
Reading and Multimedia Annotations: Going Beyond Bells and Whistles, Hot Links and Pop-up Windows

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Introduction

Annotations (e.g., definitions, translations, grammatical notes) have long been thought to aid and influence the level of reading comprehension. Virtually all foreign language textbooks to date exhibit some type of "glossing," whether it is in the form of short definitions or notes that explain the meaning of unfamiliar words, typically on the side or bottom margins of the page. As already argued by many (see, for example, Davis 1989; Nation 1983; and Pak 1986), the rationale behind such glosses is to prevent continual dictionary consultation that may hinder or interrupt the fluid second language (L2) reading comprehension process. Today, with an ever-increasing emphasis on emerging digital technologies, it is not surprising to find annotations in computer-assisted language learning (CALL) applications as well. In fact, multimedia annotations have become a standard component of instructional materials for language learning (Chun and Plass 1996a, 1996b; Cohen 1987; Hanley, Herron, and Cole 1995; Leow 1995; Oller 1996; Secules, Herron, and Tomasello 1992). The advent of multimedia annotations presents language practitioners and SLA researchers alike with new challenges and with opportunities to take a fresh look at the possibilities such annotations may provide for reading software in the future.

This article deals with the utilization of digital multimedia annotations for computer-assisted reading comprehension. Specifically, the focus of this article is on the integration of effective and responsible use of CALL with digitized multimedia-based instructional reading materials. Based on the cur-

rent state of research on learning with CALL and multimedia, this article examines the effectiveness of multimedia annotations in the context of pre-reading activities and of off-line/online measures on the construction of global text comprehension, and the ways under which their combined impact may be studied in the future. This discussion is followed by specific recommendations for planning for instruction with multimedia annotations. Finally, the article proposes a framework for an interactive digital approach to reading, including the theoretical and pedagogical issues involved in the programming of multimedia reading software for multilevel computer-managed instruction.

Multimedia Annotations

Unlike any other time in the era of instructional technology, the last two decades of the twentieth century saw an explosive growth of articles, monographs, books, and conferences on CALL and multimedia applications to second language learning. At least one monograph or book on CALL has been published every year since 1982, and Dissertation Abstracts International lists more than a dozen doctoral studies on CALL in second language teaching that have been completed since 1980. An extensive bibliography on CALL by Stevens et al. (1986) identifies more than 1700 articles, monographs, and other writings on the subject. Virtually all studies of modern media in foreign language education have been concerned with such fundamental epistemological questions as—How do we achieve better teaching and more efficient learning via CALL? What are the principles that, in the future, should guide the use of CALL in research efforts, the design and evaluation of software, teacher training, and curriculum design?

Diamond (1980), for example, has observed that most success in instructional design has stemmed from hunches and personal experience across disciplines. Similarly, Ragsdale (1982) and Hurly and Hlynka (1982) have argued that blind faith in the power of the computer has strongly shaped current American educational practices. In much the same vein, Alatis (1983) reminds us that if we wish to take the value of second language study seriously, we must not shy away from technological learning aids; on the contrary, we should explore all of their possibilities. Eisele, taking a more cautious stance, observes that "scarcely anyone is now opposing the use of computers for learning; but, neither is anyone able to pronounce the real value of their use with any degree of confidence based on research" (Eisele 1984, 34).

A decade later, Doughty (1994) emphasizes the unique advantages that the computer offers in making research man-

ageable and accessible to the classroom teacher. Weible (1994), on the other hand, contends that inappropriate use of the medium is a major reason why CALL's potential has not yet been fully realized, despite the fact that the computer is probably the most radically new information medium ever invented. Weible's line of argument is echoed by Wyatt (Wyatt 1994, 87) who states that the computer is not tied to a particular type of pedagogy such as instructional CALL, but can potentially be used in a wide variety of approaches to second language teaching. That is, computer applications in second language learning are potentially at least as relevant to the natural approach as they are in an audiolingual or cognitive setting. No less significant than these claims are the findings of one study that demonstrated that learners who used technology frequently had significantly higher involvement, satisfaction, and motivation to achieve than learners who used technology moderately or infrequently (Waxman and Huang 1997). It is equally no less surprising for research to support the claim that learners have more positive affective outcomes in classrooms where technology is slightly or moderately used than in classrooms where technology is infrequently used.

