Visual Elements and Their Effects on the Learning Outcomes of E-learning

by

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ABSTRACT

This research contributes to emergent body of knowledge regarding the understanding of relationship between visual elements and E-learning outcomes. Visual images and texts are the main visual elements within the study.

A literature review was conducted on E-learning situations, and a discussion on the role of visual elements in E-learning. Data collection was also conducted by way of a test, which randomly placed participants into three groups and assigned them to three different E-learning courses. The texts for the three courses were the same font, but the first course had text only, the second course had text and “bad” images, and the third one had text and “good” images. Every time participants finished a short course, they were requested to do a short quiz based on what they had learned. In addition, every participant needed to do a survey based on his or her E-learning experience. Research data was finally collected through the test scores and surveys.

Key findings of this research are: (1) The combination of text and “good” image materials in E-learning can greatly enhance the learning outcomes; (2) the “good” images in learning materials can add to the value of the text content as well as improve the satisfactory level of learners in E-learning; (3) “bad” images do not enhance E-learning outcomes; and (4) E-learners will spend a longer time to complete learning materials containing images, no matter how good or “bad” the images are.
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CHAPTER 1

INTRODUCTION

1.1 Purpose of Study

The development of Internet technologies has helped colleges and universities worldwide to offer E-learning classes. Because of the flexibility of E-learning, more and more people enroll in online classes, and continue their life-long education.

For the purpose of developing E-learning courses, designers, instructors, and programmers usually work together to create the total educational system. Frequently, instructors and designers like to use visual elements in online course material when they want to make the content attractive or illustrate some difficult knowledge points. Therefore, the visual elements in E-learning environment can play an important role.

However, when images are compared to text in E-learning, which of the two is more effective to E-learners? Do visual elements like images and text affect the E-learning outcomes differently? Some people may assume that learning with good images will achieve the best E-learning outcomes than learning with text or bad images. However, there is no research done previously to support this assumption. This study investigated the correlation between visual elements and E-learning outcomes.

1.2 Significance and Rationale

According to Scriven and Paul (2007), online education in the United States has increased from 1.98 million in 2003 to 2.35 million in 2004. Projections call for even higher expected numbers. In addition, "It has been projected that by the year 2020,
knowledge will double every 73 days" (Webster’s Unabridged Dictionary 1983). Therefore, E-learning becomes more and more important.

This study is focused on the relationship between visual elements and E-learning outcomes. In addition, the study to investigate the correlation between visual elements and E-learning outcomes can support E-learning teams to develop more effective online courses in the future.

1.3 Scope and Limitations

The scope of this research is defined as the relationship of E-learning outcomes and visual elements at the university level. In addition, the course content is limited to the introduction of Chinese ancient chairs. This research examines the different effects on E-learning outcomes by using text, “good” images, and “bad” images as the content. Therefore, the visual elements in this research are only limited to text, “good” images, and “bad” images, and no other visual elements are included.

1.4 Research Topics and Questions

This research is focused on the relationship between visual elements and E-learning outcomes. The key research topics and questions are organized into one category: the role of visual elements in an E-learning environment.

*Research Questions of the relationship between E-learning and visual elements:*

1. How does text affect the E-learning outcomes?

2. How do “good” images affect the E-learning outcomes?
3. How do “bad” images affect the E-learning outcomes?

4. Which role do visual elements play in E-learning courses?

1.5 Conceptual Framework

The conceptual framework for this study is comprised of the visual elements and E-learning. As shown in the figure (see figure 1.1), the research reveals the relationship between visual elements and E-learning based on two main aspects.

Within the section of E-learning, the literature review includes the development, current situation, advantages and disadvantages, and subjective factors of E-learning. According to Schramm and Roberts (1971), the estimated global population today stands at over 6.5 billion people. Of these, just over 1.1 billion or 16.9% are active users of the Internet. In the United States, online education has increased from 1.98 million in 2003 to 2.35 million in 2004 and the projections call for even higher numbers (Scriven & Paul, 2207). Therefore, we are living in an era where online education is growing quickly and it is playing an important role both in our personal lives and at work. It is worth pointing
out that it has been further projected that by the year 2020, knowledge will double every 73 days (Webster’s Unabridged Dictionary, 1983). With E-learning, people of all ages or who have a disability or who have difficulties attending class regularly could get the education or training they need. E-learning can help people realize the importance of lifelong learning, whether for personal interest or career enhancement (Porter, 1997, p. 1). However, E-learning is not a panacea for all the people. The outcomes of E-learning might be affected by some subjective factors. For example, previous studies have considered student perceptions of individual components of the course design (Kim, Liu, & Bonk, 2005; Stewart, Hong, & Strudler, 2004); degree of interactivity (Ku, Tseng, & Akarasriworn, 2013; Sun & Hsu, 2013); and various demographic variables such as age, gender, ethnicity (Arbaugh, Bento, & Hwang, 2010), grade point average, and previous experience with online courses (Marks, Sibley, & Arbaugh, 2005). Gender has also been considered as an influential demographic variable in studies considering personality traits and different contexts related to online and technology usage such as computer self-efficacy (Saleem, Beaudry, & Croteau, 2011). To summarize, the literature review in this section considers the importance of E-learning and factors that can affect E-learning outcomes.

Another portion of the literature review is the visual element, which includes visual literacy, images and text. Based on Pettersson (2002), “visual literacy” refers to the ability to recognize and comprehend the meaning of the visual messages accurately. Research conducted by Lohr (2007) and Strokes (2002) showed that most individuals can remember images better than words and the combination of images and words enhances learning. Compared to the role of images, text is the essential visual element in E-
learning. Research found readability of text is conditioned by the font size, the color and other criteria (Walker, 1992; Wilkins, 1995; Yurdakul, 2004). Readability is also conditioned by the medium where the text appears. For instance, "sans serif characters are much more readable than the serif characters on the computer screen" (Geske, 1996; Bradshaw, 2000; Chandler, 2001; Erdogan, 2008). Overall, according to Yurdakul, the content, expressions, activities, graphics, pictures, and texts – that is, every component that will be used in an online learning environment – have to be designed according to the needs of the users (2004). The literature review in this part reveals the findings of relationship between visual elements and E-learning in previous studies, which provides the base information for this research.
2.1 E-learning

2.1.1 The Development of E-learning & E-learning Current Situation

According to Schramm and Roberts (1971), over 1.1 billion or 16.9% of global population were active users of the Internet; and there was a growth of 208.7% from 2000 to 2007. In the United States, online education had increased from 1.98 million in 2003 to 2.35 million in 2004 and the projections called for even higher numbers.

People are living in an era in which online education is growing quickly and is playing an important role both in our personal lives and at work. Based on Webster's Unabridged Dictionary, "the sum total humankind's knowledge doubled from 1900-1950, and doubled again from 1960-1965". In addition, “it has been further projected that by the year 2020, knowledge will double every 73 days” (Webster’s Unabridged Dictionary, 1983).

With the availability of the Internet to most individuals (Mixer et al., 2008), the typical learning experience has been grown from the physical classroom only to physical and E-learning classrooms. "Today's knowledge can be enhanced through educational and informative tools, such as desktops, laptops, tablets, TV and mobile phones" (Costagliola, Polese, & Scanniello, 2005). When those devices are connected to the Internet, students can find information and stay connected. Therefore, "the Internet created a dynamic learning environment" (Mixer et al., 2008), which necessitated a significant change in the way we approach learning and teaching.
Based on "Learning Environment" (Beasley & Smyth, 2004), an "Online Learning Environment" can be defined as:

“A distinct, pedagogically meaningful and comprehensive synchronous or asynchronous environment by which learners and faculty can participate in the learning and instructional process at anytime and anyplace without having any obligation of being physically together.” (Kuzu & Ceylan, 2010).

Online learning environments manifest a variety of technical tools that support instructional delivery and communication in online formats. In addition, "dynamic delivery structures were embedded to enhance the instructional, learning and communication processes taking place" (Dringus and Terrell, 1999).

When they are designed, these environments foster learning by taking instructional design principles into consideration when these are appropriate to the needs of the target group and when they include almost every activity that was used in the classroom. "A well-developed E-learning environment enables students to foster their long-term understanding through the content and the contexts presented in the environment and through the interactions with peers and tutors" (Jonassen, 1999).

2. 1. 2 The Advantages and Disadvantages of E-learning

According to Tavangarian et al. (2004), "E-learning comprises all forms of electronically supported learning and teaching with information and communication systems, whether networked or not, and serves as specific media to implement the learning process". In the design practice, it could be more simple than it definition indicated.
E-learning could assist people of all ages and people who had a disability to acquire the education, and provided them with the opportunity to get lifelong learning (Porter, 1997). Besides, "People could learn independently, at their own pace, in a convenient location, at a convenient time" (Porter, 1997). Strokes (2002) found a same result in his research. Namely, "students using self-paced modules completed their work more quickly and were found to perform better than those using structured timed designs". Porter also argued that E-learning is an important way for educational institutions, from public elementary schools to state-funded and private college and universities, to offer instruction to a new market of students (Porter, 1997, p. 1-2). It is worth pointing out that E-learning offers a good opportunity for companies to train their employees (Porter, 1997). What's more, "the online environment provides flexibility by allowing 'anytime, anywhere' learning to occur and thus opening education to individuals whose circumstances or situations prevented them from attending a traditional class" (Sabau, 2008).

