I. Introduction

In recent years, learning language through technology has become an important part in applied linguistics (Chapelle, 2001). As a consequence, it is urgent to know the nature of the technology and how the medium can be used to enhance language learning. To meet the challenge, researchers in this area are attempting to provide technological support for cooperative and collaborative language learning. Among the technologies, distance learning, especially in computer-mediated environments, is the new trend in language education (Peterson, 2001). Online Annotations is one of the applications of computer-mediated communications (CMC). With the growing popularity of computers in foreign language learning, scholars and teachers are beginning to examine the impact of online annotations on language learning.

Annotations are the notes a reader makes to himself/herself, such as what the students make when studying texts or researchers create when noting references they plan to pursue (Wolfe, 2002). Annotations that support communication about comments can increase interaction between authors and reviewers. Historically, the use of annotation is often associated with medieval manuscript cultures (Wolfe, 2001; Wolfe, 2002). Wolfe (2002, p. 471) explained that, “Medieval scholars habitually used the interlinear spaces and margins of manuscripts as a forum for sharing knowledge, debating readings of a text, and illuminating different reading strategies.” Medieval readers then used the interlinear spaces and margins of manuscripts to discuss, critique, and learn from the annotations left behind by earlier readers (Wolfe, 2001). These annotations involve four major functions: remembering, thinking, clarifying, and sharing (Ovsiannikov, Arbib, and McNeill, 1999). As a case in point, annotations were central to knowledge sharing in medieval literary cultures.

In contrast to the richness of medieval annotation practices, print annotation practices are relatively poor. Wolfe (2001) noted that medieval literary cultures were able to support the exchange and discussion of annotations because multiple readers typically all had access to the same copy of a text. In cultures with print technologies, however, most readers purchase individual copies of a text, so any

annotations they make in the margins or interlinear spaces remain private. As a result, “readers in cultures with print technologies, as compared with medieval readers, have limited opportunities for dialogue and learning through reading others’ interactions with a text”(Wolfe, 2001, p. 334).

In the digital age, can digital technologies revive the annotation practices for readers? In the past few years, a number of software and hardware applications have emerged that attempt to distribute the annotations made by readers of digital texts. The most widely used products are *Microsoft Word* and *Adobe Acrobat*. There are other applications that facilitate annotations and dialogues on electronic documents. Despite the increasing distribution and possible benefits of these applications, researchers observed that most readers prefer to print paper versions of electronic documents before reading them (Dayton, 1998; Haas, 1994; Ovsiannikov, Arbib, and McNeil, 1999). Dillon (1994) summarized some reasons for this preference: “…paper is more legible than computer displays, paper is portable, paper allows readers to move back and forth easily between multiple documents, paper documents can be easily annotated…”(cited in Wolfe, 2001, p. 340).

Although reviewing electronic documents may come with some limitations, digital annotation technologies offer functions that are unavailable to readers making annotations on paper. In addition, electronic annotation systems can take advantage of networked technologies to allow communities of readers to comment on the same virtual copy of a text. In the context of language learning, instructors frequently desire writers to receive feedback from multiple readers in the classroom. However, coordinating such feedback can be difficult when using paper texts because the restrictive margins limit the amount of commentary a particular passage can receive. Compared with paper-based annotations shared merely through printed technology, online annotations provide language learners with more opportunities for dialogue and learning through conversations.

Although it is reasonable to claim that online annotations may facilitate language learning, there is a lack of knowledge about why and how the online annotations can be used in language learning. This article focuses on recent developments in annotation systems that are most relevant to language teachers.

First, this article discusses the theoretical foundations and the potential applications of online annotations for language teaching. Second, this article reviews recent annotation systems and identifies features and problems of these programs. Finally, the implications for future system design and research are suggested.

II. The Theoretical Framework

As a language learning tool, online annotations for language learning seems to fit with the generative learning hypothesis (Jonassen, 1985), the generally accepted hypotheses of second language acquisition known as the Monitor Model (Krashen, 1985), and the collaborative language learning approach which has roots in Vygostky's (1978) cultural psychology.