As the profession begins to take such claims to heart, it becomes important to remember that certain learning tasks for certain learners can be facilitated by the use of CALL. CALL is highly context-bound: variables such as learner differences, learning tasks, and the computer's coding options are therefore taken into account when learners construct their own multisensory learning and critical thinking strategies. This is precisely why it is so important to orient learners to CALL thoroughly in order to enhance their learning in a technologically driven instructional situation. The effectiveness of multimedia annotations and off-line/on-line measures for computer-assisted reading comprehension is reviewed next.

Multimedia Annotations and Off-Line/On-line Measures

Multimedia annotations have sparked renewed debate on the effectiveness of annotations for text recall, text comprehension, and the construction of a situation model (i.e., integration of textbase with background and other world knowledge) as defined by Zwann and Brown (1996). At one pole is the view that glossing does not promote a global comprehension of the text (Johnson 1982; Pak 1986), whereas at the other is that view supporting the utilization of glossing in L2 reading (Davis 1989; Hulstijn, Hollander, and Greidanus 1996; Jacobs 1991, 1994; Jacobs, Dufon, and Hong 1994; Liontas 1999; Lomicka 1998) for text comprehension and recall.

Unlike traditional text annotations that were fixed on page

margins and were limited in scope and depth, hypertext multimedia annotations, such as print images, audio, video, text, guiding questions, and cultural, historical, or geographical references (Chun and Plass 1996a), are "invisible and unobtrusive" (Davis 1989, 42) in the reading comprehension process. Most importantly, however, a learner can consult them immediately, selectively, and with various degrees of intensity as s/he desires. According to Martínez-Lage (1997), a hypertext-annotated text provides learners with much more than simply "immediate access to textual, sound, and visual annotations" (p. 149): it provides learners with an opportunity to approach the text more globally than linearly, enhancing overall text comprehension.

Martínez-Lage's views are confirmed by Lomicka (1998) who reports that computerized reading with full glossing may promote a deeper level of text comprehension than computerized reading with little or no glossing. Her findings using second-semester students of French support earlier results from Jacobs (1994) with third-semester students of Spanish, as well as from Lyman-Hager, Davis, Burnett, and Chennault (1993) with intermediate-level French students. In all of these studies it was found that performance (text comprehension and vocabulary retention) and positive attitudes toward computerized L2 reading increased significantly when learners were provided with access to multimedia glosses than when they were not. An added interesting piece of research evidence is supplied by Chun and Plass (1996a), who examined the relationship between look-up behavior and vocabulary test performance on a recall protocol. Chun and Plass report that the recall protocol for visual annotations (i.e., words annotated with text, pictures, animated pictures, sound, and video) was higher than for words annotated with text alone.

Similarly, in two studies by Swan (1996-1997) that compared responses to, and recall from, hypermedia materials with and without integrated video segments, it was found that embedded video can enhance learning from hypermedia. This is largely due to the fact that video adds an affective dimension to hypermedia materials, thus making such materials more meaningful and memorable to the learner. That is, video presents material to memory in a more complex form than text alone, thus providing, as Swan suggests, more links to elaborated knowledge. Consequently, it is not unreasonable to posit that vivid video images can provide important input in memory that makes associated linguistic information easier to recall,

which in turn enhances second language learning to great extent. (For an extensive list of categorical pluses and minuses of integrating video and CALL in the language curriculum, see Ariew 1994, 47-49 and 51.)

Clearly, research is beginning to support the effective utilization of multimedia annotations for computer-assisted reading comprehension. Given the rush to incorporate these research findings into the design and development of future multimedia reading software, it is prudent to bear in mind that such findings are based on recall protocols and other post-reading tests, which by design are the product of "off-line" comprehension measures. While such research attempts "provide a purer measure of comprehension, uncomplicated by linguistic performance and tester interference," as Bernhardt (Bernhardt 1991, 200) argues, instructors, researchers, and software developers are well advised to heed the cautions, forwarded by Myers (1990) and Lomicka (1998), that recall or post-reading measures may simply reflect readers' abilities to "recall" knowledge.

It appears quite logical, then, to postulate that a combination of "off-line" measures and "on-line" measures (i.e., assessment of the reading process and integration of text during reading) may more accurately and completely evaluate the reading comprehension process as it is occurring. Used together, off-line and on-line measures may indicate with a higher degree of validity and reliability what learners do cognitively and post-cognitively as they attempt to "make sense" (Goodman 1992, 1996; Lontas 1997, 1999) of the text information presented to them.