“However, E-learning is not a panacea for all educational or training ills” (Porter, 1997). As online course offerings and even full programs proliferate to meet the higher demand, students need to develop skills for navigation of the online world and multimedia components (Sabau, 2008). Besides, Sabau (2008) states, “in the online world students need to have intrinsic motivation and be diligent about logging in to the class and participating in the asynchronous and even in some cases the synchronous chats that accompany online courses.” Therefore, students without self-discipline or intrinsic motivation might not benefit from E-learning courses that much.
Concerning the future of E-learning, Sharples (2000) speculated that "mobile learning is claimed to be the next generation of e-learning and an important instrument for lifelong education." Moreover, with the development of home-based computer system, more and more available electronic communication networks and devices could be involved in E-learning. However, “Making these tools available cost effectively to more people, however, will be another challenge” (Porter, 1997).

2. 1. 3 The Subjective Factors of E-learning

Keller and Karau (2013) put forward “The Big Five” personality dimensions and five specific types of online course impressions, which are “engagement, value to career, overall evaluation, anxiety/frustration, and preference for online courses.” Previous research has focused on individual differences as they relate to student perceptions in various contexts and applications. For example, studies have considered students’ perceptions of individual components of the course design (Kim, Liu, & Bonk, 2005; Stewart, Hong, & Strudler, 2004); degree of interactivity (Ku, Tseng, & Akarasriworn, 2013; Sun & Hsu, 2013); and various demographic variables such as age, gender, ethnicity (Arbaugh, Bento, & Hwang, 2010), grade point average, and previous experience with online courses (Marks, Sibley, & Arbaugh, 2005). Gender had also been considered an influential demographic variable in studies considering personality traits and different contexts related to online and technology usage such as computer self-efficacy (Saleem, Beaudry, & Croteau, 2011).

More specifically, researchers (Gardner, 1983; Sternberg, Torff, & Grigorenko, 1998) have suggested that student performance increases when a fit exists between a
student’s abilities and the teaching method. More specifically, Komarraju and Karau’s (2005) assume that academic motivation would be higher when students’ personality-influenced cognitive and interaction preferences are matched with the academic environment.

In addition, previous studies (Kellogg & Smith, 2009; Saleem, Beaudry, & Croteau, 2011; Muscanell & Guadagno, 2012) found the difference in occupation, gender and the use of social networking also affect the E-learning outcome. Besides, Kleinginna and Kleinginna (1981) defined emotion as a complex set of interactions among subjective and objective factors. Based on findings in previous research (Erez & Isen, 2002; Isen & Patrick, 1983; Petty, Schumann, Richman, & Strathman, 1993; Weiss, Nicholas, & Daus, 1999), positive emotions have been studied as facilitating factors of changing people’s other affective experiences such as attitude, motivation, creativity and problem solving skills. Erez and Isen (2002) stated “positive emotions have a crucial effect on diverse cognitive processes that are relevant for learning, such as information processing, communication processing, negotiation processing, decision-making processing, category sorting tasks and even the creative problem-solving process.” According to Keller and Karau (2013), “Work experience was positively associated with engagement, value to career, and overall evaluation, and negatively associated with anxiety/frustration. Undergraduates reported stronger preferences for online courses than did graduate students”.

2.2 Role of Visual Elements in E-learning

In order to study the effects of visual elements on E-learning outcomes, a literature review was conducted as the first method in order to develop a general background of the E-learning and visual elements. Several books, journal articles, online resources were reviewed for reference. Based on Yurdakul’s research (2004), the content, graphics, pictures, texts had to be designed according to the developmental characteristics, the level of perceptions and the needs of the target audience in general E-learning activities.

2.2.1 Visual Literacy in E-learning

“Visual Literacy” was first coined in 1969 by John Debes who offered the following definition of the term: “Visual Literacy refers to a group of vision competencies a human being can develop by seeing and at the same time having and integrating other sensory experiences.” The development of visual literacy competencies was fundamental to normal human learning. Compared to Debes’ definition, Pettersson (2002, pp. 6m 7-79) gave a further description that the concept of “visual literacy” referred to the ability to recognize and comprehend the meaning of the visual messages. So visual literacy is the learned ability to interpret visual messages accurately and to create such visual messages. Therefore visual literacy can play an important role in the E-learning process, and “interpretation and creation in visual literacy can be said to parallel reading and writing in print literacy.” (Heinich, Molenda, Russell, 1982).
Figure 2.1 Visual Literacy

Figure 2.1 outlines the major components of visual literacy, which were discovered in previous research (Sabau, 2008). Visual learning includes visual thinking, visual communication and visual learning. Because the focus in this research is the investigation of the relationship between E-learning outcomes and visual elements visual learning becomes an essential factor to discuss in this chapter, and the most important part within visual literacy.
According to Sabau (2008), visual learning pertains to the use of images for learning and teaching knowledge. Furthermore, visual learning (see figure 2.2) includes decoding the messages of visual images and media; creating and delivering multimedia presentations; portfolios; instructional design-processes and applications of images in instruction; utilizing images in support of educational activities; and reading and understanding visual materials (Sabau, 2008).

With the development of technology, visual learning is much more important now than before. As Enser (1995) noted “…we now belong to a society experiencing technological advances which are serving to promote the importance of the visual
medium for message transmission and knowledge representation.” This sentiment was reinforced by Miller and Burton that "Today's average college grads had spent less than 5,000 hours of their lives reading, but over 10,000 hours playing video games (not to mention 20,000 hours watching TV). Computer games, email, the Internet, cell phones and instant messaging were integral parts of their lives" (1994). Therefore, these new learners might feel more comfortable to study by way of images instead of text in online courses.

2.2.2 The Role of Images in E-learning

According to Pettersson (2002), visual language had an apparent meaning in E-learning, but it must be learned for true comprehension. Pettersson also emphasized that prior experience and context played a significant role in visual language, and formative images should be designed in order to achieve the clarity of communication.

In addition to Pettersson (2002), previous research has discovered that images can assist with learning. Lohr points out that most individuals can remember images better than words and the combination of images and words enhanced learning (2007). “We know that visuals are perceived much more rapidly and readily than text” (Fleming & Levie, 1978, 1993; Sinatra, 1986). Visuals also improve communication of ideas (Dunsworth & Atkinson, 2007; McCrudden, Schraw, Lehman & Poliquin, 2007; Stokes, 2002).

More specifically, former studies found visuals could assist with memories (Stokes, 2002; Leshin et al, 1992; Metallinos, 1994; Levie, 1987), comprehension of text
(Duchastel, 1983; Levin 1981; Duchastel & Waller, 1979), and focusing attention (Sabau, 2008; Lester, 1995; Pettersson, 2002) in E-learning.

First, visuals in E-learning can help with remembering information. According to Stokes (2002), images in E-learning can facilitate with the memory process and help students organize information in ways in which they could better understand and remember. In addition, Leshin et al. (1992) replicated Strokes’ finding that visual images can aid comprehension and retention of information through organizational, structural, and mnemonic (assisting memory) functions. Besides, Metallinos (1994) compared the memory process between text and images and noted that memory for pictures was better than memory for words thus providing for the “pictorial superiority effect” (Metallinos, 1994, pp. 54-59). Another researcher explained further that images could assist with memories. “Visual thinking includes mental images, which can also be spontaneously generated and manipulated through the use of long-term memory, enable a variety of thinking processes from spatial reasoning to problem solving and the discovery of novel properties and depend on the maintenance of the image, its vividness, size, color and orientation and more complex operations of rotation, scaling or scanning” (Levie, 1987).

Another finding based on previous research is that images or visuals in E-learning can facilitate the understanding of text. The visuals in E-learning might be “appealing to the eye” (Duchastel, 1983; Levin, 1981); motivated a person to pick up, browse through, and read the text (Duchastel, 1978, 1983); and making reading more enjoyable (Duchastel & Waller, 1979). Also, images can help learning from text by enhancing comprehension and memory, because images could be used as a supplement to text (Levie & Lentz, 1982).
As stated by Sabau (2008), E-learning course modules must provide means for students to understand the knowledge as well as hold the students’ attention. Studies conducted previously found the connection between images and attention. Lester (1995) noted that visuals were a powerful tool of communication because they stimulated both intellectual and emotional responses – they made us think as well as feel. Therefore, visuals could help in holding a learners’ attention more than text alone. Furthermore, Pettersson's study (2002) on eye movements revealed that people’s attention did not last a long time; however, visual materials constantly redrew the person’s attention and held his or her interest on learning. Therefore, it was deemed important to use visuals sparingly in order to minimize distraction and tangential wanderings (Sabau, 2008).

“It should be remembered that pictures can have a positive, a neutral, or a negative effect on learning process” (Levin et al., 1987; Sims-Knight, 1992; Winn, 1993; Rieber, 1994). Pictures can be used to persuade, flatter, tease, shame, scare, and seduce and readers (Zakia, 1985). Also, visuals can have a purely decorative purpose (Selander, 1988) and have no relationship to the E-learning content. Massoumian (1989) concluded that: “…haphazard use of visuals may lead to minimal or no instructional gain and gradual loss of effectiveness as an instructional tool.” Besides, Massoumian discovered in previous study that students might ignore many of the images, when too many images are used (1989). It was also noteworthy that students might take 2-3 seconds to recognize the content of an image (Paivio, 1979; Postman, 1979). Some researchers even found that “in some situations, all kinds of pictures might be distracting and increase extraneous cognitive load.” (Oaksford, Morris, Grainger, & Williams, 1996). The findings mentioned above were much different from studies conducted by Stokes (2002), Leshin
(1992), Metallinos (1994). So based on those findings, the result of research conducted this time might be opposite to the assumption. Using materials that contain bad images or text only may be more effective on E-learning outcomes than good images.

