# COMPARISONS OF LEARNER-GENERATED VERSUS INSTRUCTOR-PROVIDED MULTIMEDIA ANNOTATIONS

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**ABSTRACT**
The purpose of this study was to explore the effectiveness of using learner-generated and instructor-provided multimedia annotations on foreign language reading comprehension and attitudes. The four research questions are: (1) what are the effects of using different multimedia annotations on reading comprehension for learners of different cognitive learning styles (field-dependent and field-independent)? (2) What are the effects of using different multimedia annotations on reading comprehension for learners with different learning abilities (higher-level and lower-level)? And (3) what are learners' attitudes toward using a multimedia annotation system? The results of this study are listed as follows: First, for reading comprehension, the learner-generated annotation group performed better than the instructor-provided group, no matter which cognitive learning style they were. Second, higher-level learners with learner-generated annotation performed better than those with instructor-provided annotation. However, the difference between lower-level learners with learner-generated annotation and those with instructor-provided annotation was not significant. Finally, learners had positive attitudes toward multimedia annotation use and thought text annotation was the most useful of the different types.

## INTRODUCTION

Annotation refers a note that is made while reading any form of text (Chen, Hwang, & Wang, 2012). The behavior of making marks on reading material is important in traditional learning activities (Hwang, Wang, & Sharples, 2005). There is a great deal of research showing that annotation can facilitate reading comprehension (Hwang, Wang, & Sharples, 2007; Pan, 2006; Sung, 2007), including that of second language (L2) learners (Widdowson, 1984). Roby (1999) divided annotation into two types: learner-generated and instructor-provided. Learner-generated annotation refers to annotations that are made by the learners themselves when they want to comprehend the reading texts. It can help remind them of the content or the significant points of the reading materials. However, learners may miss some important information or make mistakes while making annotations by themselves.

Instructor-provided annotation is made by experts or instructors. It provides an efficient way for learners to acquire unfamiliar but important knowledge more easily. The advantage of instructor-provided annotation is that it provides more comprehensive and more correct information about the texts. It can also help less-able learners perform better. The disadvantage of instructor-provided annotation is that the annotation provided by the professional may not induce learners' interest (Ariew & Ercetin, 2004; Akbulut, 2007a; Akbulut, 2007b; Akbulut, 2008; Chun, 2001; Saker & Ercetin, 2005).

With the rapid development of technology, language learners have many opportunities to receive online reading information as hypertext with multimedia via the Internet (Ariew & Ercetin, 2004). As a result, how readers can annotate online reading materials has attracted considerable interest. Previous researchers have attempted to provide multimedia annotation tools which enable readers to make marks on online reading materials. Multimedia annotation refers to computer-based applications that provide annotation through multiple types of hypermedia, such as text, audio, video, graphics, and animation (Sakar & Ercetin, 2005).

In terms of reading comprehension, there are many factors that influence learners' reading comprehension, including annotation types (Ariew & Ercetin, 2004; Akbulut, 2007a Saker & Ercetin, 2005; Akbulut, 2008), cognitive learning styles (Akbulut, 2007a; Akbulut, 2008; Salmani-Nodoushan, 2005; Vivaldo-Lima, 1997), and learners' reading proficiency ability (Ariew & Ercetin, 2004; Akbulut, 2007b).

For annotation types, some studies have shown that learner-generated multimedia annotation (Hwang, Wang & Sharples, 2007) or instructor-provided multimedia annotation (Lomicka, 1998; Sakar & Ercetin, 2005) have a positive influence on facilitating reading comprehension. Vivaldo-Lima (1997) pointed out that there was a

positive and highly important correlation between cognitive learning styles and reading comprehension. According to Salmani-Nodoushan (2005), cognitive learning styles can be divided into field-independence (FI) and field-dependence (FD). However, the result of Hwang, Wang and Sharples's (2007) study showed that there was no relationship between the quantity of annotation and the cognitive learning styles in multimedia reading environments. Proficiency level is also one of the predicators of reading comprehension in multimedia annotation learning environments (Ariew & Ercetin, 2004; Akbulut, 2007b). Hwang, Wang and Sharples (2007) pointed out that the students with higher-level ability made more annotations. However, Chun's (2001) study showed that although the higher-level students looked up fewer words than the lower-level students, the differences between the higher- and lower-level students were not significant.

To sum up, the studies which are available have revealed insufficient and inconclusive results regarding what types of multimedia annotations learners with different cognitive learning styles prefer to use, and what types of multimedia annotations facilitate reading comprehension. Thus, the purpose of the present study was to explore the effectiveness of using different multimedia annotations (learner-generated vs. instructor-provided) on English reading among different characteristics of learners (cognitive learning styles and reading proficiency levels). The specific research questions were as follows:

Q1 What are the effects of using different multimedia annotations on reading comprehension for learners of different cognitive learning styles?
Q2 What are the effects of using different multimedia annotations on reading comprehension for learners with different learning abilities?
Q3 What are learners' attitudes toward using a multimedia annotation system?