On-line measures such as think-aloud protocols (i.e., verbalization of contextual understanding at the sentence level recorded on computer, audiotapes, or videotapes) have been widely endorsed by both L1 and L2 reading researchers (Ericsson and Simon 1984; Horiba 1990, 1996; Kern 1994; Lontas 1997, 1999; Lomicka 1998; Olson, Duffy, and Mack 1984; Rikard and Langley 1995; Trabasso and Magliano 1996; Trabasso and Suh 1993; Whitney and Budd 1996; Whitney, Ritchie, and Clark 1991; Zwann and Brown 1996). Coupled with measures of the number and types of glosses consulted by the learner, plus the length of time the learner needs for such consultation (via a tracking device incorporated into the software) during reading or listening, on-line measures can supply powerful insight into the meaning construction process while the learner reads or listens to authentic texts as well as

into what cognitive level (surface, textbase, analytic, global comprehension) and under what metacognitive conditions text comprehension is achieved.

Tracking data collected electronically by computer, however, affords much more information than simply the whats, wheres, and how longs of comprehension. In addition, electronically collected data produces a "comprehension processing log": a reconstructed roadmap, if you will, that helps to explain why and how certain glosses were consulted, where comprehension difficulties arose, which metacognitive strategies learners used in consulting each gloss, and what effect each gloss had on the overall scheme of comprehension. When combined with the insights gleaned from the transcriptions of think-aloud and recall protocols, our understanding of the reading comprehension process increases dramatically and learners' causal inferences, levels of mental representations of a text, and constructions of situation models become concrete and unmistakably real. (For a more recent account of such insights, see Liontas 1999).

The Process of Reading and Text Comprehension

The process of reading in general and text comprehension in particular has long intrigued L1 and L2 researchers alike. As a result, various explanations have been offered for these phenomena. With regard to multimedia annotations, however, it would be helpful to revisit a key set of questions raised by Chun and Plass (1997): "How does the process of comprehension of text differ from comprehension of pictures, and how does the combination of pictures and text affect comprehension? What effect do students' learning preferences, abilities, and cognitive styles have on the answers to these questions?" (60).

In an attempt to answer these questions, Chun and Plass argue that text represents language information in symbolic structures and is processed sequentially; that is, word for word or sentence by sentence. In contrast, still pictures—unlike animated pictures or videos that undergo structural transformation over time—convey their information by means of a static visuo-spatial structure (Chun and Plass 1997, 64). Pictures thus represent the subject matter by analogy (Schnotz 1993) via the construction of a direct corresponding mental model and cause information to be encoded in parallel or simultaneously, a view also shared by Clark and Paivio (1991). Comprehension of text information, on the other hand, requires an indirect transformation between the symbolic representation of the text and the analog mental model that is mediated by one's existing cognitive schemata (Carrell 1984; Johnson-Laird 1983).

This in effect means that there are at least two different storage systems for information—a verbal and a nonverbal system. Extending the dual coding theory of Chun and Plass's model to multimedia annotations therefore enables us to specify the collaborative functions of spatial and verbal information necessary to support the various cognitive processes involved in text comprehension. This, of course, has important design implications for learning from different multimedia information sources that manifest multiple presentation modes (i.e., text, video, sound, and pictures individually or in combination), leading to the construction of different mental models. Hence, we know that texts represent information in symbolic structures and are processed sequentially; that still pictures convey their information by means of a static visuo-spatial structure and represent subject matter by analogy; that animated pictures or videos undergo structural transformation over time. We are further aware that comprehension of text information requires an indirect transformation between the symbolic representation of the text and the analog mental model mediated by one's existing cognitive schemata. This knowledge can help future software engineers design more appropriate multimedia annotations for overall (text) comprehension.