Based on the findings mentioned in this section, it can be concluded that images can play many roles in E-learning (Winn, 1993). Educators must analyze the needs (e.g. learner's characteristics, prior knowledge, etc.) of students for the visuals before these are used (Mixer, McFarland & McInnis, 2008). Similarly and according to Pettersson, visuals must contain the information they were intended to convey in the design and production of instruction for E-learning. Without clear content, visuals will most likely not function well in E-learning (2002).

2.2.3 The Role of Text in E-learning

As discovered in the previous section, images can play an important role in E-learning. However, Pettersson (2002) claimed that the “The use of visuals does not automatically improve the achievements of the learners. For some objectives text is enough.” As stated by Melin (1992), the comprehensibility in a text is dependent on perspective, abstraction, context, complexity, and redundancy. A message could be comprehensible if the reviewer grasped it without difficulty. Explanatory information that is easily reachable places a text within a realm of understanding, as opposed to information without any additional easily accessible references.

Readability was another factor when considering text, and is conditioned by font size, color and other similar criteria (Walker, 1992; Wilkins, 1995; Yurdakul, 2004). Istek (2005) stated further that every font character had a unique feature and effect, and
misunderstandings could occur if the character was not suited to the intended message. Kuzu and Ceylan also shared their findings in font and that “choosing the appropriate typeface, which would be used in E-learning environment to the intended content, was very important in terms of transferring the message with a proper meaning” (2010). As shown in previous studies readability is also conditioned by the medium where the text appears. For instance, the typeface used in printed material differs from the typeface used on the computer screen (Kuzu & Ceylan, 2010). “Sans serif characters are much more readable than the serif characters on the computer screen.” (Geske, 1996; Bradshaw, 2000; Chandler, 2001; Erdogan, 2008). Based on Pettersson (2002), “care must be taken to not use two or more different typefaces coming from different font families (such as serif fonts or sans serif fonts) in the screen-oriented environments like online learning environments, which could produce some difficulties in users’ perceptions.” Burger (1993) also suggested that instead of using two or more different typefaces variety could be achieved by the variations of bold, italic and light types of the same character. Another factor that could affect the readability of text is font size. “Basic measure of a letter (point) is a name that is denominated by the distance between the very top part of the letter and the very bottom part of the letter” (Kuzu & Ceylan, 2010). Chandler (2001) pointed out that this feature varied from typeface to typeface, and in different ways of display. In printed material, for example, small point size could be read comfortably while on the computer screen bigger points need to be used for better readability.

Last, according to Brown and Bookman all text documents faced the following challenges: users’ different level of understanding of the meaning of all terminology such
as whether users could use the information they were given; different users' command of English or other language; different background; and different learning pace (1997).
CHAPTER 3
METHOD AND METHODOLOGY

3.1 Introduction

This chapter introduces the methods and methodology used in the research. The main method in this study was a test, which divided participants into three different groups, each one tested on one of three different E-learning systems. Each E-learning system included several online courses and a quiz. Therefore, quantitative data was collected through the scores from three different groups. Once the E-learning experiment was completed a survey was undertaken based on the E-learning experience. The survey was conducted to understand the differences in subjective evaluation from participants of three different groups. Data collected by survey was essentially quantitative data.

The methodology used in this study included a sampling strategy, data collection through test and survey, and quantitative data analysis.

3.2 Sampling Strategy

The test participants for the E-learning system were male and female college students with an age range from 22 to 33 selected from different majors. Some students had previous E-learning experience and some had not. The educational level of the participants ranged from undergraduate to Ph.D. level.

The recruited participants (see table 3.1) were randomly placed in three different groups. By following the group name list every participant received a link. By clicking this link, they were sent to different E-learning systems. Participants were also confirmed
to finish their learning through an assigned online course. After the online course, participants were required to do a multi-question quiz based on what they had learned, which was followed by a short survey about their E-learning experience.

Table 3.1

Participants List

<table>
<thead>
<tr>
<th>Participant Number</th>
<th>Gender</th>
<th>Age</th>
<th>Educational Degree</th>
<th>Major</th>
<th>Have previous experience with E-learning (Yes or No: Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P 1</td>
<td>F</td>
<td>26</td>
<td>Master</td>
<td>Communication</td>
<td>N</td>
</tr>
<tr>
<td>P 2</td>
<td>F</td>
<td>23</td>
<td>Bachelor</td>
<td>Accounting</td>
<td>Y</td>
</tr>
<tr>
<td>P 3</td>
<td>F</td>
<td>25</td>
<td>Master</td>
<td>Industrial Design</td>
<td>Y</td>
</tr>
<tr>
<td>P 4</td>
<td>M</td>
<td>24</td>
<td>Master</td>
<td>Interaction Design</td>
<td>Y</td>
</tr>
<tr>
<td>P 5</td>
<td>F</td>
<td>26</td>
<td>Master</td>
<td>Architecture</td>
<td>Y</td>
</tr>
<tr>
<td>P 6</td>
<td>F</td>
<td>24</td>
<td>Master</td>
<td>Education</td>
<td>N</td>
</tr>
<tr>
<td>P 7</td>
<td>M</td>
<td>25</td>
<td>Master</td>
<td>Electronic Engineering</td>
<td>N</td>
</tr>
<tr>
<td>P 8</td>
<td>M</td>
<td>24</td>
<td>Master</td>
<td>Computer Science</td>
<td>Y</td>
</tr>
<tr>
<td>P 9</td>
<td>M</td>
<td>24</td>
<td>Master</td>
<td>Optical Communication</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>---</td>
</tr>
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<td>Exhibition Design</td>
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</tr>
<tr>
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<td>Y</td>
</tr>
<tr>
<td>P 12</td>
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<td>Master</td>
<td>Visual Design</td>
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<tr>
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<td>25</td>
<td>Master</td>
<td>Industrial Design</td>
<td>N</td>
</tr>
<tr>
<td>P 14</td>
<td>M</td>
<td>33</td>
<td>J.D.</td>
<td>Justice</td>
<td>Y</td>
</tr>
<tr>
<td>P 15</td>
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<td>25</td>
<td>Master</td>
<td>Interaction Design</td>
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</tr>
<tr>
<td>P 16</td>
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<td>24</td>
<td>Master</td>
<td>Visual Design</td>
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</tr>
<tr>
<td>P 17</td>
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<td>24</td>
<td>Ph.D.</td>
<td>Biology</td>
<td>Y</td>
</tr>
<tr>
<td>P 18</td>
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<td>24</td>
<td>Master</td>
<td>Finance</td>
<td>Y</td>
</tr>
<tr>
<td>P 19</td>
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<td>Ph.D.</td>
<td>Biology</td>
<td>Y</td>
</tr>
<tr>
<td>P 20</td>
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<td>Mechanical</td>
<td>N</td>
</tr>
<tr>
<td>P 21</td>
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<td>Master</td>
<td>Computer Science</td>
<td>N</td>
</tr>
<tr>
<td>P 22</td>
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<td>28</td>
<td>Ph.D.</td>
<td>Industrial Design</td>
<td>N</td>
</tr>
<tr>
<td>P 23</td>
<td>M</td>
<td>26</td>
<td>Master</td>
<td>Industrial Design</td>
<td>Y</td>
</tr>
<tr>
<td>P 24</td>
<td>M</td>
<td>27</td>
<td>Master</td>
<td>Geography</td>
<td>N</td>
</tr>
<tr>
<td>P 25</td>
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<td>25</td>
<td>Master</td>
<td>Industrial Design</td>
<td>N</td>
</tr>
<tr>
<td>P 26</td>
<td>M</td>
<td>24</td>
<td>Master</td>
<td>Industrial Design</td>
<td>N</td>
</tr>
<tr>
<td>No.</td>
<td>Name</td>
<td>Gender</td>
<td>Age</td>
<td>Degree</td>
<td>Major</td>
</tr>
<tr>
<td>-----</td>
<td>------</td>
<td>--------</td>
<td>-----</td>
<td>--------</td>
<td>------------------------------</td>
</tr>
<tr>
<td>27</td>
<td></td>
<td>M</td>
<td>30</td>
<td>Ph.D.</td>
<td>Electronic Engineering</td>
</tr>
<tr>
<td>28</td>
<td></td>
<td>F</td>
<td>26</td>
<td>Master</td>
<td>Computer Science</td>
</tr>
<tr>
<td>29</td>
<td></td>
<td>F</td>
<td>27</td>
<td>Bachelor</td>
<td>Supply Chain</td>
</tr>
<tr>
<td>30</td>
<td></td>
<td>F</td>
<td>26</td>
<td>Master</td>
<td>Communication</td>
</tr>
<tr>
<td>31</td>
<td></td>
<td>M</td>
<td>25</td>
<td>Master</td>
<td>Electronic Engineering</td>
</tr>
<tr>
<td>32</td>
<td></td>
<td>F</td>
<td>26</td>
<td>Master</td>
<td>Architecture Design</td>
</tr>
<tr>
<td>33</td>
<td></td>
<td>F</td>
<td>25</td>
<td>Master</td>
<td>Public Relationship</td>
</tr>
<tr>
<td>34</td>
<td></td>
<td>F</td>
<td>24</td>
<td>Master</td>
<td>English Culture</td>
</tr>
<tr>
<td>35</td>
<td></td>
<td>M</td>
<td>24</td>
<td>Master</td>
<td>Electronic Engineering</td>
</tr>
<tr>
<td>36</td>
<td></td>
<td>F</td>
<td>25</td>
<td>Master</td>
<td>Interaction Design</td>
</tr>
<tr>
<td>37</td>
<td></td>
<td>F</td>
<td>23</td>
<td>Bachelor</td>
<td>Business Management</td>
</tr>
<tr>
<td>38</td>
<td></td>
<td>M</td>
<td>25</td>
<td>Master</td>
<td>Supply Chain</td>
</tr>
<tr>
<td>39</td>
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<td>M</td>
<td>25</td>
<td>Master</td>
<td>Electronic Engineering</td>
</tr>
<tr>
<td>40</td>
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<td>F</td>
<td>26</td>
<td>Master</td>
<td>Finance</td>
</tr>
<tr>
<td>41</td>
<td></td>
<td>F</td>
<td>25</td>
<td>Master</td>
<td>Justice</td>
</tr>
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<td>Master</td>
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</tr>
<tr>
<td>P 43</td>
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<td>25</td>
<td>M.D.</td>
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<td>Bachelor</td>
<td>Accounting</td>
<td>Y</td>
</tr>
<tr>
<td>P 45</td>
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<td>24</td>
<td>Master</td>
<td>Social Media Study</td>
<td>Y</td>
</tr>
</tbody>
</table>

*Note:* The first column indicates the name code of participants. Their real names are concealed based on consent form signed before the research. For example, P1 means the first participant.

