capable at gathering information from environments that are text and visually rich (Peterson, 1996). Thus, as we move into this age of visual multimedia there is a need for us to practice more enlightened visual literacy and this calls for the appropriate use of design principles (such as, unity, focal point, and balance) (Graves, 1941; Greenberg & Jordan, 1991; Lauer, 1979). According to the seminal writings of Graves (1941), the design principles are the building blocks of any visual design. "When an artist organizes these elements he [she] creates Form, which is Design or Composition... [If we are to create such a visual image] we must understand the elements and principles of design" (Graves, pp. 3-4). This is not to say, however, that every good visual design needs every design principle; but when the designer is striving for a technically good design, the use of design principles produces a visual image which is that much better.

The principles of design include unity, focal point, balance, and color. The first three design principles were varied for the study but color was controlled. Color was not a variable under investigation for the study because there is a lack of understanding about our color genes as well as the science of color (color physics). Another exclusionary reason was that the use of color could create a number of uncontrollable variables, such as, the possibility of participants having color blindness, the participants would have different color monitors and/or different contrast and brightness settings, and changes in the color due to uncontrolled lighting. To avoid these problems, the computer based lessons were developed without color.

Design Principles Used in the Study

The principles of design used for this study were unity (also referred to as harmony), focal point (also referred to as dominance or emphasis), and balance. Color was not a variable under investigation. To control color as an influencing variable, the tutorial was designed in a gray scale.

Unity/harmony. "Unity implies that a congruity or agreement exists among the elements in a design; they look as though they belong together, as though there is some visual
connection beyond mere chance that has caused them to come together" (Lauer, 1979, p. 2). Another term also used for unity is harmony. The basic assumption behind unity is that if objects in a design appear separate and/or unrelated, the pattern falls apart and lacks unity. According to Lauer, the purpose of unity is to make a visual image coherent and readable. Graves (1941) defined unity as cohesion, consistency or oneness. Graves considers it the fundamental design element of a visual composition: "Composition implies unity; the words are synonymous. To say that a composition lacks unity is a contradiction of terms. If it does, it is not a composition" (Graves, p. 52).

Creating unity is, according to Lauer (1979), a relatively easy task; it is already in our nature to seek organization or to make sense of things. Specifically, the observer is already searching for some coherent unity; all the designer must do is provide some clues. Every visual image is a collection of units or items; the challenge is more in the organizing of the elements (Taylor, 1981). In other words, it is the skill of the organization (or design) that produces a unified pattern. A critical consideration of visual unity is that the whole must dominate over the parts. The viewer must first perceive the entire design prior to observing the individual elements (Graves, 1941; Greenberg & Jordan, 1991; Lauer, 1979; Taylor, 1981). It is also important not to confuse visual unity with intellectual unity. "Visual unity denotes some harmony or agreement between the items that is apparent to the eye... A conceptual unity is not observable by the eye. A unifying idea will not necessarily produce a unified pattern" (Lauer, 1979, p. 4).

There are several ways to achieve unity such as proximity, repetition, and continuation. Figure 1a is an example of an un-unified composition whereas Figure 1b is an example of a unified composition. If the units are to be viewed as a group (as is Figure 1b), the space between each object should be less than the width of each object.

![Figure 1a. Un-unified](image)
Focal point (dominance or emphasis). "The designer's main enemy is boredom. It is almost better for viewers to stand and revile your image, rather than to pass it quickly with a bored "ho-ham." [c it-singer's] job is to catch attention and provide a pattern that stimulates the viewer by offering some visual satisfaction" (Lauer, 1979, p. 22). Lauer also notes that although nothing will guarantee success, one design that can help is a point of emphasis, a focal point. This will attract the viewer's attention and encourage the viewer to look further (Riddell, 1984).

When creating a visual image the designer will want to lead the viewer's eye into the visual image. To achieve this, designers use a focal point also referred to as the center of interest, dominance, or point of emphasis. The purpose of a focal point is to draw attention and encourage the viewer to continue looking (Greenberg & Jordan, 1991; Lauer, 1979; Riddell, 1984). A focal point alone will not make a design; rather, it is a tool designers use to grab the viewer's attention. There are many ways to achieve a focal point. The following figures illustrate two common techniques used to create a focal point: contrast (Figure 2a) and isolation (Figure 2b). In Figure 2a, even when there is just a slight change on the object third from the left, the eye is attracted to it, resulting in a focal point.