Accommodating Differences in Learning Styles

Long before we can begin to reap the fruits of our research labors, however, several critical questions still remain unanswered. That is, how do we best accommodate individual differences among learners including (but not limited to) their learning preferences, abilities, strategies, and styles; their linguistic competence, prior knowledge, and cognitive styles; and affective factors such as their interests, motivation, and attitude? What should the learning goal be each time learners are asked to engage in learning with multimedia annotations? What is the nature of the interaction that learners transact when engaging in various multimedia contexts? Such questions challenge our fundamental theoretical orientations and pedagogical belief systems, for they require a critical look at our research methods and instructional practices. But the answers we find to these questions will aid our efforts to foster learners' communicative and sociolinguistic competence to a great extent.

According to Pederson (1994), cogently designed basic research on the computer's coding options and their interaction with learner variables known to play a crucial role in language acquisition is the most fruitful means to arrive at truly gener-

alizable conclusions about what CALL can and cannot accomplish for a learner in a given learning environment. She argues that "CALL, in and of itself, does not result in more and better learning; rather, it is the specific way instruction is coded in CALL software that has the potential of affecting learning positively, for specific learners, in specific contexts" (Pederson 1994, 107). Readers interested in exploring these issues further might start by reading Anderson, 1991; Chun and Plass, 1997; Gardner, Day, and MacIntyre, 1992; Jamieson, 1992; Kern, 1989; and Raymond, 1993. The answers we seek will underscore our views of the "learner as manipulator" or the "learner as communicator." Despite the divisive arguments in the foreign language profession, it can be argued quite convincingly that research that fails to take learner differences into account falls into a trap similar to that of comparative research that seeks to demonstrate that one medium communicates better than another.

To this end, Chapelle offers several helpful questions for and methods of L2 classroom research with emphasis on the "interactionist" approach and discourse analysis. She suggests that the researcher's description of the nature of the language entailed in various CALL tasks is an essential first step toward understanding the potential value of a CALL activity. L2 learning activities can therefore be guided by describing "the input provided to the learner, the learner's output, and the interaction that is constructed through the turns consisting of input and output" (Chapelle 1997, 24). Description of observed language and non-language moves in CALL tasks is the first step toward gaining such an understanding. (For a more complete account of the ideal qualities of L2 input, output, and interaction, see Chapelle 1997, 24-25). A second but no less important step suggested by Chapelle is to provide "a means for assessing the degree of authenticity of CALL activities in relation to the activities learners will encounter outside class in the target language" (Chapelle 1997, 25). Taken together, these observable criteria provide applied linguists with a means to evaluate the ideal qualities of the L2 language (pragmatic role, linguistic characteristics, and quantity) that learners use while working on language-related tasks.

Many other similar studies can be cited here, but the challenge still remains: How do we design an effective and responsible interactive approach to reading? Specifically, what are the implications for multimedia-based learning and for related research with such technology? Here, the researcher offers a few recommendations that may aid our future endeavors to

Using Multimedia Annotations

support the learning needs of our students more effectively. They are simplified greatly for the sake of example. All of the suggestions below are based upon current research findings and seek to accommodate individual differences among learners. Much of what is recommended rests on the premise that instructors have access to or are capable of developing digital aids for learning with instructional multimedia materials. It is nevertheless still unclear at this point, however, how multimedia texts (presented in a digital audio or graphic format) are to be designed and presented to students with differing learning preferences and cognitive styles. Using many multimedia "bells and whistles" without there being a sound methodology in place for their use will not ensure that different learners will employ them in the most beneficial ways.

- First, make an inventory of all available multimedia materials and categorize them according to type. These could include digital "audio (e.g., individual words spoken, entire narration of dialogues or texts, background sounds that enhance accompanying video); graphics (e.g., charts, tables, graphs, diagrams); static or still images (e.g., photographs, drawings); and dynamic video (video clips, films, animations)" (Chun and Plass 1997, 72).
- Provide all learners with digital visual aids (e.g., text, still pictures, animated pictures, sound, and video annotations), especially those with low verbal ability who are poor readers. Visual aids have been found to help such learners to build more effortlessly the right mental representations needed for text comprehension (Levie and Lentz 1982; Peek 1993).
- Either allow learners to be in charge of selecting their own digital annotations, or provide your auditory learners with verbal annotations and your visual learners with visual annotations. Tailor-made annotations have been found especially effective for helping learners to recall vocabulary (Chun and Plass 1996a, 1996b).
- Annotate lexical items in a rich variety of information presentation modes (Kellogg and Howe 1971; Chun and Plass 1996a). Supplying such a variety can help learners with differing needs to acquire vocabulary and to comprehend the overall text in the most effective ways possible.
- Offer a visual preview of the text to visual learners, and supply both visual and auditory annotations for text comprehension in general. Auditory learners, on the other

hand, can choose the type of digital multimedia annotations they need for text comprehension (Chun and Plass 1996a, 1996b).