### 3.3 Test

#### 3.3.1 Test Design

For the purpose of comparing the learning outcomes from using different visual elements in E-learning, the test was designed to randomly send participants into one of three different groups (see table 3.3). Participants in each group were informed to finish one E-learning system, and different groups used different E-learning systems. Even though there are three different E-learning systems (see table 3.2), all of them included in two parts: an online course and an online quiz. In addition, the last part (online quizzes) in each E-learning system was exactly the same.

Therefore, the only part that differentiated the three E-learning systems was the first part, the “online course.” There were three different online courses in total. All three courses shared the same text content, which was an introduction to “Ancient Chinese Furniture.” However, the course in System 1 included text content only; the course in System 2 included text and “bad” images (i.e. pictures are in the wrong color, the wrong
size, the wrong angle, out of focus, low resolution); and the course in System 3 included text and “good” images (i.e. pictures are in true color, true size, correct angle, regular resolution).

Table 3.2

Three E-learning Systems

<table>
<thead>
<tr>
<th>E-learning System</th>
<th>STEP 1</th>
<th>STEP 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-learning System 1</td>
<td>Online Course (Text only)</td>
<td>Quiz</td>
</tr>
<tr>
<td>E-learning System 2</td>
<td>Online Course (Text + “bad” images)</td>
<td>Quiz</td>
</tr>
<tr>
<td>E-learning System 3</td>
<td>Online Course (Text + “good” images)</td>
<td>Quiz</td>
</tr>
</tbody>
</table>
Table 3.3
Participants in Three Groups

<table>
<thead>
<tr>
<th>Group Number</th>
<th>Population in Different Genders</th>
<th>Average Age</th>
<th>Population in Different Educational Levels</th>
<th>Previous E-learning Experience</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
<td>Undergraduate</td>
<td>Graduate</td>
</tr>
<tr>
<td>Group 1</td>
<td>8</td>
<td>7</td>
<td>24.86</td>
<td>1</td>
</tr>
<tr>
<td>Group 2</td>
<td>6</td>
<td>9</td>
<td>24.93</td>
<td>1</td>
</tr>
<tr>
<td>Group 3</td>
<td>8</td>
<td>7</td>
<td>25.32</td>
<td>2</td>
</tr>
</tbody>
</table>

3.3.2 E-learning system prototype design

The E-learning system prototypes were created by using the combination of several online tools (Weebly.com and Qualtrics). Participants could only access the test by a link, which was sent to them by email. Once the participant clicked the link, they were automatically sent to the assigned E-learning system.

In each group, participants saw the same main page of the E-learning system (see figure 3.1). There was a red text asking the participant to record the time they used for the
whole learning process at the bottom, followed by a green button, which could bring participants to the E-learning courses.

Figure 3.1 Home Page

Participants in Group 1 saw the content in E-learning system prototype 1 (see figure 3.2).

Figure 3.2 E-learning System 1 Prototype (Text only)
Participants in Group 2 saw the content in E-learning system prototype 2 (see figure 3.3).

Figure 3.3 E-learning System 2 Prototype (Text with “Bad” Images)

Participants in Group 3 saw the content in E-learning system prototype 3 (see figure 3.4).

Figure 3.4 E-learning System 3 Prototype (Text with “Good” Images)

After going through every course, each participant was provided with access to the "GO TO QUIZ" button. This link would bring them to the next step of the E-learning system; participants could no longer go back to the course page. In this second step, each participant was asked to complete a short quiz (see figure 3.5) based on what they had learned on the online course in their group. There were nine questions in total; all questions were designed to test the participant's understanding of the course content.
3.4 Follow-up Survey

A follow-up survey was designed for a greater understanding of participants' E-learning experience. There were six questions in the survey (see figure 3.6), which included multi-answer questions and five-point Likert scale questions. The survey was incorporated in the same website of online quizzes. Once the participants had finished all the questions in the quiz they would click next, which would take them to the survey. Once they completed all the questions in survey, they submitted their answers, from which the data was collected.
3.5 Data Analysis

Based on the methods chosen in previous sections, different types of quantitative data were collected. The first type of data was collected through the E-learning test and survey. The quantitative data included the score of each question from three groups, the total score of the test from three groups, and the length of time participants used for the online learning. Based on the data collected, quantitative data analysis was considered the best method to use. The analysis of these data helped reveal the different performance of participants in three groups, as well as the relationship between E-learning outcomes and visual elements.

Quantitative data was also derived from survey questions. Therefore quantitative data analysis method was undertaken again to analyze the difference of subjective evaluation on their E-learning experience from different groups of participants, for getting a sense of how people feel about their E-learning process, and for E-learning performance and E-learning outcomes.
CHAPTER 4
DATA ANALYSIS

4.1 Introduction

The quantitative data collected in each group was a critical quantitative measure of learning outcomes of three different E-learning systems. This chapter reviews two main results in two parts. It begins with a discussion on the result of quantitative data collection from the quizzes. These quantitative data include the scores of each group as well as the time consumed by each group. These data help the researcher to develop a deeper understanding of how different visual elements affect learning outcomes.

Next, data collected from follow-up survey are discussed in detail. These data consist of the initial feedback of participants in three groups after they completed the online courses that were assigned to them. It contains quantitative data revealing participant’s evaluation of three E-learning systems.

The data analysis chapter assists the research in finding the patterns of relationship between visual elements and learning outcomes in E-learning environments. It is also beneficial to designers and educators who offer online courses to develop a better user-centered E-learning system for their future users.
4.2 Quiz Data Analysis

4.2.1 Quiz Scores of Three Groups

The accuracy data of each question in each group was based on how many participants in each group delivered the right answer to each questions. The total number of questions was nine, and there were 15 participants in each group.

The Figure 4.1 examines the three groups’ accuracy patterns of each question. For example, in question 1, Group 1 had an accuracy of 80%, Group 2 had an accuracy of 93%, and Group 3 had an accuracy of 100%. The original assumption for the accuracy pattern was that group 1 (text only) had the lowest accuracy, Group 3 (text with “good” images) had the highest accuracy and Group 2 (text with “bad” images) had the medium accuracy.
The results of the quiz showed only Question 1, 5, 8 and 9 fit with the assumption of accuracy pattern in three groups. The abnormal patterns appeared in Question 2, Question 3, Question 4, Question 6 and Question 7.

In Question 2, Group 3 had the highest accuracy, while Group 2 had the lowest accuracy instead of Group 1. In other words, for Question 2, Group 3 had the best learning outcomes and Group 2 had the worst learning outcomes. Although the picture used for this part of content in Group 2 and Group 3 did not contain the information for Question 2. It could be speculated that the pictures of wrong colors in Group 2 decreased the attention of participants on text content. Or the bad images might affect the learners’ comprehension of text. Therefore, Group 2 had the most undesirable learning outcomes.

In Question 3, Group 1 had the highest accuracy; however, Group 2 and Group 3 had low accuracy. The picture chosen for this section in Group 2 and Group 3 had no relation with Question 3 but showed some information on Question 4. Therefore, on one hand, we might assume the pictures used in Group 2 and Group 3 distracted the attention of participants; on the other hand, since there was no pictures in Group 1, participants of this group could focus on the text content totally, which allowed Group 1 to reach the highest accuracy for this question. Besides, it is worth pointing out the finding that if good or bad pictures used in E-learning materials had no relation to the text content, they are bad images for educational purpose.

The accuracy in Group 2 was much lower than for Group 1, while Group 3 had an accuracy of 100% in Question 4. In terms of the picture used for this section in Group 2 and Group 3, both of them contained clear information for Question 4. However, the picture in Group 2 had the wrong color and a weak color contrast. Therefore it could be
assumed that the wrong color usage and weak color contrast resulted in the lower understanding of information in pictures.

The lowest group accuracy appeared in Question 6. First, the question was more difficult than other questions. Despite the pictures and its connection to the question, the accuracy of Group 2 and Group 3 were low. The picture used in Group 2 had the wrong color with a lot of shades, which might put a negative impact on the participants’ attention or emotions. Group 2 got the lowest accuracy in this question.

The results for Question 7 were highly abnormal. Compared to the high accuracy in Group 1 and Group 2, Group 3 had the lowest accuracy. The question asked whether furniture of Ming dynasty had a complex decoration. Looking back at the pictures in Group 3, the beautiful color and pleasant shape of several pictures of Chinese chairs might have distracted the attention of the participants in Group 3. However, compared to modern chair designs, the simplest style of Chinese ancient chair could be considered as complex to the participants. It could therefore be speculated that the participants in Group 3 were confused by their past memories of pictures. In addition, since the pictures in Group 2 were “bad” pictures, participants in this group paid less attention to the pictures. Without the confusion of pictures, Group 1 and Group 2 therefore had a high accuracy for this question.
There were nine questions in the quiz, and each of them was worth 10 points, for a total score of 90 points. The average score and median score in each group were calculated based on the scores of 15 participants.

