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# A Study on Illustration Design in Learning Infant Development

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Abstract: This study aims to explore the effect dynamic and static illustrations design of infant multimedia materials in learners' visual behaviors and learning outcomes. An eye-tracking experiment was conducted with purposive sampling of 20 volunteers in Taiwan. The participants were randomly assigned to either static group or animation group. Mann–Whitney U test and Pearson's correlation analyses were used to analyze the data. The preliminary results showed that the static group had significant higher scores than the animation group on immediately posttest. Besides, there has high significantly in the area of interest, except the middle title and the illustrations (subtitle & text content) reading time and fixation count of the static group is more than the dynamic group. Although no significant relationships were found between visual behaviors and posttest in dynamic group, some significant correlations were found between visual behaviors and learning effectiveness in static group. More details results are discussed in the paper.

Keywords: eye-tracking, selective attention, multimedia design, visual behavior

## 1. Introduction

Technological development enables educational systems to create and combine enormous amounts of different learning materials. Besides compressing the complex content, its can combine with different multimedia objects, such as pictures, sounds, text, animation, etc., making teaching material more lively and interesting. However, although these designs satisfy human sensory needs and increase learning contexts, but teachers nowadays often use auxiliary content to supplement their course contents, such as charts and illustrations. Different presentations support textual information and to some degree facilitate learning interest, learning motivation and thus expanding the attention span. Previous study (Mayer, 2005) showed that learners who learned with textual and pictorial representations had better performance than those who learned with textual only information. Whether the learning contents are presented in hard copy or multimedia format, images have some particular functions to assist learners achieving a positive effect on learning (Carney & Levin, 2002). Duchastel (1978) held a similar view saying that illustrations could attract attention, explain, and enhance memory. However, Vernon (1953) suspects that illustrations may distract learners' attention from the text and affect learning. Atkinson & Mayer (2004) pointed out that pictures have the function and potential to enhance learning, but improper decorative or layout designs were not helpful in learning. The results of the above studies are not consistent, so it is necessary to understanding of the learning effect of illustrations is not easy. Therefore, this study mainly explores the effect of visual-based multimedia teaching materials design with decorative illustrations on learning effect.

In addition, many studies related to multimedia learning were evidenced through the learning outcomes, and seldom concerned about learning strategies in depth. This study produces a detailed account of changes in the learner's visual perception through eye tracking software, which include their attention distribution characteristic in the specific area and browsing behavior. The expected research results provide suggestions for the design of future multimedia teaching materials.

### *1.1. Selective Attention and Redundancy Effect*

In the modern age which information explodes, human beings have to face a lot of information in daily life, so how to choose the information is very important. Selective attention helps us determine the importance of external stimuli and filter unnecessary or less importance information before the brain starts processing. In addition to stimulating their own physical characteristics factors, human beings' interest, motivation and cognitive strategies for receiving stimuli can also influence the process of attention selection (Mesulam, 2000). Because selective attention contains the process of filtering external information, it plays an important role of people's learning and development. The scholar advocate that people cannot control attention by themselves, they manage attention by visual features. For example, a red ball in a group of green balls always attracts human attention. When the red object is the task target, it can improve the search efficiency. Conversely, when the object is not a task target, it will be an interference information of "attentional capture" (Theeuwes, 1994).

Therefore, the decoration of teaching materials is also a source of cognitive load on learning. When students face multiple sources of information, even if each piece of information is clear and concise, the amount of cognitive load on their working memory will cause a redundancy effect which lowers their learning achievement. The redundancy principle comes from Richard E. Mayer's seminal Multimedia Learning (Mayer,2001) and states that "people learn better from graphics and narration than from graphics, narration and on-screen text."

### *1.2. The effect of illustration on learning*

Students likely have been heavily exposed to PowerPoint in their school education. Although PowerPoint presentations can be created in a variety of formats, a majority of faculty members rely solely on traditional PowerPoint, in which slides are filled with bullet points and excessive wordiness that may lead to student boredom and fatigue during lectures, so often with illustrations.

According to Levin's five functions that pictures serve in text processing—five functions: decoration, representational, organizational, interpretational and transformational. Briefly, decoration pictures simply decorate the page, bearing little or no relationship to the text content. (Levin et al., 1987). Learning benefits occur when pictures and text provide congruent, or supporting, information.

Decorational illustrations may help to make the text more attractive or more marketable, but they are unlikely to enhance desired outcomes related to understanding, remembering, or applying the text content.