## RESEARCH BACKGROUND

### Reading and annotation

According to Brown (2007), reading ability will be developed best in association with appropriate reading strategies. Led by Goodman's (1970) work, bottom-up and top-down processing became two distinctive reading methodologies. In terms of bottom-up processing, readers must first recognize linguistic signals to decode the texts. The linguistic signals include letters, morphemes, syllables, words, phrases, grammatical cues, and discourse markers. On the other hand, top-down processing refers to the fact that readers draw on their intelligence and experiences to understand texts.

More recent research on reading has shown that a combination of bottom-up and top-down processing, what has been called the interactive reading model, is more appropriate (Akbulut, 2008; Chun & Plass, 1997). "This model takes into account the contribution of both text-driving features (i.e., decoding of the text) and reader-driving features (i.e., interpretation based on background knowledge). In such an approach, a weakness in one area can be compensated for in another area in successful reading" (Akbulut, 2008, p.40).

Multimedia annotation offers various types of annotation, such as text, sound, graphics, video, and animation (Chun, 2001), and one major feature is the fact that it is nonlinear (Yu, Pedrinaci, Dietze, & Domingue, 2012). This means that the information units are networked, and can be processed in various orders. These features conform to the features of bottom-up processing, top-down processing, and the interactive reading model (Yang, Zhang, Su, & Tsai, 2011). Thus, they facilitate the comprehension of the texts simultaneously.

### From traditional annotation to multimedia annotation

Traditional annotation means marks made by readers or professionals on reading matters (Hwang, Wang, & Sharples, 2007), which can be presented before or during reading (Hwang, Shadiev, & Huang, 2011). The major functions of traditional annotation are to provide textual information, such as definitions of words, and to offer extra information related to the topic of the text (Ariew & Ercetin, 2004). Because of the rapid development of the Internet and technology, more kinds of multimedia are emerging in traditional annotation (Chen, Hwang, & Wang, 2012; Su, Yang, Hwang, & Zhang, 2010). According to Akbulut (2008), multimedia annotation refers to computer-based applications that provide information in a nonlinear way through multiple types of annotation.

Regarding the comparison between traditional and multimedia annotation, some studies have indicated that multimedia annotation is more efficient than traditional annotation in terms of increasing learners' vocabulary size (Roby, 1991;Kim & Kim, 2012), and reading comprehension (Hwang, Wang, & Sharples, 2007; Lomicka, 1998). Chen (2009), Lomicka (1998) and Hwang, Wang, and Sharples (2007) showed that computerized reading with multimedia annotation promotes a deeper level of reading comprehension than no annotation or traditional annotation which provides only word definitions. Moreover, Lomicka (1998) claimed that those who had access to multimedia annotation generated a greater degree of ability in which learners connect events in a text at a local

or global level, and thereby demonstrate comprehension. The results of Chen's (2009) study indicated that students using video annotation perform significantly better on tests than those using picture annotation.

Multimedia annotation has a positive impact on L2 learning and teaching due to its integration of various media (Hwang, Wang, & Sharples, 2007; Pan, 2006; Sung, 2007). According to Sung (2007), multimedia annotation systems have made a great contribution to language learning. First of all, learners have great motivation while using them. They provide learners with an opportunity to use a microphone to record their audio annotation for the content of the learning materials. Such systems also let them make text annotations that can help them review the information they have learned. Moreover, the learners can post some graphics that they think can remind them of the important information.

**Theoretical frameworks for instructor-provided and learner-generated annotation**

**Table 1:** Comparison of Two Theories of Multimedia Annotation

| Theory | Instructor-provided annotation | Learner-generated annotation |
|---|---|---|
| Cognitive load theory | Providing annotation decreases the level of extraneous cognitive processing and allows generative processing. | Generating annotation increases the level of extraneous cognitive processing and limits generative processing. |
| Activity theory | Providing annotation does not encourage generative processing. | Generating annotation by learners encourages generative processing. |

Table 1 summarizes the rationale for instructor-provided annotation on the basis of cognitive load theory and the rationale for learner-generated annotation on the basis of activity theory (adopted from Stull & Mayer, 2007, p.810). According to cognitive load theory, instructor-provided annotation can encourage learners to engage in generative processing by challenging them to see how the linear text was annotated using different modes of annotation, such as text, graphics, and so on, through organizing it into a coherent structure (Plass, Moreno, Brünken, 2010). Thus, learners are less likely to waste cognitive capacity on extraneous processing. Not asking learners to generate annotation does not necessarily encourage generative processing, but rather frees cognitive capacity that can be used for generative processing. In contrast, learner-generated annotation creates extraneous cognitive processing in which learners must focus on how to create annotation themselves, so leaving less capacity for generative processing (Stull & Mayer, 2007). This is the cognitive load theory rationale for learning by viewing.