The assumption was that participants in Group 3 (text and “good” images) had the highest average score and median score, participants in Group 1 (text only) had the lowest average score and median score, while participants in Group 2 had the medium average score and median score. Figure 4.2 shows the average scores and median scores of each group, which are in part similar to the assumption. Group 3 had the highest average score and median scores. However, Group 1 and Group 2 had the same average scores, and the median scores in Group 1 was higher than for Group 2. It could be generated that there were slight differences in E-learning outcomes between learning through text only, and learning through the combination of bad images and text.
Figure 4.3 and table 4.1 show the standard deviation of scores in each group. The deviation value for Group 1 is 21.31; the deviation value for Group 2 is 16.82; and Group 3 has the lowest deviation, which is 9.15. Moreover, the scores of Group 1 and Group 2
both varied from 20 points to 90 points, while Group 3 varied from 60 to 90 points. It is worth pointing out that full scores did appear in each group; it appeared twice in Group 1 and Group 3, but appeared only once in Group 2.

Based on the data above, it could be summarized that scores in Group 1 had the highest deviation value, which meant the responses were very polarized. Besides, the scores in Group 2 were relatively scattered from the mean value, therefore the deviation value was on the second place among three groups. Last, the lowest deviation value in Group 3 indicated that the overall scores from each participant were in convergence. Therefore, it could be concluded that good images could bring a positive impact on E-learning outcomes to general learners. At the same time, the effects from bad images or text on E-learning outcomes to individual learner were discriminative.

4.2.2 Time Consumed on Answering Questions

Within each quiz, there was an invisible question for each group. This was the overall time consumed on answering the questions, which is called the question submit time.
Figure 4.4 Average Question Submit Time

Result in figure 4.4 displayed the tendency of average question submit time from Group 1 to Group 3. The differences among the three groups were significant. Compared to participants in Group 1 and Group 2, participants in Group 3 took more time to answer the questions. The average time consumed in Group 3 was nearly twice the time consumed in Group 1, and 1.5 times the time consumed in Group 2. The reason for the differences among the three groups could be speculated from the impact of different visual elements. The “good” images in Group 3 might play a positive effect on attention attraction and memories, as well as raise the learning interest of participants. Therefore, compared to others, participants in Group 3 appear to want to answer the questions more carefully.
4.3 Survey Data Analysis

4.3.1 Time Consumed on E-Learning Phase

Figure 4.5 Time Consumed on E-learning Phase

Figure 4.6 Average Time Consumed on E-learning Phase

Figure 4.5 shows the time consumed on E-learning phase in each group. The analysis begins by looking at the deviation for time in each group. The time deviation in Group 2 was relatively located around 300 seconds to 600 seconds. The time deviation in
Group 1 and Group 3 was dispersed. Overall, the largest part of participants in Group 1 took less than 300 seconds on learning, which reached the proportion of 53%. Meanwhile, there were 87% of participants in Group 2 took 300 to 600 seconds, and 60% of the participants in Group 3 took 300 to 600 seconds.

It was apparent to see the tendency of the average time consumed in three groups in figure 4.6. Participants spent 350 seconds on E-learning phase in Group 1. Participants in Group 2 spent more time than Group 1, which was as high as 410 seconds. Group 3 had the longest average time on E-learning phase, which was 430 seconds. The difference of average time length among Group 1 and Group 2 and Group 3 was dramatic. However, the average time scale in Group 2 and Group 3 was quite close to each other. So participants learned through text only spent less time than participants learned through bad and good images.

When figure 4.6 is compared to figure 4.5 the conclusion could be drawn that even though the average time spent on E-learning in Group 3 was a bit longer than for Group 2, more participants spent over 300 seconds in Group 2 than in Group 3. Meanwhile, participants in Group 1 spent the shortest time on E-learning period. As mentioned above, it can be assumed that participants would spend more time if the online course has pictures in the content, no matter if they were “good” or “bad” images. Also, participants spent a longer time in the course with “bad” images course with “good” images. The participants might be distracted by the “bad” images, or they might take some time to figure out what information the image contained.
4.3.2 Evaluation of Different Visual Elements

![Evaluation of Text Help in E-learning](image)

**Figure 4.7 Evaluation of The Help of Text In E-learning**

The result of figure 4.7 showed the evaluation of the importance of text in E-learning from the three groups. Based on the data above, participants in Group 1 delivered a relatively scattered feedback. However, the reviews of Group 2 and Group 3 were much more focused on the level of “much important.” There were 14 participants in Group 1 and Group 2 that agreed that text did help them in E-learning, and 100% of participants in Group 3 agreed with the importance of text.

![Evaluation of Images Help in E-learning](image)
Figure 4.8 Evaluation of The Help of Images In E-learning

Figure 4.8 was generated from the question of “For online activities that included images, to what degree did the image help you in the learning progress.” Since there were no images in Group 1, this question asked for an evaluation that included all online courses.

The result of data (see figure 4.8) indicated that more than half of the participants in all groups confirmed the help of images in general E-learning process. In Group 1 there were nine participants who ranked the help of images from “much” to “a great deal”. In Group 2, seven out of 15 participants marked the importance degree of images as “much” and “a great deal”. In Group 3, 10 participants considered the help of images in E-learning as “much” and “a great deal.” As the data displayed above, participants in Group 2 evaluated the help of images as less important than other groups. It can be speculated that “bad” images in Group 2 delivered less information to the participants. Therefore “bad” images put a negative effect on participants and made them feel dubious about the importance of images in the E-learning process.

![Group 1: Negative Effect Level of “Bad” Images](image)

Figure 4.9 Negative Effects Level of “Bad” Images in Group 1
Figure 4.10 Negative Effects Level of “Bad” Images in Group 2

Figure 4.11 Negative Effects Level of “Bad” Images in Group 3

Figure 4.9 to Figure 4.11 show the results of evaluation of negative effects of “bad” images in three groups. Table 4.2 was generated with the data collected through the three figures. Table 4.2 indicates the sequence of negative effects of “bad” images in each group.

Table 4.2

The Sequence of Negative Effects of “Bad” Images
<table>
<thead>
<tr>
<th>No. 1</th>
<th>No. 2</th>
<th>No. 3</th>
<th>No. 4</th>
<th>No. 5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group 1</strong></td>
<td><strong>Group 1</strong></td>
<td><strong>Group 1</strong></td>
<td><strong>Group 1</strong></td>
<td><strong>Group 1</strong></td>
</tr>
<tr>
<td>Images that are too small in size</td>
<td>Images with the wrong colors</td>
<td>Images that are pixelated</td>
<td>Images appearing in different locations</td>
<td>Images that are rotated</td>
</tr>
<tr>
<td><strong>Group 2</strong></td>
<td><strong>Group 2</strong></td>
<td><strong>Group 2</strong></td>
<td><strong>Group 2</strong></td>
<td><strong>Group 2</strong></td>
</tr>
<tr>
<td>Images that are pixelated</td>
<td>Images with the wrong colors</td>
<td>Images that are too small in size</td>
<td>Images that are rotated</td>
<td>Images appearing in different locations</td>
</tr>
<tr>
<td><strong>Group 3</strong></td>
<td><strong>Group 3</strong></td>
<td><strong>Group 3</strong></td>
<td><strong>Group 3</strong></td>
<td><strong>Group 3</strong></td>
</tr>
<tr>
<td>Images that are too small in size</td>
<td>Images appearing in different locations</td>
<td>Images with the wrong colors</td>
<td>Images that are rotated</td>
<td>Images that are pixelated</td>
</tr>
</tbody>
</table>

**Note 1:** The sequence of negative effects was generated by the value from high to low in order. For example: in Group 1 (see figure 4.9), the No. 1 negative image type is “images that are too small in size”, because this type of image were ranked by the most participants in Group 1 as the No. 1 negative image.

**Note 2:** If several types of images had the equal values within the same ranking order, the final order would be based on the sum of previous order number. For example: in Group 2 (see figure 4.10), the value of “images that are rotated” and the value “images that are too small in size” are same in No. 3 (the result of survey). However, the sum of numbers of participants ranked “images that are too small in size” as No. 1 and No. 2 is 5, the sum of numbers of participants ranked “images that are rotated” is 3. Therefore, in the final order “images that are too small in size” goes before “images that are rotated”.

The top three “bad” images in Group 1 were “images that are too small in size,” “images with the wrong colors,” and “images that are pixelated.” The top three of the most negative “bad” images in Group 2 were “images that are pixelated,” “images with
the wrong colors,” and “images that are too small in size.” The top three of undesirable
image types were “image that are too small in size,” “images appearing in different
locations,” and “images with the wrong colors.”

It is also worth pointing out that the participants in Group 1 and Group 3 chose
the same image type as the No. 1 negative images, which was “pictures that are too small
in size,” while the most negative images evaluated by Group 2 was “images that are
pixelated.” During the E-learning progress, participants in Group 1 could only see text,
and participants in Group 3 could see text with “good” images. Different from Group 1
and Group 3, participants in Group 2 learned through text and “bad” images. Therefore,
on one hand, participants in Group 1 and Group 3 might answer this question based on
their previous E-learning experience or even imagination. This might be the reason why
the results between Group 1 and Group 3 were more close to each other. On the other
hand, the sequence evaluated by Group 2 was based on their real experience. So the result
from Group 2 might be more persuasive than Group 1 and Group 3.