Some studies indicate that illustrations have no effect on learning, probably the students did not get into the habit of observing the illustrations. So, most of the school learning is delivered through verbal or text, illustrations are dispensable, and students do not pay attention to the illustrations when they read.

### *1.3. Eye movement*

In the beginning of 1990's, visual attention application of reading and information processing eye movement research developed gradually. The eye is one of the most important sensory sources when humans receive message, and most of the messages in the message processing process are visually obtained. In recent years, eye-tracking has become one of the useful tool to explore cognitive processing and provide effective eye movement data (Rayner, 1998; Radach & Kennedy, 2004; Rayner, Chace, Slattery, & Ashby, 2006). Rayner (1998) indicated that researchers can understand learners' reading processing and learning process with the eye movement.

## 2. Purpose

The purpose of this study was explore the effect of multimedia illustrations designed with PowerPoint learning achievement and attention distribution, a pilot eye tracking examination was used in this study. Particularly, this study explored how two different designs of multimedia illustrations in the PowerPoint (i.e., static illustration and dynamic illustration) effect learning performance (i.e., posttests for infant development) and visual behavior? (i.e., percentage of reading time in zone,

percentage of total fixations, and percentage of fixation duration in zone). The research questions are as following:

- RQ1: What are the effects of multimedia illustrations design between static and dynamic illustrations in infant development materials on students' learning achievement?
- RQ2: What are the effects of multimedia illustrations design between static and dynamic illustrations in infant development materials on students' attention distribution?
- RQ3: Are there any relationships between learning achievement and distribution of attention when looking at static or dynamic illustrations in multimedia learning material?

## 3. Methods

### *3.1. Participants*

Twenty participants were selected from a university of Taiwan in this study. Most of them have no prior knowledge about human development. The number of participants in each group is ten. Participants in static group read the learning material static illustrations, while participants in dynamic group read the learning content with dynamic illustrations.

### *3.2. Instruments*

#### *3.2.1. Background Questionnaire*

The Background Questionnaire was developed to realize participants' major, age, gender, the experiences, attitude of multimedia learning and whether the participants have experiences in learning infant development.

#### *3.2.2. Posttest*

The asked questions were created from the learning material to determine how the extent participants have. Furthermore, the given answers were also taken as references to understand the effect on short-term memory through learning.

#### *3.2.3. Eye-Tracking system*

FaceLab 4.5 with a sampling rate of 60 Hz was used to record participants' eye-movements during the reading process. The system uses infrared lights and two cameras to identify six facial features to determine where on the screen the eyes were focused on. Gazetracker full 10.0 was used to analyze eye movement data.

#### *3.2.4. Learning material*

The learning material in this study was about infant development. Illustrations were presented in different modes as two versions of learning materials: dynamic illustration and static illustration. Each participant read the same content, but illustration design has different with dynamic and static. The purpose of this study is to explore the effects of multimedia illustrations on student's distribution of attention and learning

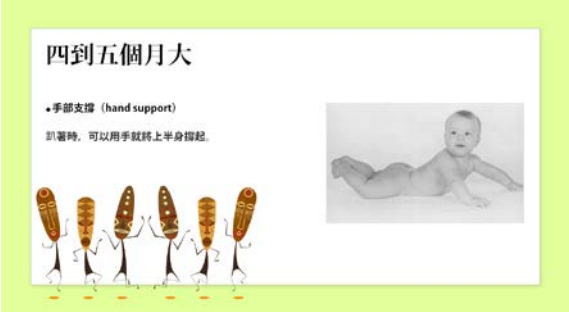


Figure 1. Material for the static group.

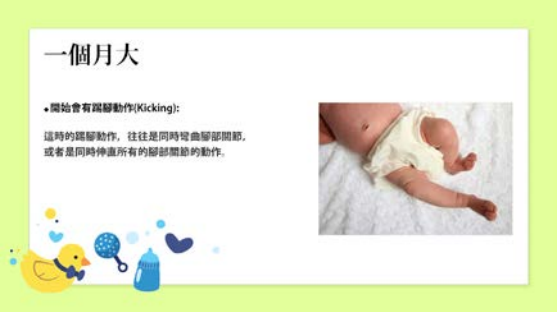


Figure 2. Material for the dynamic group.

## 4. Results

### *4.1. Results of Mann–Whitney U test result on posttest scores*

As shown in table 1, the result showed that there is a significant difference between static and animation group in terms of posttest scores ($p$ = .015), the participants in static group got higher scores (Mean = 10.00) than the participants in animation group (Mean = 8.50).