As for the activity theory rationale for learning by doing, it is based on the claim that learning occurs when learners are encouraged to engage in productive learning activity (de Jong, 2005; Kirschner, Sweller, & Clark, 2006; Klahr & Nigam, 2004; Lillard, 2005; Mayer, 2003, 2004). Constructing annotations by learners can be considered a productive learning activity because the learner must engage in an activity that is related to the instructional objective—making relevant annotations on the text and organizing them into a coherent structure. According to activity theory, learner-generated annotation encourages generative processing, whereas instructor-provided annotation does not. Activity theory predicts that learners who read a text in which they generate their own annotation will perform better on reading quizzes than those who read the text with instructor-provided annotation (Stull & Mayer, 2007). Even though learning by doing appears to be an active treatment, it can inhibit generative cognitive processing if learners become confused as to how to carry out the task. The complexity of the activity may create extraneous cognitive processing which reduces the amount of cognitive capacity available for generative processing.

## METHOD

### Participants

The participants were 93 students enrolled in two different sections of an English course at a mid-sized university in Taiwan. The two annotation treatments (learner-generated vs. instructor-provided) were each to be assigned to one intact class, but participants had already self selected the class at the beginning of the semester according to their preferences and individual needs.

In order to understand the participants' reading proficiency level, they were required to complete an English proficiency reading pre-test. And then, according to the scores of the test, those whose scores were lower than the average were classified as lower-level learners. Those whose scores were higher than the average were classified as higher-level learners. Participants were also asked to complete a Group Embedded Figures Test (GEFT) to identify whether their cognitive learning styles were field-independent (FI) or field-dependent (FD).

**Instruments**

**Reading material**

Three articles included in the high-intermediate proficiency level of an English magazine were selected as the reading materials in this research. The basic vocabulary size required for the readers was 3,000-5,000 words. The magazine was chosen as the teaching material not only in consideration of the articles being novel and lively, but also because they are graded to different English proficiency levels. It was not necessary for the learners to have any pre-knowledge of any specific domain before they could understand the articles.

**Pre and post English proficiency tests**

The purpose of the pre- and post-tests was to evaluate the subjects' English ability before and after they read the articles. There were 25 reading comprehension test items for each test. Participants whose pre-test scores were higher than the average scores were regarded as higher-level learners. However, those whose scores were lower than the average were regarded as lower-level learners. The reliability of the pre-test was .80. The difficulty level was .56 for the pre-test and .55 for the post-test.

The comprehension questions were meant to test learners' understanding of the implications, meanings, and structures presented. Four types of questions included in the proficiency tests were: (1) factual questions, (2) inference questions, (3) main idea questions, and (4) tone questions. Factual questions are empirical questions-how/why things occur? Unlike factual questions, inference questions do not test learners' knowledge of explicitly-cited facts, but rather their ability to draw conclusions from other information. Main idea questions ask the test taker to identify the passage's overall theme, as opposed to supporting facts and arguments. Tone questions usually ask what the author's tone is, but may occasionally ask for the author's attitude.

**Group embedded figures test** (GEFT)

The original GEFT test designed by WitKin et al. (1971) was utilized to measure the students' FI/FD cognitive learning styles in this study (Chen, 2005, p.42). The number of simple figures correctly identified on the last two sections constituted the scores ranging from 1 (strongly field dependent) to 18 (strongly field independent). Those whose scores were higher than the average scores of all participants were assigned as having an FI cognitive style, while those whose scores were lower than the average were assigned as having an FD cognitive style.

**HyperMedia Editor (HME) annotation software**

HyperMedia Editor (HME) is free annotation software designed by Thibeault (2001). Learners can not only use this software to make text annotations, but can also use it to make graphics, audio, video, and web-link annotations. These functions of HME make it easier for learners to review the content they have read, and also help learners to become familiar with the habit of using multimedia-based learning material. The participants received two points for making one annotation.