Based on the negative image type sequence results and times appeared in the top
three places, the overall top three most negative image types evaluated by three groups
are: images with the wrong colors, images that were pixelated, and images that were too
small in size. Images that were rotated had the least negative influence on E-learning
outcomes to participants.
4.3.3 Feedbacks on E-learning Experience

The data illustrated in figure 4.12 revealed the result of the subjective evaluation on how much participants learned through the E-learning system. The number of participants selected the degree of “much” and “a great deal” in Group 1 is nine. There were 11 out 15 of participants in Group 2 who reviewed “much” and “a great deal,” and there were 10 participants in total who felt they had learned “much” and “a great deal” in Group 3. To summarize, even though the gap among the subjective evaluation level in three groups was quite small, it was worth pointing out that Group 2 had the highest level of subjective evaluation on how much participants learned during the E-learning experience, while Group 1 arrived at the lowest level.
Figure 4.13 Level of Satisfaction on E-learning Experience

Figure 4.13 shows the differences of satisfaction on E-learning experience among the three groups and shows that participants in Group 1 had the lowest level of satisfaction. In Group 3, 93% of the participants expressed a degree of satisfaction from “satisfied” to “extremely satisfied”, which was the highest among the three groups. Furthermore, the level of satisfaction in Group 2 was not the highest; it was quite close to the satisfaction level of Group 3. There were 86% of participants who evaluated it as “satisfied” and above. The analysis of the data supports the original assumption, that students who learn through text and “good” images had the highest satisfaction about the E-learning experience while students who learn through text only have the lowest satisfaction about their learning experience. The reason for the result could be explained by previous studies that show that “The material containing images may be ‘appealing to the eye’ (Duchastel 1983; Levin 1981); motivated a person to pick up, browsed through, and read the text (Duchastel 1978, 1983); and making reading more enjoyable” (Duchastel & Waller 1979).
4.3.4 E-learning Time and E-Learning Outcomes

Figure 4.14 Average Time Consumed on E-learning Phase

Figure 4.15 Average Question Submit Time

Figure 4.16 Average Scores

A connection was made among three factors: 1) the data of time consumed on E-learning phase, 2) question submit time data and 3) data of scores. As a result a
relationship among the three factors was revealed. First, the tendency patterns among the three factors illustrate their value to be quite close to each other (see figure 4.14, figure 4.15 and figure 4.16). Group 3 always reached the highest values in three figures, while Group 1 stayed at the lowest values.

It was noteworthy that participants in Group 3 spent the longest average time on E-learning process and on answering questions; this group earned the highest average score at the end. Meanwhile, participants in Group 2 spent a relatively longer time on E-learning and questions than did Group 1, but the average scores of Group 2 and Group 1 were the same. It could be speculated that during the E-learning process, participants would spend some time on image content no matter if the images were “good” or “bad.” Nevertheless, participants derived the information from “good” images more accurately.

Therefore, it could be concluded that during the E-learning process, images, whether good or bad, affected the time length of E-learning; however, only “good” images helped in increasing the E-learning outcomes.
CHAPTER 5
DISCUSSION AND CONCLUSION

5.1 Conclusion

5.1.1 Text and E-learning Outcomes

A final conclusion can be generated through interpretation of collected test and survey data, and the data analysis in chapter 4.

Of participants involved, 93.33% in Group 1 (text only) and Group 2 (text with “bad” images) confirm that text helped in E-learning whereas 100% of participants in Group 3 (text with “good” images) confirm that text helped from “somewhat” to “a great deal.” It appears that most participants admit that text is important in the E-learning process; however, the “good” images added value to the text.

Even though most of the three groups’ participants agreed on text help, the data from the test showed that the group with text content only received the lowest scores (64 out of 90). Therefore it can be concluded that text is essential to E-learning outcomes; however, the learning outcomes can be improved if “good” images are included.

5.1.2 “Good” Images and E-learning Outcomes

Based on the analysis in chapter 4, “good” images in E-learning courses are images in the right colors, the right size, and the correct placement; these images are in focus and highly relevant to the key learning content. The research finds that good images may have short-term effect as well as long-term effects on E-learning outcomes.
First, the test and survey results reveal the value of “good” images to E-learning outcomes. The participant group that studied through text and “good” images achieved the highest average scores in comparison to the other two groups, which indicates studies through the combination of text and “good” images will most likely increase the E-learning outcomes. This result concurs with the findings discovered by previous researchers, such as Lohr (2007) and Stokes (2002). Previous research conducted by Lohr (2007) shows that most individuals can remember images better than words, and, combined images and words enhance learning. Meanwhile, Stokes (2002) finds that images are effective in learning because they facilitate memory processes and assist students in organizing information in a way they can remember. Therefore, it can be concluded that the combination of text and “good” images could apparently raise the short-term E-learning outcomes.

Second, “good” images also raise the satisfactory level of participants in an E-learning experience. The satisfaction of E-learning experience is very important because it can affect the learning outcomes in the long term. As the data showed in chapter 4, the group that studied with text and good pictures gave relatively high reviews on the satisfaction of this E-learning experience, while the satisfaction reviews in the other groups were much lower. The reason of the result may be speculated to be that good images in content help participants understand the text more easily, and alleviate the pressure of learning new knowledge. In addition, the result of the test in this research can also be explained by conclusions of previous studies. Lester (1995) notes that: “visual messages are a powerful form of communication because they stimulate both intellectual and emotional responses – they make us think as well as feel.” Another study also found
that visual materials may be ‘appealing to the eye’ (Duchastel 1983; Levin 1981), motivate a person to pick up, browse through, and read the text (Duchastel 1978, 1983) and make reading more enjoyable (Duchastel & Waller 1979). Therefore, it can be assumed that there are more opportunities for students who are highly satisfied with the E-learning system to come back to learn more in the future. The high satisfactory level of E-learning experience even can trigger the interest of learners in one specific area. To summarize, good images cannot only have a short-term effect on increasing the E-learning outcomes, but can also put a positive long-term impact on E-learning outcomes.

5.1.3 “Bad” Images and E-learning Outcomes

With the data collected through test and survey in this research, the relationship between bad images and E-learning outcomes is revealed.

The term “bad” images in this investigation refers to images that are in the wrong colors, images that are too small in size, images that are rotated incorrectly, images that are pixelated, and images that are in different locations. The results of the research discovered the top three bad images types that could have the most negative impact on E-learning outcomes. Reviewed by 45 participants in the research the top three negative images are the ones with the wrong colors, that are pixelated, and that are too small in size. Images that were rotated had the least undesirable impact on E-learning outcomes. During the data analysis process, another type of “bad” images was found. This type of bad image can be in the right color, in the right size, in the correct places, and is not rotated; however, the image is “bad” because it is irrelevant to the learning content. In other words, good pictures cannot assist with increasing E-learning outcomes if they are
not related to the learning materials. This finding was similar to Massoumian’s that: “…haphazard use of visuals may lead to minimal or no instructional gain and gradual loss of effectiveness as an instructional tool” (1989). To summarize, “bad” images in E-learning include images that are in the wrong colors, images that are too small in size, images that are rotated, images that are pixelated, images that in different locations, and images that are irrelevant to the learning content. Among those images, the top three negative types are images with the wrong colors, images that are pixelated, and images that are too small in size.

One assumption with this research was that the combination of “bad” images and text facilitated the E-learning outcomes better than text alone. However, the data from test and survey showed different results. First, the average scores in the test showed participants in Group 1 (text only) and Group 2 (text and bad images) attained the same value, which was the lowest among three groups. The reason for this result could be due to the fact that bad images do not provide desirable information to the participants. Previous study conducted by Pettersson arrived at the same conclusion. According to Pettersson (2002), images have an apparent meaning to learning, but it must be learned for true comprehension. Therefore, “bad” images may cause participants to understand images inaccurately. As the test showed, Group 2 (text and “bad” images) contained images, but those images did not help with increasing the E-learning outcomes. To conclude, there is essentially no difference on E-learning outcomes between using materials that includes text only, and materials that includes text and bad images.

If time spent on the E-learning process is taken into consideration, materials containing bad images and text will lead to lower learning outcomes than text materials
alone. The collected data in test and survey showed that, even though Group 1 (text only) and Group 2 (text and “bad” images) got the same average scores, participants in Group 2 spent more time on E-learning and answering questions than did Group 1. As previous studies found “it may take 2-3 seconds to recognize the content in an image” (Paivio, 1979; Postman, 1979). So even if the “bad” images do little help to understand the text, participants still need 2-3 seconds to recognize each of them. It can be assumed that compared to learning with text only, students who learn through the combination of text and “bad” images will spend more time but with no better outcomes in general E-learning activities. Therefore, it can be concluded that if time factor (time consumed on E-learning process) is taken into consideration, using the combination of text and bad images as the content achieves the less desirable learning outcomes than using text only content.

5.1.4 Final Conclusion

In conclusion, visual elements are essential towards more effective learning outcomes in online courses, but different types of visual elements affect the E-learning activity in different ways.

First, even though text is the most important visual element in online courses, students will learn better if “good” images are included. This investigation shows that using the combination of “good” images and text as E-learning material can bring the most positive both short-term and long-term impact on E-learning outcomes.

Second, there is no obvious evidence from the research that students learn better through text and “bad” images than they do with text only. Instead, if time data is taken
into consideration, the materials include text and “bad” images lead to less effective learning outcomes than text only materials.

Therefore, the combination of “good” images and text is the most effective visual elements to increase E-learning outcomes; text only materials are less effective than materials that include “good” images and text; however, materials that include “bad” images and text are the least effective visual elements to increase learning outcomes in general E-learning environment.