1. Generative Hypothesis

Language learning is an active, constructive process whereby learners generate meaning for information by accessing and applying existing knowledge. An instructional model that manifests the above principles is the generative hypothesis (Jonassen, 1985). As Eskey (1986) mentioned, no matter how well a student may know a language, he cannot read in that language with good comprehension if the subject of the text is one he knows nothing about. In other words, reading comprehension is most likely to occur when students are reading what they want to read, or at least what they see some good reasons to read.

The generative hypothesis asserts that meaning for materials presented by any medium is generated by activating the existing knowledge structures in order to interpret what is presented. The structures are then encoded in memory as distinctive features that may be accessed later to explain new information. According to the generative hypothesis (Jonassen, 1985), reading comprehension requires the active transfer of existing knowledge to new materials, and generative reading activities are those that require readers to consciously and intentionally relate new information to their existing knowledge rather than responding to material without using personal, contextual knowledge.

Online annotations can help readers navigate documents, functioning much as user-created hyperlinks that allow readers to look up information, pursue citations,

or return to earlier sections of a document (Golovchinsky and Marshall, 2000). By facilitating such easy movement between texts, annotation tools can emphasize the intertextual nature of reading. Tools for manipulating and rearranging annotations can scaffold different note-taking and information strategies that help students learn to move from reading to writing (Bargeron et al., 2001).

2. The Monitor Model

Online annotations can also be examined with Krashen's (1985) Monitor Model which is developed from four main hypotheses.

(1) The acquisition-learning hypothesis---According to Krashen (1985), acquisition is subconscious and is similar to the way children develop ability in their first language. In other words, acquisition is picking up a language naturally in informal situations. In doing so people are not aware of the rules of the language that is being acquired. Instead, people develop a feel for grammatical correctness. In contrast, learning refers to the formal knowledge of a language that people learn by consciously attending to rules as in formal classroom situations. Unlike classroom activities where the teacher sets an agenda, interactions through online annotations is a one-to-one activity where the students themselves choose the topics they wish to share or discuss. As in genuine conversations, students can choose to answer the peer's queries in one word and move on to another topic, which they think, is more interesting. Or they can write long annotations if they are really inspired by the topic. Just as the topics are negotiated with the learners rather than dictated by the teacher, the feedback is highly individualized.

(2) The monitor hypothesis---Acquisition is responsible for fluency whereas learning is more related to the role of a monitor of conscious rules about language. Certain conditions need to be met in order for the monitor to be used effectively. First, the performers must be focusing on the form, not on the content of the message. They also need time to think about and use the conscious rules in order to correct their output. Third, they must know the grammar rules of the language in which they are communicating. The feature of asynchronicity of online annotations allows second language/foreign language learners the extra time they need to elaborate and polish written texts using the language and cultural resources from

their teachers, peers and community members.

(3) The affective filter hypothesis ---According to Krashen (1985), success in second language acquisition depends on a number of attitudinal variables. He mentions low anxiety, high motivation and self-confidence as being determining factors in promoting second language. When the filter is high, acquisition may be blocked. When the filter is low, there is no barrier to acquisition. Thus, learners are more receptive to the language input that they receive and they are also encouraged to interact with confidence with speakers of the target language. Online Annotations is one of the applications of computer-mediated communication, which offers genuine interpersonal communication and provides access to authentic language input. For language learning, online annotations increase the opportunities for authentic language practice in a motivating environment. Engaged in a genuine act of communication in the target language, the learners can be more motivated to carry on with the activity.

(4) The input hypothesis---This hypothesis states that people acquire language by going for meaning rather than focusing on form and that when people are concerned with understanding oral or written input, they consequently acquire the structure of the language. It also states that the input must be comprehensible and provided in sufficient quantities. Moreover, second language acquisition depends also on comprehensible input. It should be interesting, relevant and used in a genuinely communicative way. According to Krashen (1985), acquisition occurs when comprehensible input is available and focus is on meaning. In online annotations, students are placed in a realistic situation in conditions that appear to be optimal for the acquisition process to be fully operational.