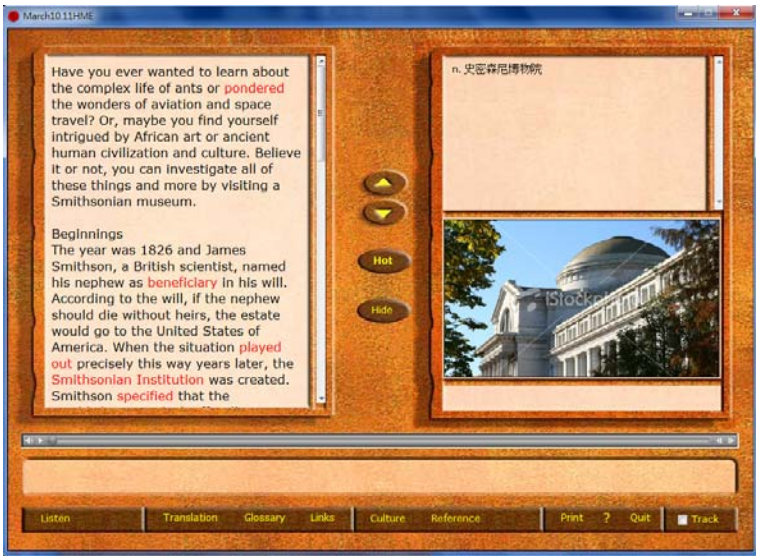


**Figure 1:** A screen shot showing the interface of HME annotation (adopted from Liu, Chuang, Chen, & Yang, 2010)

**Annotation assignments and rubric**

The participants in the learner-generated group had to use HME to make multimedia annotations for the three articles as annotation assignments, and then turned in the assignments in class. The highest possible score for each type of annotation (text, graphics, audio, video, and web-link) was 20 points, and the total score of the assignment was 100. The rubric for the annotation assignment is as below (adopted from Yang, 2010, p. 44):

**Table 2:** The Rubric of Annotation Scores

| Annotation type | points | Description |
|---|---|---|
| Text Annotation | 20 | Make one text annotation, get 2 points (make over 10 text annotations, get 20 points) |
| Graphic Annotation | 20 | Make one graphic annotation, get 2 points (make over 10 graphic annotations, get 20 points) |
| Audio Annotation | 20 | Make one audio annotation, get 3 points (make over 7 audio annotations, get 20 points) |
| Video Annotation | 20 | Make one video annotation, get 10% (make over 2 video annotations, get 20 points) |
| Web-link Annotation | 20 | Make one web-link annotation, get 4 points (make over 5 web-link annotations, get 20 points) |
| Total | 100 | |

**Annotation attitude questionnaire**

The questionnaire was revised from Pan's (2006) study, and included 40 items using a Likert five-point format (Strongly Agree, Agree, Undecided, Disagree, Strongly Disagree) and five personal information items. The main purpose of this questionnaire was to examine the learners' perceived usefulness ($N$ = 15), perceived ease of use ($N$ = 10), and learning satisfaction ($N$ = 15) regarding five functions of HyperMedia Editor (HME), namely text, graphic, audio, video, and web-link annotation, after the experiment.

This paper utilized the SPSS software package to analyze the reliability of the questionnaire. The results are shown in Table 3. From the results, Cronbach alpha values in all dimensions are higher than .70 (total = .98). This shows the reliability of the questionnaire is sufficiently high.

**Table 3:** Questionnaire dimension and the Cronbach alpha values

| # | Dimension | Cronbach alpha value |
|---|---|---|
| 1 | Perceived usefulness of HME | .95 |
| 2 | Perceived ease of use of HME | .94 |
| 3 | Learning satisfaction | .96 |
| Total Cronbach alpha value | | .98 |

**Procedure**

The experiment lasted for eight weeks. The English reading proficiency pre-test was administered in the first week to know participants' reading proficiency (higher-level vs. lower-level), and the result also confirmed that there was no significant difference in the pre-test for the two classes ($t$ = - .83, $p$ = .41). In the second week, the two classes were randomly assigned to the learner-generated annotation group and the instructor-provided annotation group. Both groups were asked to complete the Group Embedded Figures Test (GEFT) to know their cognitive learning styles (FI/FD). The third week took place in the computer lab and lasted two hours. After a one hour demonstration on how to operate the HyperMedia Editor (HME) annotation software, all participants were asked to practice using HME, and the learner-generated annotation group needed to practice how to make multimedia annotations for texts.

From the fourth to six weeks, the participants in the learner-generated annotation group were asked to read one article each week, use HME to make annotations, and then turn in their annotation assignment in class. For the instructor-provided annotation group, participants were asked to use HME to read one article each week in class for general comprehension with annotations provided by the researcher.

In the seventh week, a post-test was conducted in class to know participants reading comprehension of these three articles. The post-test took 20-30 minutes to complete. In the last week, all participants completed the Annotation Attitude Questionnaire to know their attitudes toward HME. Data were reported as means, ranks, and percentage of Likert scales for each annotation function.

## RESULTS

### Learner-generated annotation had positive effects on both cognitive style learners

To answer RQ1 - What are the effects of using different multimedia annotations (learner-generated vs. instructor-provided) on reading comprehension for learners of different cognitive learning styles (FI vs. FD)? The means and standard deviations for the different multimedia annotations of the learners of the different cognitive learning styles on the reading post-test are reported in Table 2.

**Table 4:** Descriptive Statistics of Participants' Reading Achievements by Annotation Type and Learning Style

| Learning style | Annotation type | *N* | *M* | *SD* |
|---|---|---|---|---|
| Field-independent | Learner-generated | 27 | 67.41 | 15.68 |
| | Instructor-provided | 30 | 44.40 | 18.95 |
| | Total | 57 | 55.91 | 17.32 |
| Field-dependent | Learner-generated | 17 | 62.35 | 20.15 |
| | Instructor-provided | 19 | 38.53 | 16.77 |
| | Total | 36 | 50.44 | 18.46 |

Two-way ANOVA was used to analyze the data to identify the interaction between using different multimedia annotations on reading comprehension for different cognitive learning style learners. Overall, the results revealed that learners with different learning styles had no significant difference in their reading achievements no matter what type of annotation they used ($F$ = .23, $p$ = .63). However, there is a significant difference between learners' reading achievements by annotation type ($F$ = 50.18, $p$ = .00*). The learner-generated annotation group performed better than the instructor-provided annotation group no matter which cognitive style the learners were.