5.2 Implications

Visual elements play an important role in the design of online courses of different majors. However, they should be used with care and attention. As Sabau noted "E-learning course modular units must fulfill the goals and objectives of the course ensuring continuity and coherence by providing means for students to understand the general ideas as well as specific topics studied and keep the students’ attention focused on the subject." (2008).

Designers or instructors of online courses usually give images a high value in E-learning activities; however, the data of this research shows only “good” images play a positive effect on increasing learning outcomes. Also, “good” images can add to the value of text and make users have a higher E-learning satisfaction. Thus designers and educators need to incorporate “good” images into online course materials. As the finding discovers in previous studies has shown, however, it should be remembered that pictures can have a positive, a neutral, or a negative effect on E-learning process. “When too many pictures are used, readers may ignore many of them” (Massoumia, 1989).
Consideration therefore must be given to the purpose of visuals, the learner's characteristics, and prior knowledge. Only then should the educator make decisions about what to emphasize and how to organize information in order to inspire the learners.

As is also mentioned in the “Conclusion”, there is little difference in learning outcomes between using text and text with “bad” images. Moreover, materials containing “bad” images and text take students a longer time to finish than materials with text only. Therefore, it is preferable to use text only than to use text and “bad” images. Because adding bad images or even “good” images that are irrelevant to the content does not only require more time from the E-learning development teams, but will also require more time from the students in learning process with little expectation of increased learning outcomes.

5.3 Limitations

The research revealed the relationship between visual elements and learning outcomes in E-learning environment; however, there are some limitations in the research to be noted. First is the sample size. Although there were a total of 45 participants, there were only 15 participants in each of the three groups. Second, the bad image types are limited in E-learning materials due to length of courses. During this study, only five types of “bad” images were used, which included images in the wrong colors, images that were too small in size, images that were rotated, images that were pixelated, and images that were in different locations. The conclusion will be more persuasive if more types of “bad” images can be included in the test.
5.4 Further Research

Future study could include more visual elements such as tables and figures because the latter are quite popular in online courses especially for the majors of science and engineering. How do tables and figures impact E-learning outcomes differently from images? How do E-learners and previous studies define the “bad” tables or figures? If more visual elements are involved, the more persuasive evidence can be found from the research.

The learning styles should be taken into consideration in future study. Participants should be asked their learning style for the survey because visual elements may have a different impact on learning outcomes based on learning styles.
REFERENCES


Appleberry, J. B. (1992). Changes in our future: how will we cope? Faculty Speech Presented at California State University, Long Beach, California, August, 28, 1.


Chandler, S. B. (2001). Comparing the legibility and comprehension of type size, font selection and rendering technology of onscreen type. Faculty of the Virginia Polytechnic Institute and State University, Blacksburg, Virginia.


Sinatra, R. (1986). *Visual Literacy Connections to Thinking, Reading and Writing*. Charles C. Thomas, Publisher, 2600 South First St., PO Box 4709, Springfield, IL 62708-4709.


APPENDIX A

QUIZ QUESTIONS
1. The golden age in wood furniture making occurred during the reign of which emperor?
   A. Emperor Jiajian.      B. Emperor Kangxi.
   C. Emperor Qin Shihuang.  D. Emperor Qianlong.

2. Most of Ming dynasty furniture was made from red sandal wood. True or false?
   A. True.                B. False.

3. Huanghuali wood was chosen for furniture because of which feature?
   A. Durability and color.  B. Flexibility and resistance to distortion.
   C. Resistance to water and texture.  D. Hardness and quality of grain.

4. Huanghuali wood was used in the Ming Dynasty. In which part of China did it grow?
   A. East.                B. West.
   C. South.               D. North.

5. Which function allows the Huanghuali wood chair to fold conveniently?
   A. It is small in size.  B. There is a pivot in each of the legs.
   C. It can be disassembled easily.  D. Not mentioned in the text.

6. Some Ming style furniture has a part called "Chong", which represents promoting a higher position step by step. True or false?
   A. True.                B. False.

7. In Ming dynasty, the furniture style is complicated. True or false?
   A. True.                B. False.

8. There are only 3 categories of chairs in Ming Dynasty. True or false?
   A. True.                B. False.
9. Red Sandal wood replaced Huanghuali wood because of ____?

A. Deforestation of Huanghuali wood.  
B. Glass making skill was introduced to China.  
C. Red Sandal wood is more previous.  
D. People in the Qing Dynasty prefer a darker color.
APPENDIX B

SURVEY QUESTIONS
1. Approximately how much time did you spend doing this online activity?
   A. Less than 10 minutes.  
   B. 10~20 minutes.  
   C. 20~30 minutes.  
   D. 30~40 minutes.  
   E. More than 40 minutes.

2. To what degree did the text in each slide help you in the learning process?
   A. None.  
   B. Little.  
   C. Somewhat.  
   D. Much.  
   E. A Great Deal.

3. For online activities that included images, please rank order the images according to the effectiveness in understanding the content of each slide. The least effective images should be first; the most effective should be last.
   A. Images with the wrong colors.  
   B. Images that are pixelated.  
   C. Images appearing in different locations.  
   D. Images that are rotated.  
   E. Images that are too small in size.

4. For online activities that included images, to what degree did the image help you in learning process?
   A. None.  
   B. Little.  
   C. Somewhat.  
   D. Much.  
   E. A Great Deal.

5. How much do you think you’ve learned from this course?
   A. None.  
   B. Little.  
   C. Somewhat.  
   D. Much.  
   E. A Great Deal.

6. How were you satisfied with this online learning experience?
   A. Dissatisfied.  
   B. Neither satisfied nor dissatisfied.  
   C. Satisfied.  
   D. Very Satisfied.  
   E. Extremely Satisfied.
APPENDIX C

PARTICIPANTS INFORMATION
<table>
<thead>
<tr>
<th>Participants</th>
<th>Gender</th>
<th>Age</th>
<th>Educational Degree</th>
<th>Major</th>
<th>Previous Experience with E-learning (Yes or No Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P 1</td>
<td>F</td>
<td>26</td>
<td>Master</td>
<td>Communication</td>
<td>N</td>
</tr>
<tr>
<td>P 2</td>
<td>F</td>
<td>23</td>
<td>Bachelor</td>
<td>Accounting</td>
<td>Y</td>
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</tr>
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<td>Master</td>
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<td>Education</td>
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<td>J.D.</td>
<td>Justice</td>
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<td>Master</td>
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<td>Industrial Design</td>
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<tr>
<td>P 23</td>
<td>M</td>
<td>26</td>
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APPENDIX D

PROTOTYPES OF E-LEARNING SYSTEMS
Chinese Chairs

Please Record The Time For Learning The Context

Back to Home
Introduction

With a long and honored history, the Chinese furniture making became unique characteristics in the Ming Dynasty (1368-1644). The furniture of the Ming Dynasty was inspired from the Han Dynasty to the early Ming Dynasty (1368-1424). An important feature of Ming Dynasty is the beautifully-shaped furniture. The furniture is simple and clean, a sense of stability. The size and proportion of the different parts adhere to aesthetic principles but also take practicality of use into consideration. It combines aesthetics, mechanics and practical usefulness into one integral style.

Lesson 1

In China, wood furniture was developed between the Tang and Yuan Dynasty. Beginning with the Ming dynasty, the Chinese government imported large amounts of precious wood from Southeast Asia, bringing furniture-making skills by which have been called the golden age in an era when Ming Emperor Jianshun was in power.

Lesson 2

During the Ming Dynasty, a great deal of wooden furniture made with exquisite use of Huanghuali wood, which grows mainly in Hainan Province, Hainan Province is on the south part of China. Huanghuali wood was chosen for its flexibility and for its resistance to distortion.

Lesson 3

Huanghuali wood has been used for the legs. The Huanghuali wood sometimes shown lies as a folding chair. There is a joint in each of the legs allowing for assembly.

Lesson 4

Some legs of Ming Dynasty chairs havexekor projections under their legs. These are called "Ding". The "Ding" in the front of the Ming Dynasty chair generally lower than the one at the back. This difference represents being able to sit, step, step and sit.

Lesson 5

The decoration associated with Ming Dynasty furniture is unique. For example, the legs usually have pierced carvings with floral designs on the lower part. If the left one is pushed, the right one will come, well and vice versa.

Lesson 6

Although there are many categories of chairs in the Ming Dynasty, only three types of chairs are well-known.

1. The ant chair
2. The back branch chair folding back
3. The official test armchair

Lesson 7

Huanghuali wood was replaced with red sandalwood in the middle of the Qing Dynasty. The sandalwood carving became the decoration, which is the Ming Dynasty and the Qing Dynasty. The sandalwood carving is mainly focused on Huanghuali wood. Moreover, the sandalwood carving is free to interpret the times. Huanghuali wood is constructed by wood and paper for plains. As a result, interior decoration and more detailed wood carving, which allowed people to appreciate sandalwood’s dark red color.

Lesson 8

During the Qing Dynasty, chairs became larger and with more decoration than during the Ming Dynasty. The back of the Qing Dynasty chair is upright, instead of the Ming Dynasty.

Group 2 (text and “bad” images)
Chinese Chairs

Ancient Chinese Chairs

Introduction
With a time honored history, the craft of furniture making became a unique characteristic in the Ming Dynasty (1368-1644). Furniture of the Ming Dynasty style varies in form and decoration from the Ming Dynasty to the early Qing Dynasty (1644-1891). An important feature of Ming Dynasty is the beautifully shaped furniture. The furniture is simple yet concise in design and structure. The size and proportion of the different parts adhere to aesthetic principles but also take practicality of use into consideration. It combines aesthetics, mechanics, and practical use into one integral whole.