3. Collaborative Language Learning

Collaborative language learning is a methodological innovation for language teaching. In collaborative learning, students work together to achieve shared learning goals (Nunan, 1993), and language acquisition is facilitated by students interacting in the target language (Larsen-Freeman, 2000). According to Nunan (1993), through collaborative learning, learners themselves are important resources for their own learning. Moreover, collaborative learning can help students use their

own prerequisite knowledge to go beyond what they currently think. Collaborative language learning accommodates the principles of social constructivism as proposed by Vygotsky (1978). According to Vygostsky's zone of proximal development, individual learning is mediated through either adult guidance or collaboration with a more capable peer. Collaborative language learning is also consistent with communicative language learning and Krashen's (1985) assumption of second language acquisition, which emphasizes that while learning a second language, learners need to interact actively with the external environment.

As Larsen-Freeman (2000) addressed, it is not the group configuration that makes collaborative learning distinctive; it is the way that students and students or students and teachers work together that is important. As suggested by Nunan (1993), the following question should be considered: In collaborative language learning, what patterns of classroom organization and types of classroom tasks are most beneficial to language acquisition? It has been argued that "those tasks in which learners are required to negotiate meaning among themselves in the course of completing and interactive task are particularly suited to language development" (cited in Nunan, 1993, p. 4). In recent years, researchers in the computer-mediated communication (CMC) have attempted to provide technological support for collaborative language learning (e.g., Chapelle, 2001; Sperling, 1998). Online Annotation is one of the applications of CMC. As Wolfe (2002) addressed, systems that support communication about comments can increase interaction between authors and reviewers. It also facilitates broad access to authentic information and rapid exchange of information.

III. Applications and Research of Annotations in Language Learning

Many instructors have implemented annotations in their language classrooms. For instance, Salvatori (1996) asked students to photocopy and distribute their annotations on literary texts as a means of discussing the arguments that different readers construct from the text. Lunsford and Ruszkiewicz (1999) published essays together with the annotations of multiple readers to help students visualize the social nature of reading and to suggest how the backgrounds and biases of different

readers affect their interpretations of a text. They suggested that reading annotations left behind by previous readers can influence students' task representations and writing activities.

Some researchers examined the impact of annotations on language teaching. In an exploratory study about annotations on videos of classroom lectures, researchers at Microsoft (Bargeron et al., 2001) discovered that most subjects found reading others' annotations thought-provoking and useful in guiding their thinking. Moreover, instructors using the program frequently commented on feedback made by peer reviewers, a practice relatively rare in traditional classroom commenting situations. In addition, Kiewra (1989) found that annotations made while reading can facilitate rereading, providing readers with efficient retrieval cues when they review the subject matter and helping them to locate specific information from the text.

In a similar study, Chun and Plass (1996) examined the effects of annotations with different forms of media on vocabulary acquisition and comprehension from a reading passage. This study focuses on particular listening strategy, namely the use of multimedia annotations for vocabulary words, and the effect of these pictorial and written annotations that accompany an aural text on students' vocabulary acquisition and aural comprehension. They found that pictorial information in addition to written information helped support micro- and macro-level processing in L2 computer-based reading activities. These researchers indicated that processing supportive information affects positively students' comprehension.

In an observational study, Neuwirth and Wojahn (1996) suggested that an annotation program allowing students to comment on their teacher's feedback encouraged students to ask questions about, rather than dismiss feedback they did not understand. Hulstijin, Hollander, and Greidnus (1996) studied the influence of annotations, dictionary use, and the reoccurrence of unknown words on incidental vocabulary learning. They found that incidental vocabulary learning is higher when L2 learners have access to the meanings of words through annotations.

IV. Reviewing Annotation Systems

Although annotation technologies seem to increase student-student or student-teacher dialogue over written products, these conversations can be strongly affected by the commenting interface (Wolfe, 2002). In the past, a number of software and hardware applications have emerged that capture and distribute the annotations made by readers of digital text. This section reviews five recent developments in annotation systems that are most relevant to language teachers. These programs are *CoCoA* (Communicative Correction Assisting System) (Feng, Ogata, and Yano, 1999), *Annotator* TM (Ovsiannikov, Arbib, and McNeill, 1999), *Virtual Notes* (Koch and Schneider, 2000), Hsu and Lin's system (Hsu and Lin, 2001), and Mason and Woit's system (Mason and Woit, 1999). The review involves three dimensions: (1) treatment of the original document, (2) annotation uses, and (3) annotation functionality.