**Table 5:** Results of Two-way ANOVA Analysis of Using Different Multimedia Annotation Types on Reading Comprehension for Learners of Different Learning Styles

| *Source* | *SS* | *df* | *MS* | *F* | *p* |
|---|---|---|---|---|---|
| Annotation Type | 9969.52 | 1 | 9969.52 | 50.18 | .00* |
| Learning Style | 53.88 | 1 | 53.88 | .27 | .60 |
| Annotation Type * Learning Style | 45.87 | 1 | 45.87 | .23 | .63 |
| Error | 17681.79 | 89 | 198.67 | | |
| Total | 269695.49 | 93 | | | |

*$p$ < .05

### Higher-level learners benefited more from learner-generated annotations

To answer RQ2 - What are the effects of using different multimedia annotations (learner-generated vs. instructor-provided) on reading comprehension for learners with different proficiency levels (higher-level vs. lower-level)? The means and standard deviations of the different proficiency level learners' performance on the annotation assignments by multimedia annotation type are reported in Table 5. The higher-level learners performed better than the lower-level learners no matter which multimedia annotation type they used.

**Table 6:** *Descriptive Statistics of Participants' Reading Achievement by Annotation Type and Proficiency Level*

| Ability | Annotation type | *N* | *M* | *SD* |
|---|---|---|---|---|
| Lower-level | Learner-generated | 37 | 41.71 | 18.02 |
| | Instructor-provided | 35 | 38.67 | 20.69 |
| | Total | 42 | 40.19 | 19.34 |
| Higher-level | Learner-generated | 37 | 69.95 | 13.45 |
| | Instructor-provided | 14 | 48.00 | 11.64 |
| | Total | 51 | 58.98 | 12.55 |

Two-way ANOVA analysis revealed that there was a significant interaction between the learners with different annotation types and proficiency levels ($F$ = 4.79, $p$ = .03*) (see Table 6). Learners with different proficiency levels had significant differences in their reading achievement when they used different types of annotation. The main effects of annotation type ($F$ = 12.09, $p$ = .00*) and proficiency level ($F$ = 23.45, $p$ = .00*) are also significant. By running the following two independent t-tests for learners with different proficiency levels, the results indicated that learner-generated annotation has more influence than instructor-provided annotation for higher-level learners on reading comprehension ($t$ = 5.38, $p$ = .00). However, there was no significant difference found for the lower-level learners.

**Table 7:** Results of Two-way ANOVA Analysis of Using Different Multimedia Annotation Types on Reading Comprehension for Learners of Different Proficiency Levels

| *Source* | *SS* | *df* | *MS* | *F* | *p* |
|---|---|---|---|---|---|
| Annotation Type | 1895.70 | 1 | 1895.70 | 12.09 | .00* |
| Ability | 3684.35 | 1 | 750.34 | 23.45 | .00* |
| Annotation Type * Ability | 750.34 | 1 | 156.82 | 4.79 | .03* |
| Total | 269695.49 | 93 | | | |

*$p < .05$

**Table 8:** Results of Independent Samples T-test: learning achievements of lower level

| | *Annotation type* | *N* | *M* | *SD* | *t* | *p* |
|---|---|---|---|---|---|---|
| Lower-level | Learner-generated | 37 | 41.71 | 18.02 | .36 | .72 |
| | Instructor-provided | 36 | 38.67 | 20.69 | | |
| Higher-level | Learner-generated | 37 | 69.95 | 13.45 | 5.38 | .00* |
| | Instructor-provided | 14 | 48.00 | 11.64 | | |

*$p < .05$

**Participants favored text annotation than others**

Regarding the perceived usefulness part, the main purpose of the questionnaire was to explore participants' attitudes toward the usefulness of HME, including the text, graphic, audio, video, and web-link annotations. The results show that the participants thought the "text" (*M*=3.36), "audio" (*M*=3.35), and "graphic" (*M*=3.33) annotations made their reading more effective during the online reading process. As for their reading performance, the participants thought the "text" (*M*=3.50), "video" (*M* =3.44), and "graphic" (*M*=3.42) annotations did improve it.