Lesson 1.
In China, wood furniture was developed between the Song and Yuan dynasties. Beginning with the Ming Dynasty, the Chinese government imported large amounts of precious wood from Southeast Asia, bringing furniture-making skills to what has been called the golden age in an era when Ming Emperors also vied for power.

Lesson 2.
During the Ming Dynasty, a great deal of wooden furniture made with exquisite carving designs and wooden legs was typical. Wood grows mainly in Henan Province. Henan Province is in the south part of China. Hardwood wood was chosen for its flexibility and for its resistance to distortion.

Lesson 3.
The Chinese lingzhi bed, now rare, was a type of bed in which the bed frame was a giant mushroom straw and the mattress was a giant mushroom. Its design is simple yet graceful.

Lesson 4.
Some Ming or Qing dynasty chairs have wooden arms, while others have metal arms. In the Ming Dynasty, the chair was placed in a room. The front of the Ming dynasty chair is usually lower than the rear. This difference represents being a different life step by step.

Ming Emperor Zajian

China

Wooden Chair

Ming Dynasty Chair

Ming Dynasty Chair
Group 3 (text and “good” images)

Chinese Chairs

Ancient Chinese Chairs

Introduction:
With a long history, the craft of furniture making became unique characteristics in the Ming Dynasty (1368-1644). Furniture of the Ming Dynasty style refers to furniture from the Ming Dynasty to the Sui Dynasty (1644-1911). An important feature of Ming Dynasty furniture is its simplicity and elegance. The design and proportion of the different parts adhere to aesthetic principles but also have practicality in use. This is considered to be a balanced and practical use of natural materials.

Lesson 1:
In China, wood furniture was developed between the Sui and Tang Dynasties. Beginning with the Ming Dynasty, the Chinese government imported large amounts of precious wood from Southeast Asia. The Ming Dynasty is known for its fine woodcarving skills, which have been passed down through the ages.

Lesson 2:
During the Ming Dynasty, a great deal of wicker furniture made with durable wood was exported to Southeast Asia, which became popular in the late Ming Dynasty. Today, many of these wicker furniture pieces are still in use and highly valued.

Lesson 3:
During the Ming Dynasty, the design of furniture was simplified. The use of natural materials became more common, and the furniture design was more practical and functional.
Lesson 3:

Huanghuali folding hornback armchair. The Huanghuali wood armchair shown is a new folding chair. There is a pivot at each of the legs allowing the back to swivel and the back is simple yet graceful.

Lesson 4:

Some Ming or Qing dynasty chairs have wooden seats under three legs. These are called “Chong.” The “Chong” on the front of the Ming dynasty chairs is usually lower than the rear of the back. This difference represents being aotton We, stop by stop.

Lesson 5:

Huanghuali wood was replaced with red sandalwood in the middle of the Qing Dynasty. One reason was the denigration during the Qing Dynasty and the future extinction of Huanghuali wood. Meanwhile, European glass work then introduced to China, leading to traditional window construction changing from wood and paper into glass. As a result, interior light became better than ever, which allowed people to appreciate ornate woodwork with red color.

Lesson 6:

During the Qing Dynasty, chair legs became larger and with more decoration than during the Ming dynasty. The back of the Qing dynasty chair is straight, instead of the Ming’s S-shape.
APPENDIX E

INITIAL DATA
Data of Quiz

1. The golden age in wood furniture making occurred during the reign of which emperor?

*Group 1:*

- A. Emperor Jiajing
- B. Emperor Kangxi
- C. Emperor Qin Shihuang
- D. Emperor Qianlong

*Group 2:*

- A. Emperor Jiajing
- B. Emperor Kangxi
- C. Emperor Qin Shihuang
- D. Emperor Qianlong

*Group 3:*

- A. Emperor Jiajing
- B. Emperor Kangxi
- C. Emperor Qin Shihuang
- D. Emperor Qianlong
2. Most of Ming dynasty furniture was made from red sandal wood. True or false?

*Group 1:*

![Bar Chart]

*Group 2:*

![Bar Chart]

*Group 3:*

![Bar Chart]
3. Huanghuali wood was chosen for furniture because of which feature?

*Group 1:*

- A. Durability and color.
- B. Flexibility and resistance to distortion.
- C. Resistance to water and texture.
- D. Hardness and quality of grain.

*Group 2:*

- A. Durability and color.
- B. Flexibility and resistance to distortion.
- C. Resistance to water and texture.
- D. Hardness and quality of grain.

*Group 3:*

- A. Durability and color.
- B. Flexibility and resistance to distortion.
- C. Resistance to water and texture.
- D. Hardness and quality of grain.
4. Huanghuali wood was used in the Ming Dynasty. In which part of China did it grow?

*Group 1:*

- A. East.
- B. West.
- C. South.
- D. North.

*Group 2:*

- A. East.
- B. West.
- C. South.
- D. North.

*Group 3:*

- A. East.
- B. West.
- C. South.
- D. North.
5. Which function allows the Huanghuali wood chair to fold conveniently?

*Group 1:*

A. It is small in size.

B. There is a pivot in each of the legs.

C. It can be disassembled easily.

D. Not mentioned in the text.

*Group 2:*

A. It is small in size.

B. There is a pivot in each of the legs.

C. It can be disassembled easily.

D. Not mentioned in the text.

*Group 3:*

A. It is small in size.

B. There is a pivot in each of the legs.

C. It can be disassembled easily.

D. Not mentioned in the text.
6. Some Ming style furniture has a part called "Chong", which represents promoting a higher position step by step. True or false?

Group 1:

A. True.

B. False.

Group 2:

A. True.

B. False.

Group 3:

A. True.

B. False.
7. In Ming dynasty, the furniture style is complicated. True or false?

*Group 1:*

![Bar chart for Group 1]

*Group 2:*

![Bar chart for Group 2]

*Group 3:*

![Bar chart for Group 3]
8. There are only 3 categories of chairs in Ming Dynasty. True or false?

*Group 1:*

- A. True.
- B. False.

*Group 2:*

- A. True.
- B. False.

*Group 3:*

- A. True.
- B. False.
9. Red Sandal wood replaced Huanghuali wood because of ___?

*Group 1:*

A. Deforestation of Huanghuali wood.
B. Glass making skill was introduced to China.
C. Red Sandal wood is more precious.
D. People in the Qing Dynasty prefer a darker color.

*Group 2:*

A. Deforestation of Huanghuali wood.
B. Glass making skill was introduced to China.
C. Red Sandal wood is more precious.
D. People in the Qing Dynasty prefer a darker color.

*Group 3:*

A. Deforestation of Huanghuali wood.
B. Glass making skill was introduced to China.
C. Red Sandal wood is more precious.
D. People in the Qing Dynasty prefer a darker color.
Data of Survey

10. Approximately how much time did you spend doing this online activity?

**Group 1:**

- **Less than 5 minutes:** [Bar chart showing distribution]
- **5-10 minutes:** [Bar chart showing distribution]
- **10-20 minutes:** [Bar chart showing distribution]
- **20-30 minutes:** [Bar chart showing distribution]
- **More than 30 minutes:** [Bar chart showing distribution]

**Group 2:**

- **Less than 5 minutes:** [Bar chart showing distribution]
- **5-10 minutes:** [Bar chart showing distribution]
- **10-20 minutes:** [Bar chart showing distribution]
- **20-30 minutes:** [Bar chart showing distribution]
- **More than 30 minutes:** [Bar chart showing distribution]

**Group 3:**

- **Less than 5 minutes:** [Bar chart showing distribution]
- **5-10 minutes:** [Bar chart showing distribution]
- **10-20 minutes:** [Bar chart showing distribution]
- **20-30 minutes:** [Bar chart showing distribution]
- **More than 30 minutes:** [Bar chart showing distribution]
11. To what degree did the text in each slide help you in the learning process?

**Group 1:**

![Bar chart for Group 1]

**Group 2:**

![Bar chart for Group 2]

**Group 3:**

![Bar chart for Group 3]
12. For online activities that included images, please rank order the images according to the effectiveness in understanding the content of each slide. The least effective images should be first; the most effective should be last.

**Group 1:**

![Image 1](image1)

**Group 2:**

![Image 2](image2)
13. For online activities that included images, to what degree did the image help you in the learning process?

**Group 1:**

**Group 2:**
14. How much do you think you’ve learned from this course?

Group 1:

Group 2:

Group 3:
15. How were you satisfied with this online learning experience?
Group 3:
APPENDIX F

ASU IRB ID NUMBER
EXEMPTION GRANTED

Jacques Giard The Design School 480/965-1373 JACQUES.GIARD@asu.edu

Dear Jacques Giard:

On 1/2/2014 the ASU IRB reviewed the following protocol:

<table>
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<th>Type of Review:</th>
<th>Initial Study</th>
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<tr>
<td>Title:</td>
<td>The Role of Visual Elements In Online Education</td>
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<tr>
<td>Investigator:</td>
<td>Jacques Giard</td>
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<td>• consent.pdf, Category: Consent Form; • Questions 2.docx, Category: IRB Protocol; • Jacques Giard, Category: IRB Protocol;</td>
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The IRB determined that the protocol is considered exempt pursuant to Federal Regulations 45CFR46 (2) Tests, surveys, interviews, or observation on 1/2/2014.

In conducting this protocol you are required to follow the requirements listed in the INVESTIGATOR MANUAL (HRP-103).

Sincerely,

IRB Administrator

cc: Yanfei Wang