In Figure 2b, when one object is positioned apart from the other objects it becomes a focal point (Lauer, 1979). That is, by separation, an object takes on a visual importance. The object does not need to be any different from the other elements; it becomes different by its placement, not its form.
Balance.

A sense of balance is innate; as children we develop a sense of balance in our bodies and observe balance in the world around us. Lack of balance or imbalance disturbs us. Dangerously leaning trees, rocks, furniture, ladders, and so forth are avoided carefully. But even when no physical danger is present, as in a design or painting, we still feel more comfortable with a balanced pattern (Lacer, 1979, p. 36). Once a designer selects the images for a composition, a decision must be made how these images are to be balanced within the page (Riddell, 1984). This requires, according to Riddell, "some thought, experimentation and experience." (p. 42) When looking at a visual image we envision a vertical axis and usually expect to see some sort of visual weight grouping on either side (Greenberg & Jordan, 1991; Lacer, 1979; Poore, 1967). This functions as the fulcrum on a scale and should provide a sense of balance. When this balance is not present a "...certain vague uneasiness or dissatisfaction results. We feel a need to rearrange the elements, in the same way we automatically straighten a picture on the wall" (Lacer, p. 36). The following figures illustrate the two ways to achieve balance: symmetry (Figure 3a) and asymmetry (Figure 3b) (Bates, 1960; Lacer). When there are objects of the same general size and shape placed in an equal distance from the center, the result is a symmetrical balance, as Figure 3a illustrates. When objects are not of the same general size and shape, as Figure 3b illustrates, balance can be achieved in a variety of other ways. In Figure 3b, for example, balance is achieved by placing the larger object lower in the composition. This is asymmetrical balance. Asymmetrical balance is more complicated to accomplish, as it requires a "causal" relationship.

Figure 2b. Isolation

Figure 3a. Symmetrical Balance
The question addressed in this study was: Do achievement, completion rate, and lesson time vary with screen layouts using good design principles, compared with screen layouts that use poor design principles, in instruction delivered by computer based instruction with part-time adult learners from a research university in Western Canada?

Two versions of the same self-paced, computer-based tutorial, which presented identical content (How to Write a Term Paper) and strategy, were prepared by the researchers using Authorware Professional™ on a Macintosh computer and converted to the Windows operating system. A subroutine was also developed that tracked the time spent doing the computer based lessons.

One version of the tutorial had screen layouts that used good design principles (unity, focal point, and balance), while the other tutorial had screen layouts that used poor design principles. An expert in the field of art and design judged the screen layouts. To control color effects, both versions of the lesson were developed in a gray scale. Levin, Anglin, and Carney (1987) identified five different purposes or functionalities of instructional graphics in text learning; decoration, representation, organization, interpretation, and transformation. In this study, instructional graphics would be classified as representation. Figure 4a, Figure 4b, Figure 5a, Figure 5b, Figure 6a, and Figure 6b are examples of good and poor screen designed used in the study.
Figure 4a and 4b. Example of a unified and unified screen for the computer based lessons
A mastery of library skills is a pre-requisite for conducting research for a term paper. Mastery can be accomplished by becoming thoroughly familiar with the various library facilities.

When one object is positioned apart from other objects it becomes a focal point. An object can also become a focal point through contrast. In both Figure 5a and b the graphic (book) is used to draw the viewer's eye into the screen. However, if a focal point is positioned too close to an edge, it will tend to draw the viewer's eye out of the picture, such as example figure 5a. In figure 5b the dark edge of the book leads the viewer's eye into the text.

Figure 5a and b. Example of a screen design that has an appropriate and an inappropriate focal point for the computer based lessons.
Figure 6a and b. Example of a screen design that is balanced and unbalanced for the computer based lessons.

To participate in this study, students had to have access to a computer with Windows 3.1 or Windows '95, 25 MHz 386, SVGA monitor with 1 MB video RAM, mouse and a 3.5 inch high density floppy disk drive. No student declined to participate because of a lack of equipment.

Achievement was defined as recall of information on the subject of how to do a term paper as measured by a 36 item multiple choice paper and pencil test. The Cronbach Alpha reliability for the posttest used in this study was at 0.99. Time to compete the lesson and completion rates were the other two dependent variables.