1. Treatment of the Original Text

(1) Original Text Changed

These annotation systems, which will change the original text, mainly employ two methods for creating annotations. The first method (*CoCoA* as an example, see Figure 1) allows the user to insert directly the annotation codes or comments in the original text. *CoCoA* (Feng, Ogata, and Yano, 1999) is an educational environment designed to provide personal instruction to learners of Japanese especially at the intermediate level. Since this system is designed for writing instruction, it has some features that are especially suitable for error feedback. First, *CoCoA* provides teachers and learners with an effective environment for exchanging mark-up documents to realize error corrections. Second, this system allows teachers to mark students' writing errors anywhere in the document. Then the system saves teachers' mark ups and later presents the marked document to the students. Third, this system can automatically find out writing errors that are often made by foreigners in the marked text, know the types of writing errors, accumulate writing errors, and create feedback information for learners. Although *CoCoA* allows users to query a specific type of annotations, users cannot do anything about the already-entered annotations, such as deleting or revising even self-made annotations.

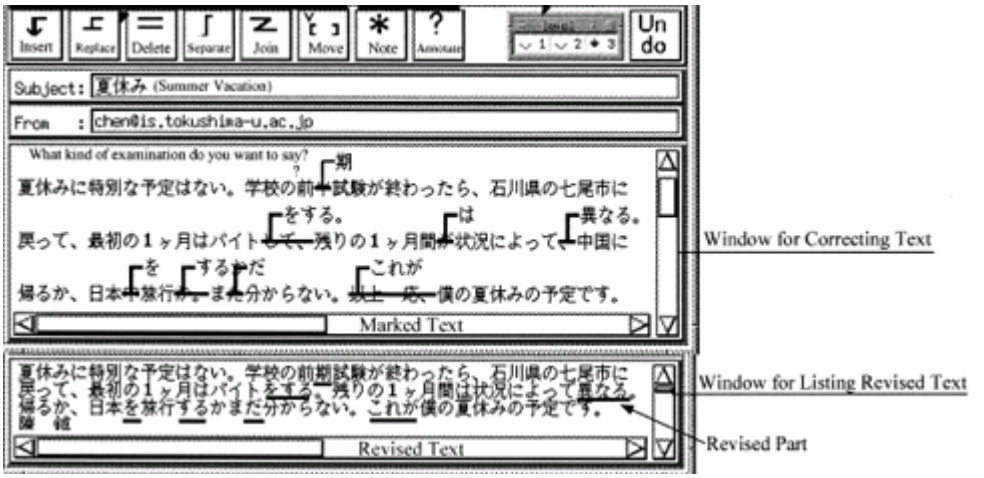
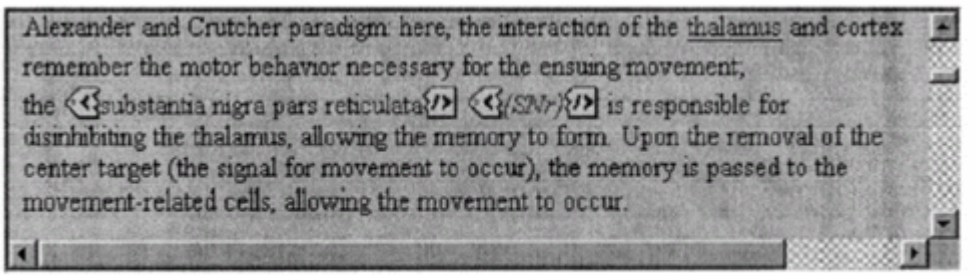


Figure 1 A sample screen of *CoCoA*
(Feng, Ogata, and Yano, 1999)

The second method provides *Netscape Composer* plug-ins and allows the user to insert anchors and enter the comments after the word strings (*Annotator* TM as an example, see Figure 2) (Ovsiannikov, Arbib, and McNeill, 1999). The user can view the annotated document with *Netscape Communicator* or edit it in *Netscape Composer*. *Netscape Composer* is extended with a set of plug-ins to support the annotation process. An edited document can be submitted to the proxy, which will intercept and parse the data. Having extracted comments, it will update the annotation database. Viewing annotations in *Annotator* TM is simple. The user needs only to open an annotated document. Annotations will be fetched from the annotation database and inserted automatically at the correct places by the proxy. When the page is being loaded, annotations also show up in a separate window, called Annotation Index (AI). Clicking on an AI item will scroll the document window to the target annotation.