- Make pre-reading activities and comprehension strategy training available to all learners, regardless of their ability levels and learning preferences. All learners benefit immensely from activating their prior knowledge via multiple verbal, visual advance organizers (Hanley et al. 1995; Teichert 1996), and tree graphs (Tang 1992). All of these in turn affect both content schemata and cultural background knowledge (Anderson and Pearson 1984; Carrell 1984, 1985), and integrate newly acquired knowledge with existing mental models. (See also the research by Kang [1997] who studied the effects of using an advance organizer on learners' learning in a computer-simulated environment using HyperCard. As was predicted, the advance organizer had a positive, facilitative effect on learners' learning.)

For such efforts to yield optimal results, however, a few critical issues must be considered. First, if today's ever-evolving digital technology is to be integrated into the classroom successfully, language teachers must have not only the necessary hardware and software, but they must also be able to use them competently themselves. Second, learners must be made familiar with the software, the navigation tools and, in particular, the benefits derived from using them if they are to use multimedia reading software effectively. Finally, to avoid misinterpretations of what it means to "comprehend" a text in another language, instructors are well advised to discuss the concept of comprehension with their learners. As Lomicka correctly asserts, "Many students erroneously interpret comprehension as a process consisting of mere translation and paraphrasing. Students seem to be generally satisfied with achieving a minimal level of comprehension via quick and basic translation. If they are able to translate the words into their L2, then they assume that they have understood the text. In doing this, students often fail to achieve a global understanding of the text" (Lomicka 1998, 11).

Getting learners beyond the "quick and basic translation" of a text is a formidable challenge by any account. This is not to suggest that bottom-up processing skills (i.e., the "mechanical" aspects of the reading process such as single word or phrase decoding, translation, and paraphrasing) are less useful than top-down processing skills (i.e., interpretation, inferencing, and general knowledge associations). In fact, both types of

processing occur in experienced readers, a notion well supported by reading theory research (Goodman 1996; Liontas 1997, 1999; Samuels and Kamil 1984; Silberstein 1987; Swaffar, Arens, and Byrnes 1991). If care is given to both types of processing behavior early in reading instruction efforts, we may be able to avoid a significant problem found among learners by Lyman-Hager and Davis (1996) and Lomicka (1998): a significant dependence on English definitions as a means of understanding multimedia-based annotated texts. Such dependence impedes global text comprehension and should therefore be avoided. For this reason, it is important that future research (including experimental, correlational, introspective, and ethnographic studies) investigate the effect that off-line and on-line measures have on learners' comprehension of authentic texts of various types and lengths. Findings from these investigations could then be judiciously incorporated into state and departmental language curricula, as well as into the development of future multimedia software for reading instruction, evaluation, and measurement.

One needs to emphasize, however, that foreign language educators cannot wait until every research question is answered about how multimedia annotations can best be designed for learner use before using such digital technologies. Indeed, there is no need for this, since the prospects for using CALL today are better than ever before (Ariew 1994; Weible 1994). This is undoubtedly due to the broader range of tasks to which computers can now be put, as well as, more specifically, to recent successes in applying CALL to practical tasks in language learning and teaching (Hope, Taylor, and Pusack 1984; Robinson, Underwood, Rivers, Hernandez, Rudesill, and Ensenat 1985). Pusack (1994) underscores the notion that providing CALL to second language classrooms means engaging in a long-term process whose success ultimately depends on teachers, who must either articulate their needs to those who publish commercial software or be prepared to author courseware themselves. In the meantime, however, while we wait for research to address the most pressing issues regarding CALL, those who wish to begin authoring their own multimedia software may want to consider the interactive approach to reading presented next.

Annotations for Text Comprehension

The reading approach presented next was first developed in 1992. It has since been tested successfully and implemented at both intermediate and advanced levels at various colleges and universities in the United States (Baginski and Liontas 1994a,

1994b). It is believed by the author of this article (not to mention colleagues and students of German who have testified to the success of this approach) that this approach to reading with authentic materials can easily be adapted to digital technology.