Eighty-seven adult learners were randomly assigned to one of two groups using a class list and a table of random numbers. Each subject was then provided with one of the
versions of the computer based tutorial program. One group completed the tutorial that had screen layouts that used good design principles; the other group completed the tutorial that had screen layouts that used poor design principles. The lessons were completed during out of class time to allow for optimal variation in learning time to be observed. After completing the computer-based tutorial, each participant completed the achievement test. Fifty-two of the 87 who agreed to participate completed the computer based tutorial and posttest required for this study. The initial assignment of students was 43 for the tutorial with good design principles (group one) and 44 (group two) for the tutorial with poor design principles.

Data Analysis

Of the 43 participants in group one, 32 completed the computer based tutorial and posttest; of the 44 in group two, 20 completed both the computer based tutorial and posttest. A t-test was used to compare the difference in completion rates for the computer based tutorial between group one and group two. As is shown in Table 1 there was a significant difference in completion rates between the group using the lesson that contained the screen layouts that used good design principles (74% completion rate) compared with the group using the lesson that used poor design principles (45% completion rate).

There was no significant difference in achievement scores between the lesson that contained screen layouts using good design principles compared with the lessons that contained screen layouts not using good design principles (Table 2).

A t-test (Table 3) revealed a significant difference in time to compete the lesson, favoring the group using the lesson containing screens that used good design principles (21 % less time).

DISCUSSION

Using a lesson with good screen design principles as used in this study appears not to affect achievement one way or the other. What this indicates, then, is that the screen design principles chosen in the study (unity, focal point, and balance) do not affect recall learning. Poor use of these design principles, however, is related to increased instructional time and a reduced completion rate, or persistence.

There are several hypotheses as to why poor screen design might result in increased instructional time and reduced persistence. Research on visuals in instruction shows that more complex diagrams lead to more visual inspections when reading an illustrated text (Hegarty, Carpenter, & Just, 1991) and that detecting an object within a visual is faster if the visual is coherent rather than jumbled (Biederman, Glass, & Stacy, 1973). To the extent that poor screen design contributes to perceived complexity or incoherence, more time might be spent inspecting the visuals without a concomitant gain in achievement.

As far as persistence is concerned, one might consider the hypothesis that poor screen design casts doubt in the perception of the learner, by way of the halo effect, that the instruction possesses the high quality necessary to cause persistence. Simply put, if the subject perceives the graphics are not good, it might be inferred that the instruction is also lacking and not worthy of serious attention. As such, the question of motivation begins to call for our attention.
Another hypothesis deals with automaticity of processing when it comes to learning from text (Shiffrin & Schneider, 1977). When we study, drive, or engage in a myriad of cognitive or psychomotor actions, we tend to ‘automate’ the control process. Recall having driven a stretch of road recently with absolutely no recollection of the scenery you just passed. Similarly, when approaching a learning task such as the one used in this study, one may unconsciously enter in an automatic process control mode in order to maintain some sense of efficiency of learning. Certain events in our environment, such as a signal or siren cause us to switch out of automatic mode and into manual process control where we experience a heightened awareness of our surroundings. Perhaps viewing good screen designs promotes automatic processing whereas viewing poor screen designs encourages a manual and therefore less efficient processing.

One can also question whether an interruption to manual processing might have a measurable effect upon learning a topic that is new or unfamiliar to the learner. Presumably more than one person in the present study has had experience in writing term papers, experience that overrode any other differences in achievement scores.

This study was delimited to the use of a subset of design principles, and the instructional graphics served a representative function. Studies using different design principles and graphics with different functionality should be conducted to shed more light on this area of instruction. Furthermore, effects on performance in writing a term paper might yield different results.

However, the results of this study indicate that if we are concerned with minimizing learning time and maximizing learner completion rates, as we design screens for computer based instruction we should consider applying the principles of design used in this study. An explanation for the results that occurred in this study could be that the use of good design principles in computer based learning requires less unrelated processing of information as well as easier concentration on the content in terms of recall.

Finally, more and more instructional materials are being delivered in highly visual, self-paced, individually directed study environments using computer mediated communication and the World Wide Web; that is, beyond direct (synchronous) contact with an instructor. This places a greater burden on the role of screen appearance to maintain interest and promote perseverance on the part of the learner. The results of this study suggest that selected elements of screen design should be considered in achieving this goal. In addition, with the widespread availability of clipart through such software as Microsoft Office 9™M or Corel Draw™M, the inserting of graphics into computer based instructional programs is done with relative ease by the typical instructor, without the aid or advice of a graphic designer. When an instructor adds clipart in computer based lessons without thought or an understanding of screen design, he/she may easily violate one or more screen design principles and unknowingly reduce completion rate or extend study time.
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