Adding Annotations in Netscape Composer.

By inserting annotations into the original document, both *CoCoA* and *Annotator* TM will change the original document. However, these systems will record annotations in the database for further analysis and management.

(2) Original Text Not Changed

Koch and Schneider (2000) implemented an annotation service (*Virtual Notes*) which employs icons to insert annotations to the original documents. The system then records the exact location of the icon and the annotations to the database. Once the user clicks on the document, the system will retrieve related icons from the database. If the user moves his/her mouse cursor over an icon, the annotation will appear automatically. This system also allows multi users to work either synchronously or asynchronously. It is unique that when there are new annotations coming in, the system will e-mail and invite the users to view the new annotations.

With *Virtual Notes*, an annotation can be created by pointing the cursor at the chosen area of the page and clicking there while pressing the CTRL- and the ALT-Button. This provides an intuitive way to select the portion of the HTML page the annotation refers to. To keep as much of the page visible as possible, the annotations are displayed as small icons depicting little stick-on-notes (see Figure 3). If the mouse cursor is over the icon, the note expands to show its text. If clicked upon, it stays in this form even if the cursor leaves. In addition, the Style-Sheet will record the location of the annotation in the document. Whenever a new annotation is created, a reload-event will be triggered in order to update the number of annotations on the current page. The drawback is that although this system allows users to use personal identification (ID) and password to retrieve or delete self-made annotations, the user cannot revise the already-entered annotations.

Figure 3: A sample screen of Virtual Notes (Koch and Schneider, 2000)

In the following method (e.g., Hsu and Lin, 2001; see Figure 4), the user creates annotations by overlaying marks on the original document with Java Script and Vector Markup Language (VML). Then the systems fix and record the locations and sizes of the marks. Since the systems save these annotations with tags to prevent annotation movements, the original documents will not be changed. This type of method emphasizes the convenience of the tools but neglects the error analysis function. These systems do not record annotations into the database and cannot do error analysis for the writers.

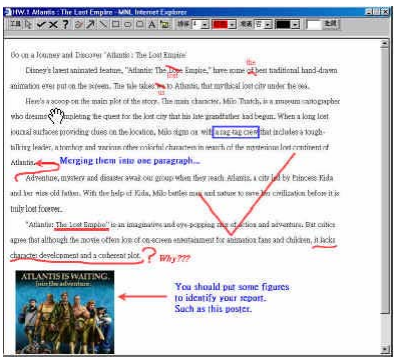


Figure 4: A sample screen of Hsu and Lin's (2001) annotation system

In the third method, the user adds annotations by creating hyperlinks (Mason and Woit, 1999; see Figure 5). The annotation program will generate a hyperlink for each significant feature of the assignment to provide marking and annotation for that section. In this program, each comment block is independently markable and the top-level design is also markable. In addition to the markable sections, there is also a comment field and assignable mark for the total assignment. Although this program features online marking with structured and detailed feedback, it is only suitable for articles with very clear structure (Mason and Woit, 1999). Markers found that, for some particular articles, the program was often repeating the same comments for several students.

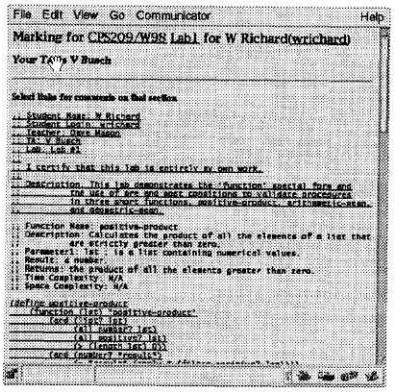


Figure 5: A sample screen of Mason and Woit's (1999) annotation system

These three methods, despite keeping the original document, cannot record annotations into the database for further analysis. Table 1 summarizes the features of the surveyed annotation systems with the dimension of treatment of the original document.