Although developed initially for teaching German, the interactive framework of this approach can be used readily for other languages as well. The approach rests on the premise that reading is neither a linear process of learning vocabulary, phrases, sentences, and then paragraphs in that order, nor a collection of skills to be acquired. Rather, reading is viewed here as an interactive process requiring learners to engage simultaneously in various bottom-up, top-down, and interactive processing activities. As a result, this approach takes into account both lower-level processing skills (identification or decoding) and higher-level comprehension and reasoning skills (interpretation, inferencing, and general knowledge associations). Text comprehension is believed to result from the interaction of all these processing types. The following is a look at the interactive approach proposed for reading with multimedia annotations.

Preliminary Cultural Considerations

To achieve optimum results, second language instructors should use authentic texts of varying linguistic and syntactic complexity, genre, style, tone, and diction. In addition, graphics (Tang 1992), images and illustrations (Cohen 1987; Levie and Lentz 1982; Teichert 1996), and (still and animated) pictures (Kellogg and Howe 1971; Omaggio 1979; Peek 1993) ought to be included where necessary as digital glosses and advance organizers of the central ideas embodied in the texts. For example, visual aids and graphics used before, during, or after each text study are especially beneficial as thought-mapping introductory devices, points of departure for group discussions, or additional essay topics (Meskill 1996; Monroe 1993; Rakes 1996; Stickels and Schwartz 1987).

In addition, second language instructors need to select authentic texts that do not portray the culture under study as idyllic and hermetically sealed. Rather, authentic texts need to portray speakers of target languages as members of societies that are struggling with historical-political, social, economic, scientific, and ecological issues, and with the concerns of racial, ethnic, and religious minorities. In other words, selected authentic texts must present speakers of the second language being learned as engaged with a variety of issues—issues that are current and pressing not only for them, but for the international community

as well. Furthermore, instructors should ensure that these texts present speakers of as many ages and walks of life as possible in order to provide a range of insights into the issues at hand.

To this end, second language instructors should select up-to-date culturally authentic reading materials that examine a central issue from a variety of perspectives. Generally speaking, texts should be short enough to be read in one assignment and allow learners to explore each issue in detail. While reading such texts, learners should be frequently asked to draw upon their own ethnic and regional cultural background not only in order to establish—by way of comparison—the learning basis for an understanding of the “foreign” experience, but also to develop an awareness of their own responsibilities as world citizens in an increasingly interdependent global community

Multimedia Annotations: Design and Presentation

In the following discussion of design and presentation, the learning process is divided into sections and sub-sections requiring the use of various language-learning strategies and reading techniques that mirror those employed in well-established communicative language and culture learning practices. It should be clearly understood at the outset, however, that the sections discussed here are not to be presented sequentially to students. Rather, because of the interactive nature of this multimedia approach, each (sub-) section, including accompanying annotations, should be presented either as a hot link or as a pop-up window that learners can access as the need arises. This gives learners maximum control over the types of digital annotations consulted and used during the act of reading.

“Like pieces of a puzzle, each piece is only as meaningful as the company it keeps.”

Like pieces of a puzzle, each piece is only as meaningful as the company it keeps. In other words, if different learners are to be provided with different multimedia aids promoting different cognitive processes and learning preferences, digital presentation of multimedia text material cannot be unchangeably predetermined by the software designer/author/programmer. Such a move locks learners into a multimedia learning path from which there is little escape. Moreover, as shall be seen below, if learners are to acquire a feel for when, where, and how to use a strategy in order to improve their overall reading comprehension, selection options must always be available to them (not to mention easy enough for them to use). Indeed, the design and presentation of reading software—from the simple to the more complex—cannot be a curricular afterthought with no systematic rationale for how learner

interaction can be best assured. As Garrett cautions, "The computer's full potential for interaction with the individual learner cannot be exploited until decisions about the kinds of materials to be used and their design are based on theoretically motivated and research-based insights into the language-learning process rather than on traditional precepts about the language-teaching process" (Garrett 1994, 170).

"Such a move locks learners into a multimedia learning path from which there is little escape."