Table 1: Results of Mann–Whitney U test on posttest scores between static and dynamic group.

| | Static group (N=10) | | Animation group (N=10) | | z | *p* |
|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | | |
| Posttest | 10.00 | 1.33 | 8.50 | 1.43 | -2.44 | .015 |

*$p$ < 0.1, **$p$ < 0.05, ***$p$ < 0.01

### *4.2. Results of Mann–Whitney U test result of visual behavior*

Table 2 shows that different group Mann–Whitney U test result of reading behavior and the result demonstrated that there is a significant difference in the area of interest, except the middle title and the illustrations (subtitle & text content) reading time and fixation count static group is more than the dynamic group.

Table2: Results of Mann–Whitney U test on visual behavior between Static and dynamic group.

| | | Static group (N=10) | | Animation group (N=10) | | z | *p* |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD | | |
| MT | PFDtiz(%) | .70 | .07 | .78 | .09 | -2.12 | .034 |
| ST | PFD(%) | .03 | .01 | .02 | .01 | -2.35 | .019 |
| C | PRT(%) | 39.18 | 8.11 | 30.78 | 6.86 | -2.27 | .023 |
| | PFC(%) | 44.60 | 7.92 | 32.20 | 7.95 | -2.65 | .008 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | PFD(%) | .44 | .09 | .33 | .07 | -2.80 | .005 |
| SA | PFDtiz(%) | .65 | .22 | .97 | .13 | -3.03 | .002 |

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$

Note: MT=Middle Title, ST= Subtitle, C= Content, SA=Static illustration & AnimationPFDtiz= Percentage of fixation duration in zone, PFD=Percentage of fixation duration, PRT=Percentage of reading time in zone, PFC=Percentage of Fixation Count

### *4.3. Correlation between Visual behavior and posttest*

As shown in Table 3, there are significant correlations among the posttest and the eye-tracking measures of static group, but animation group is not.

Table 3: Correlation between visual behavior and posttest of static group

| | PRT of MT | PFC of MT | PFD of MT | PRT of Content | PFC of Content | AFD of Content | PFD of Content |
|---|---|---|---|---|---|---|---|
| Posttest | .633* | .668* | .657* | -.851** | -.789** | -.663* | -.803** |

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$

Note: MT=Middle Title, C= Content, PFD=Percentage of fixation duration, PRT=Percentage of reading time in zone, PFC=Percentage of Fixation Count, AFD=Average fixation duration (sec)

## 5. Discussion and conclusion

This study aims to investigate the correlation between visual behaviors and performance during the process of reading the dynamic and static illustrations design of infant multimedia materials. In sum, according to the results, the participants in static group got higher scores than the participants in animation group, which means that when the materials are in a redundant state, dynamic illustrations seem to have impact on learners. In another aspect, text content shows negative correlation with the posttest, which means that learners may not be able to understand the explanatory pictures immediately, so they need to spend much more time dealing with the text content, but may not bring positive effect in limited time. The opposite of middle title had positive correlation with the posttest, the title is mainly show the timing of infant development, which means that to some extent, it seems that remember the development timing will help post-test results.

The first research question asked the effects of multimedia illustrations design between static and dynamic illustrations in infant development materials on students' learning achievement. The result from Mann–Whitney U test showed that participants have better grades in static group. This might imply that static illustrations had less interference than dynamic ones. Lowe (2003) showed that novices were more likely distracted by information with significant features in animation, and they had difficulties focusing on what was related to the subject of learning. Moreover, high-speed changes in the dynamic illustration caused cognitive over load.

The second research question asked effects of multimedia illustrations design between static and dynamic illustrations in infant development materials on students' attention distribution. The result from Mann–Whitney U test showed that the middle title and illustration gaze time of the dynamic group were longer than that in the static group. It might conjecture that dynamic illustrations are easier to attract learners' attention. The last research question asked is there any relationships between learning achievement and distribution of attention when looking at static or dynamic illustrations in multimedia learning material. The correlation analysis result showed that participants who put less attention on the content, the better learning performance they would have. A potential reason for the increase of duration may be due to lack of content knowledge, thus learners needed more time to browse and remember the slide content. According to "limited capacity model ", the longer fixation duration the greater consumption of cognitive resources, so if the more stuff you put in the more resources get allocated the more people, but the less they remember (Lang, 2000).

In this study, because the sample size of participants is small, future studies can enroll larger samples to get a deeper understanding of how the learners read. Future studies can examine the relationships between participants' cognitive load and visual attention by eye-tracking methods.

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