**Table 9:** Analysis of Perceived Usefulness of HME

| Annotation Function | *M* | Rank | SD 1 | D 2 | U 3 | A 4 | SA 5 |
|---|---|---|---|---|---|---|---|
| Q (1.4.7.10.13): I think the annotation makes reading online become more effective. | | | | | | | |
| Text | 3.36 | 1 | 3.5% | 8.1% | 41.9% | 41.9% | 4.7% |
| Graphic | 3.33 | 3 | 1.2% | 10.5% | 47.7% | 36.0% | 4.7% |
| Audio | 3.35 | 2 | 2.3% | 12.8% | 41.9% | 33.7% | 9.3% |
| Video | 3.23 | 4 | 0.0% | 15.1% | 51.2% | 29.1% | 4.7% |
| Web-link | 3.17 | 5 | 1.2% | 19.8% | 45.3% | 27.9% | 5.8% |
| Q (2.5.8.11.14): I think the annotation was useful during my online reading process. | | | | | | | |
| Text | 3.49 | 1 | 2.3% | 8.1% | 36.0% | 45.3% | 8.1% |
| Graphic | 3.40 | 2 | 2.3% | 8.1% | 44.2% | 38.4% | 7.0% |
| Audio | 3.40 | 2 | 2.3% | 14.0% | 32.6% | 43.0% | 8.1% |
| Video | 3.40 | 2 | 0.0% | 11.6% | 44.2% | 37.2% | 7.0% |
| Web-link | 3.23 | 3 | 1.2% | 16.3% | 44.2% | 34.9% | 3.5% |
| Q (3.6.9.12.15): I think the annotation did improve my online reading performance. | | | | | | | |
| Text | 3.50 | 1 | 1.2% | 8.1% | 36.0% | 48.8% | 5.8% |
| Graphic | 3.42 | 3 | 1.2% | 8.1% | 44.2% | 40.7% | 5.8% |
| Audio | 3.36 | 4 | 2.3% | 12.8% | 39.5% | 37.2% | 8.1% |
| Video | 3.44 | 2 | 0.0% | 8.1% | 45.3% | 40.7% | 5.8% |
| Web-link | 3.26 | 5 | 2.3% | 15.1% | 45.3% | 29.1% | 8.1% |

*Note.* SA: strongly agree; A: agree; U: undecided; D: disagree; SD: strongly disagree.

Regarding the results of perceived ease of use of annotation, most of the participants considered that "text", "graphic", and "video" can all be used without training and are easy to use (M > 3.40).

**Table 10:** Analysis of Perceived Ease of Use of HME

| Annotation Function | *M* | Rank | SD 1 | D 2 | U 3 | A 4 | SA 5 |
|---|---|---|---|---|---|---|---|
| Q (16.18.20.22.24): I think people can use the annotation without training. | | | | | | | |
| Text | 3.45 | 1 | 3.5% | 12.8% | 30.2% | 41.9% | 11.6% |
| Graphic | 3.43 | 2 | 1.2% | 10.5% | 40.7% | 39.5% | 8.1% |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Audio | 3.35 | 4 | 2.3% | 18.6% | 30.2% | 39.5% | 9.3% |
| Video | 3.40 | 3 | 0.0% | 14.0% | 40.7% | 37.2% | 8.1% |
| Web-link | 3.31 | 5 | 1.2% | 18.6% | 36.0% | 36.0% | 8.1% |
| Q (17.19.21.23.25): I think the annotation was easy to use. | | | | | | | |
| Text | 3.44 | 2 | 5.8% | 10.5% | 30.2% | 40.7% | 12.8% |
| Graphic | 3.49 | 1 | 1.2% | 8.1% | 41.9% | 38.4% | 10.5% |
| Audio | 3.34 | 4 | 2.3% | 16.3% | 34.9% | 38.4% | 8.1% |
| Video | 3.40 | 3 | 0.0% | 17.4% | 34.9% | 38.4% | 9.3% |
| Web-link | 3.33 | 5 | 1.2% | 18.6% | 34.9% | 37.2% | 8.1% |

*Note.* SA: strongly agree; A: agree; U: undecided; D: disagree; SD: strongly disagree.

The learning satisfaction part mainly explored participants' interest, their satisfaction with their learning achievements, and their satisfaction with the interaction in terms of the five annotation functions of HME (text, graphic, audio, video, and web-link annotation). Most of the participants thought that the "graphic" (*M*=3.53), "text" (*M*=3.45), and "video" (*M*=3.44) annotations used in this class did increase their interest in the reading materials. They also experienced more happiness in their learning.

For improving learners' reading achievements and the interaction between learners and the content of the materials, materials with "text", "video", and "graphic" annotations were considered useful. Text annotation was the most popular. The ease of use of text, graphic, and video annotation may be the reason for the result that they were the top three popular kinds of annotation while reading online. On the other hand, audio annotation was considered the least useful.