It stands to reason, then, that there needs to be a match between student needs and the technological capabilities of the medium used in the second language classroom. Student aptitude, attitude, and learning strategies, as well as media attributes are all important variables that software designers need to keep in mind when programming multimedia reading software for multilevel computer-managed instruction. In short, software design must be flexible enough to accommodate a variety of student variables and media-learning formats. The immense potential of a digital multimedia environment indeed hinges upon that environment's capabilities to accommodate an increasingly diverse adult student population effectively with different media-learning formats that aid text comprehension.

Because of the interactive nature of the approach presented here, it is assumed that learners can record their own voices on the computer in response to questions designed to measure reading comprehension, as well as type individual responses to anything requiring a written response. Furthermore, it is assumed that both spoken and written responses can be recalled and revised with a click of the mouse and/or be made available to others via Internet connections in a networked environment. For research purposes only, a record-keeping system that tracks student performance and look-up behavior (i.e., the number and types of multimedia glosses consulted, plus the amount of time taken to do so) can be used with this interactive approach.

With responsiveness to individual student needs in mind, the individual hot-link sections summarized next are offered not as a prescriptive blueprint for the design and presentation of future reading software, but as an example of how this technology can be used to help learners attain global text comprehension.

Text Preview. To prepare learners cognitively for a digital dialogue with the reading material, an advance organizer is used to supply relevant background information about the text's principal issue. This information serves as a springboard

for a number of thought-mapping and brainstorming activities. In turn, these activities help to evoke in the learner's mind the cognitive and linguistic schemata needed for a conceptual understanding of the text.

- **How ____ are you?:** This section consists of a questionnaire in which learners' general knowledge about a variety of topics and sociocultural issues is probed. At times, learners are asked to voice their personal views, attitudes, beliefs, and experiences with regard to the issue(s) under study in order to assess learners' predispositions and assumptions.
- **Knowledge Activation and Hypothesis Building:** This section has three objectives. The first objective is to place readers in a receptive and analytical frame of mind while stimulating their interest in the text selected. The second objective is to activate readers' personal backgrounds and pragmatic knowledge, while the third is to develop their text expectations based on contextual guessing. Various hypothesis-building and brainstorming activities help readers formulate both general and specific ideas regarding the issue(s) at hand.
- **Orientation with Reading Notes:** This section presents pre-reading comprehension questions that serve as advance organizers. As such, they help set the parameters for the text selection. In the process, learners encounter and decode the most important situations, characters, themes, and ideas in the reading passage before reading even a single word. Graphics, static and animated images, digital audio/video and film clips, and designs and drawings are used to introduce specific features of the text, making the material even more accessible and comprehensible.

Authentic Text. It is best to present the text in its original form, without any editing. Text is presented in a hypertext-annotated format, allowing easy access to various multimedia aids for help with morphology, grammar, vocabulary, and cultural considerations that are important for comprehension. Tasks related to the text should be open-ended to maximize learner opportunity for self-expression, and carefully crafted to fit a variety of language-teaching contexts and student needs. It is strongly suggested that the tasks accord with parameters set forth in national benchmarks (e.g., National Foreign Language Standards 1996; ACTFL Proficiency Guidelines 1982, 1986) for state and departmental curricula.

Intensive Text Study. The cornerstone of reading and interpretive mastery, this section requires learners to read for meaning and to analyze the text. Not only are learners asked to identify those elements in a text that constitute its literariness but, even more importantly, to understand the locally relevant meaning of a lexical item, sentence, and the larger discourse.

- **Text Questions:** This section promotes the acquisition of those receptive and productive skills that are indispensable for the development of critical thinking. A few examples of these skills are: awareness of text types and rhetorical context; ability to analyze the stylistic and imagistic techniques employed by the author(s); ability to analyze imagery and its aesthetic function in the depiction of ideas; ability to analyze narrative perspective, temporal organization, and stylistic coherence of the text; ability to gauge authorial intention; and ability to analyze thesis development. To promote an advanced and sophisticated understanding of the text's content, these questions should be interspersed throughout the text. The reading comprehension questions should not be restricted to the mere extraction of facts. Instead, they should also focus on a critical evaluation of the text's content. Their presentation could take the form of a question or an exercise that sends learners back to the text to demonstrate their global as well as local understanding of the text's content. For example, learners could be asked to select an appropriate heading (or subheading) for each paragraph of the text from a list of several (sub)headings; to guess the linguistic background (i.e., age, citizenship, language proficiency) and to gauge the epistemic stance of the author; to analyze how the author crafts his or her opinion (or facts); to identify lexical and discourse features that sway the reader to think in a certain direction; to analyze situations, semantic motifs, and symbols; to mine the reading passage for key words and information; to explain the meanings of specialized vocabulary and cultural expressions (including metaphors, idioms, proverbs, similes, and fixed collocations); to compare ideas found in different parts of the text; and, finally, to propose solutions to the problems addressed in the text.