Table 1 Classification of the surveyed annotation systems with the dimension of treatment of the original document

Factors / Surveyed Systems / Features	Original document changed	Original document not changed
	CoCoA, *Annotator* TM	*Virtual Notes*, *Hsu and Lin's system*, *Mason and Woit's system*
Method of adding annotations	Add annotations by inserting tags or anchors into the original document	Add annotations by overlaying marks on the original document or using hyperlinks to create annotations
Availability of annotation analysis	Yes	No
Availability of annotation management	Yes	*Virtual Notes*, *Annotator* TM

2. Annotation Uses

Table 2 summarizes the features of the surveyed systems with the dimension of annotation uses.

(1) For writing and error feedback

CoCoA(Feng, Ogata, and Yano, 1999) is a typical example, which provides learners with an environment of exchanging marked-up documents for writing error correction. For the purpose of writing, the learner first writes the original text with an editor and sends it via e-mail to the teacher. In the editor interface, the text is double-spaced to allow teacher's corrections with marks and comments. Then the teacher saves the corrected text and sends it back to the learner via e-mail. Finally, the learner can view the corrected text and revised text in the top-down windows (see Figure 1). Moreover, the system can retrieve articles with similar error types from the database for the learner to practice.

(2) For knowledge sharing

As Bargeron et al., (2001) claimed, annotations can enable asynchronous collaboration among groups of users. In other words, it allows multi users to annotate the same document for the purpose of knowledge sharing. With annotations, users are no longer limited to viewing content passively on the Web, but are free to add and share commentary and links, thus transforming the Web into an interactive medium. In addition, as *Virtual Notes* (Koch and Schneider, 2000) shows, the system will record the exact location of the icon and the annotations to the database. Once the user clicks on the document, the system will retrieve related icons from the database. If the user moves his/her mouse cursor over an icon, the annotation will appear automatically. This system also allows multi users to work either synchronously or asynchronously. It is unique that when there are new annotations coming in, the system will e-mail and invite the users to view the new annotations. Another system, *Annotator* TM (Ovsiannikov, Arbib, and McNeill, 1999), provides an annotation database for the user to integrate information. Specifically, when searching the annotation database for annotations, the user can take the advantage of information in the related clumps. The the list of search results will contain annotations found both directly and indirectly through their

context. When searching for original documents, annotations in the annotation database can provide additional information as to which texts are relevant.

Table 2 Summary of the annotation uses and functionality of the surveyed annotation systems

Functionality	Annotation Systems
Error Feedback	*CoCoA*, *Annotator*TM
Knowledge sharing	*Annotator*TM, *Virtual Notes*
Knowledge integration	*Annotator*TM
Collaborative document processing	*Annotator*TM, *CoCoA*
Highlighting key points	Hsu and Lin (2001), *Annotator*TM
Structure for related annotations	*Annotator*TM, Hsu and Lin (2001)

3. Annotation Functionality

Annotation functionality is a dimension that expands immensely when a paper annotation assumes an electronic form. It seems that none of the surveyed annotation systems has complete functionality. Table 2 summarizes the annotation functionality of the surveyed annotation systems. The different functions of the surveyed annotation systems can be explained as follows：

(1) Highlight key points or key words

Hsu and Lin's (2001) system and *Annotator* TM (Ovsiannikov, Arbib, and McNeill, 1999) mainly provide tools much like highlighters to mark key words or key points in the document, so that they can be quickly found later. Such marking helps draw the readers' attention, while the colors and marks can carry some additional meanings.

(2) Structure for related annotations

Hsu and Lin's (2001) system generates a list of related annotations, in which, related annotations will be placed together. When the user adds new annotations to the database, he/she can just press a button and add the annotations to the list. The user can also delete a certain annotation from the list.

(3) Annotation management

While the systems save the annotation contents, they also save related data for further management, such as annotators' Internet addresses, annotation types (deleted, revised, and the like), and the importance of the annotations. The following are the methods for annotation management in various annotation systems.