**Table 11:** Analysis of Learning Satisfaction

| Annotation Function | *M* | Rank | SD 1 | D 2 | U 3 | A 4 | SA 5 |
|---|---|---|---|---|---|---|---|
| Q (26.29.32.35.38): Compared with those online materials that did not provide annotation mechanisms, materials with annotation used in this class did increase my interest in the materials. I experienced more happiness in learning. | | | | | | | |
| Text | 3.45 | 2 | 1.2% | 9.3% | 40.7% | 40.7% | 8.1% |
| Graphic | 3.53 | 1 | 0.0% | 10.5% | 36.0% | 43.0% | 10.5% |
| Audio | 3.33 | 5 | 1.2% | 16.3% | 39.5% | 34.9% | 8.1% |
| Video | 3.44 | 3 | 0.0% | 10.5% | 41.9% | 40.7% | 7.0% |
| Web-link | 3.37 | 4 | 0.0% | 14.0% | 40.7% | 39.5% | 5.8% |
| Q (27.30.33.36.39): Compared with those online materials that did not provide annotation mechanisms, materials with annotation used in this class did improve my learning achievements. | | | | | | | |
| Text | 3.53 | 1 | 0% | 9.3% | 34.9% | 48.8% | 7.0% |
| Graphic | 3.43 | 3 | 0% | 12.8% | 41.9% | 34.9% | 10.5% |
| Audio | 3.31 | 5 | 1.2% | 12.8% | 44.2% | 37.2% | 4.7% |
| Video | 3.42 | 2 | 0% | 10.5% | 43.0% | 40.7% | 5.8% |
| Web-link | 3.41 | 4 | 0% | 11.6% | 44.2% | 36.0% | 8.1% |
| Q (28.31.34.37.40): A well-known saying is "Instruction is an interactive process among students, teachers and learning materials". The annotation used in this class did increase the interaction between the learners and the content of the materials. | | | | | | | |
| Text | 3.52 | 1 | 0.0% | 10.5% | 36.0% | 44.2% | 9.3% |
| Graphic | 3.45 | 2 | 0.0% | 11.6% | 39.5% | 40.7% | 8.1% |
| Audio | 3.37 | 5 | 0.0% | 11.6% | 48.8% | 30.2% | 9.3% |
| Video | 3.43 | 3 | 1.2% | 9.3% | 41.9% | 40.7% | 7.0% |
| Web-link | 3.38 | 4 | 0.0% | 14.0% | 43.0% | 33.7% | 9.3% |

*Note.* SA: strongly agree; A: agree; U: undecided; D: disagree; SD: strongly disagree.

According to the participants' responses, text annotation was regarded as the most helpful and useful annotation type, while graphic annotation was regarded as the easiest to use. However, web-link annotation was regarded as the least helpful and the least useful. The learners also felt that audio annotation was effective and useful for reading comprehension, but was not easy to use. In sum, the exploration of the attitudes of learners showed that text annotation was thought to be the most useful type and that it can increase the interaction among learners and materials, although graphic annotation was considered the easiest to use, and learners felt interested in making graphic annotations because they got more happiness from it.

## DISCUSSION

### Learning by doing is better than learning by viewing for most types of learners

Since both Q1 and Q2 were to explore the effectiveness of using different multimedia annotations among different characteristics of learners, the researchers dealt the results of these two research questions together in this section. The examination of different types of annotation used by the learners revealed that the learner-generated annotation group performed better than the instructor-provided annotation group for both cognitive style learners and for higher-level learners. This result supports the findings of Pan (2006) and Sung (2007) who pointed out that learner-generated multimedia annotation can make a great contribution to language learning. Moreover, Dollon and Gabbar (1998) and Ariew and Ercetin (2004) claimed that higher-level learners perform better when they use learner-generated annotation.

The results conformed to the activity theory which claims that deep learning occurs when learners are encouraged to engage in productive learning activities, and generating learner-generated annotation encourages generative processing. It is the learning by doing rationale that claims that learners must engage in an activity that is related to the instructional objective. In order to comprehend the text, learners in the learner-generated annotation group were asked to surf the Internet and find some related information to make different types of annotations by themselves, including text, graphic, audio, video, and web-link annotations. Thus, they had more opportunities to learn by themselves than those who read the texts with instructor-provided annotations.

One of the reasons may be that their high linguistic competence might have enabled the higher-level learners to use good reading strategies to promote their reading comprehension of the text in a multimedia environment (Ariew & Ercetin, 2004). Furthermore, the learner-generated annotation provided the higher-level learners with a better situation to develop their learning autonomy. Besides, higher-level learners have their preferred learning strategy uses and would not rely on instructor-provided annotations for reading comprehension, and they might be distracted by much less important information provided by instructor-provided annotations while reading texts. Learner-generated annotation reinforces learner autonomy because learners have opportunities to choose what they think is useful for their learning. While using the annotation system, in order to enhance their reading comprehension, learners can use different kinds of annotation, such as text, graphic, audio, video, and web-link annotation to help them remember the content or the significant points of the reading materials (Roby, 1999).

However, learners in the instructor-provided annotation group were asked to view the different types of annotation provided by instructors to comprehend the texts, so they did not learn by making their own annotations. They just needed to view the annotations they liked. According to the activity theory, learner-generated annotation encourages generative processing. However, instructor-provided annotation does not. The activity theory predicts that learners who read a text in which they generate their own annotations will perform better on reading quizzes than those who read the text with instructor-provided annotations. Therefore, the results of this research question comply with the rationale that learning by doing is better than learning by viewing.