(a) The systems (*Virtual Notes*, *Annotator* TM) recognize a user with his/her Internet address. Records that are found as a result of a query are listed in a text window, where the user can click on the items to instruct the browser to navigate instantaneously to the annotation or annotated text in a paper. The user with the matched Internet address can also delete or add an annotation using a convenient interface (e.g., drag-and-drop interface in *AnnotatorTM*).

(b) In *Annotator* TM (Ovsiannikov, Arbib, and McNeill, 1999), the user can also ask the system to prepare a summary of search results, which is a text document listing all records with their content expanded. The user can even customize the level of summary details. For instance, the user can request a summary list with level 2 importance to prevent cognitive overload.

V. Implications for System Design and Research

Section III compares and contrasts five recently developed annotation systems. Table 1 and Table 2 summarize the features of an ideal annotation system. It seems that none of the surveyed programs has the complete functions of an online annotation system that may enable language learners to share, catalogue and search annotations. According to the review, future development in annotation tools can present systems which contain the following features: (1) providing knowledge sharing and collaborative learning among peers, (2) providing annotation feedback and analysis, (3) providing annotation management, (4) providing multiple annotation functionality, and (5) achieving knowledge integration. In addition, the interface of annotation systems should be user-friendly. As Hakiel (1997) mentioned, from the perspective of courseware development, the system

development should recognize the relevance of usability to the success of the products. In the future, more reviews should be conducted by language teachers for annotation systems, and findings of the reviews will help system designers better understand the needs of language learners and make clear which features are necessary and useful and which will create problems in online annotations for language learning.

In spite of the potentials of using online annotations in language learning, the question of how annotations may actually help students' language learning has not been sufficiently addressed (Jones and Plass, 2002; Wolfe, 2002). There is a lack of knowledge about the impact of online annotations on language learning. For instance, for writing instruction, a key question is whether online annotations will improve the quality of their writings. Or will the feature of knowledge sharing in online annotations confuse the readers? What are the learners' points of view while using online annotations to receive the comments or make corrections? What are the effects of error feedback and error analysis with online annotations on language learners' linguistic accuracy and metalanguage development in online annotations? For reading instruction, a key question is whether online annotations will improve the quality of their annotations and consequently enhance their reading comprehension. What are the readers' points of view while using online annotations to share knowledge or receive the comments?

There is common concensus that annotation technologies can provide a good way for language learners to share knowledge and allow extended conversations to take place in the context of a common text, thus enhancing information processing and language learning (e.g., Bargeron et al., 2001; Chun and Plass, 1996; Lunsford and Ruszkiewicz, 1999; Salvatori, 1996). However, software designers often have little background in the theory of reading and writing processes. Therefore, language teachers must contribute to designing annotation tools by testing and evaluating new software and conducting research that will help computer designers understand the annotation needs. As Peterson (2001, p.359) urged,"[language teachers] need to pay attention to the onslaught of rhetoric about the benefits of and problems with distance learning …because the primary interface of a distance-learning course is the written word, [language teachers'] expertise will be

increasingly needed as courses are written and delivered in online environment". In addition, as pointed by Wolfe (2001), most research on annotations has been conducted in academic settings. There exists the need for more research in professional settings with a special emphasis on the ways in which professionals annotate.

VI. Conclusions

Nowadays, universities are increasingly turning to distance-education techniques and tools to deliver courses (Savenye et al., 2001). Practically, online annotations can be quite useful in the language learning setting, in which students could share their annotations to discuss reactions to a text, or they could use annotations as a type of reading journal to share with the instructor. However, with online annotations, the physical distance between students and teachers raises questions about what makes a good instruction. It also reminds us that technology alone cannot cause changes; it is the teacher's use of technology and the designers' construction of the technology that shapes its impact. To meet the challenge, it is urgent to know the nature of the technology and how the medium can be used to enhance language teaching. This paper draws attention to the theoretical foundations of using online annotations in language learning. It also discusses the advantages for the practice. Finally, this paper suggests a number of important implications for the design of better interfaces for online annotations systems. The discussions help us to understand the value of using online annotations in language teaching.

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