### Learners have positive attitudes toward multimedia annotation use

The learners thought that the “text” and “audio” annotation types were particularly useful for online reading. Especially, “text” annotation was regarded as an effective tool for reading performance. Besides, during the reading process, the participants thought that “text” annotation did improve their reading achievement and enhance the interaction between the learners and the content of the reading materials. The results also conformed to Hwang, Wang, and Sharples (2007), Pan (2006), and Sung (2007) who have all claimed that learners feel that by using “text” annotation and other functions of annotation systems, like graphic, audio, and video annotations, it becomes easier for them to review the content of the learning materials. The results also support those of Chun (2001) and Mayer (2001) who have claimed that extraneous cognitive load can be decreased by presenting reading material accompanied with words and pictures instead of only in words. Thus, one of the reasons may be that “text” annotation was easy to use, and it can be used without training. Another reason is that there was no cognitive overload because the dual coding theory maintains that learning can be facilitated when materials that involve both verbal and visual systems are utilized simultaneously. The results of Chen’s (2009) study, which indicated that learners using video annotation perform significantly better than those using picture annotation on tests, also conformed to the argument that viewing various kinds of annotation encourages generative processing.

However, not all types of annotation facilitate reading comprehension (Akbulut, 2008). Web-link annotation and audio annotation were regarded as the two least helpful and least useful annotation types by the students in this study. These findings partially comply with the findings of Ariew and Ercetin (2004) and Saker and Ercetin (2005), who found that audio annotation might distract readers, and that it has a negative impact on reading

comprehension. As for cognitive theory, one of the reasons may be that presenting too many elements to be processed may lead to cognitive overload. Another reason may be that viewing various types of annotation causes cognitive overload.

Another reason may be related to the difficulty of using audio annotation, because learners need to download and implement other software to record their annotations. Thus, some of the learners may feel that it is troublesome, and thus it may have decreased their willingness to use audio annotation while reading in the multimedia environment. In addition, as for web-link annotation, although it is easy to use, the content and information it provides may not have direct benefits for reading comprehension. Thus, the learners in this study seldom used this kind of annotation to help them comprehend the text.

## CONCLUSION

Students scored higher on a post English proficiency test after reading articles in which they were asked to construct multimedia annotation (learner-generated) that after reading articles that contained multimedia annotation (instructor-provided). The effect sizes favoring the both cognitive style learners and higher-level learners were large ($d$ > 1 for FI, FD, and higher-level learners) when they received the learner-generated annotation treatment, and was small ($d$ = .16) for the lower-level ones. The low-lever learners did not differ significantly on the proficiency test, which indicates that two groups (learner-generated and instructor-provided) of lower-level learners reached the same level of learning the basic materials. Besides the lower-level learners, the learner-generated groups showed overall deeper understanding as compared to the instructor-provided groups. The pattern of results is consistent with activity theory, which predicts that students learn more deeply by doing than by viewing.

The researchers do not recommend asking lower-level learners to construct their own multimedia annotation, especially when the learning task is difficult. Generating annotation may increases the level of extraneous cognitive processing that limits generative processing, especially when the information is new and techniques are unfamiliar. While learners studying simple material or studying complex materials with unlimited time, generating annotation by themselves is a better option to promote organization and integration (Stull & Mayer, 2007).

From the results of annotation attitude questionnaire, the analysis show that most of the students have positive attitudes toward the questions for all dimensions (perceived usefulness, perceived ease of use, and learning satisfaction). These results reveal the research shows great potential of an annotation mechanism to enhance online reading. This study is limited in several areas that should be investigated in future studies. First, the sample of field-dependent participants ($N$ = 36) was much less than field-independent participants ($N$ = 57), which may decrease the statistical power for analyses. Future research should choose more FD observations to include in a statistical sample.

On the other hand, the English reading proficiency test and annotation attitude questionnaires were administered as dependent variables to explore the effects of using different multimedia annotations quantitatively. The content analysis of annotation behaviors and student annotation interaction are suggested to discover annotation behaviors for future examination. These quality data might be helpful for instructors to understand student thinking process and learning difficulty through the analysis.

## ACKNOWLEDGEMENT

The author would like to thank the research assistant, K. T. Yang, who contributed to this study. I would like to thank her for helping in data collection and analysis, and the survey and learning material design. In addition to being a responsible and diligent assistant, she was also a wonderful student. She extended this study into her master's thesis under my tutoring and completed her defense in 2010. The other friend whose comments and ideas I made use of is Professor W. Y. Hwang. This paper was originally presented at the Some of the materials presented in this paper first appeared in K. T. Yang's master's thesis (2010). The author is grateful for the conference publisher and Yang's permission to reprint the materials here.

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