Post-Reading. This section aims to integrate reading with speaking and writing skills, and to direct learners toward critical thought and discussion as well as creative expression. Above all, it evokes some fundamental constructs of Vygotskian sociocultural theory arguing that all knowledge is socially

constructed. That is, the post-reading section of the proposed software program reveals insightful patterns of learner-learner and learner-teacher interaction as learners and teachers attempt to co-construct meaning and enable the acquisition of skills in a computer-mediated context.

The activities below are not necessarily computer-based and combine receptive skills with productive skills. All activities, however, are conducted in the target language.

- **Personal Responses and Interpretation:** To lead learners to a critical and reflective dialogue with the ideas contained in each reading passage, the questions in this section ask learners to judge critically the values embodied in the text and to express in an open, non-biased manner their personal views and values with respect to the issue(s) under scrutiny. In the process, learners examine previously unchallenged assumptions and biases. Responses can be recorded or written in separate, printable screens for future dissemination and reflection.
- **Roundtable Discussions:** Personal responses to a text should next be presented in roundtable discussion, because the exchange of ideas takes place in sociocultural contexts. To help learners imagine a real-life encounter with people such as those encountered in the text just read, learners are frequently asked to assume the role of the person or group featured in the reading passage. Synchronous on-line chat groups, news groups, and e-mail-supported discussion groups are all excellent outlets for striking a balance between virtual-based learning environments and classroom-based instruction. Other interactive tasks, such as skits, impromptu interviews, and role playing promote the development of public speaking skills and creative expression. During all these activities, the instructor assumes the role of learning facilitator, monitoring and guiding learners in the language-acquisition process.
- **Time to Write:** Engaging in interactive contextualized activities helps learners to apply their reasoning skills both orally and in writing. Therefore, within well-defined contextual parameters, learners are given the opportunity to express in writing their views on issues related to the reading in question. They could, for example, be asked to react to the text in general, or to write a critical reflection on a certain aspect of the text's content. In addition, they could

be asked to write any of this material in letter (memo, e-mail, voicemail, fax, telephone message) format in order to learn the necessary skills particular to letter writing, utilizing the necessary content and structure, different styles, and registers. Advertisements, editorials, flyers, book jacket notes, journalistic reporting, letters to the editor, personal essays, diary compositions, fantasy and futuristic story-telling, poems, and songs could easily become the desired modes and products of creative writing. Writing can be done either on the computer (e.g., Internet, chatrooms, e-mail) or on paper.

“Engaging in interactive contextualized activities helps learners to apply their reasoning skills both orally and in writing.”

Test Your Knowledge. In addition to offering interesting facts about a given issue, each authentic reading should also offer a self-test, which learners can take if they wish, to allow them to evaluate their knowledge of the issue(s) at hand. Learners should be encouraged to take this self-test only after they have sufficiently processed, analyzed, and comprehended the text. Cloze tests, C-tests, multiple-choice tests, summaries, retellings, paraphrasing, intensive reading questions, inference questions, simulations, sequential ordering of text parts, storyline, story completion, translation, word/sentence/paragraph level analysis, true-false items, matching items, logical-illogical items, sentence completion, following directions, finding of nonsense words/phrases/sentences in narrative text or dialog, supplying punctuation and capitalization in running text, and making lists of specific items from the text are some of the testing formats that could be adopted here. These computer-assisted language tests can be analyzed item by item for reliability and validity, and then turned into a large databank for placement purposes or for establishing a learner’s level of reading proficiency in the target language. These same language tests could become, using a combination of item response theory and the concept of flexilevel tests (Lord 1980), language tests that uniquely tailor their test items to examinees’ own ability levels.

Conclusions and Implications

In summary, when interactive technologies are integrated in language learning and teaching, learners increase significantly their communicative competence and develop more efficient cognitive, metacognitive, and communicative strategies and skills as a result of their continuous exposure to and practice with multimedia and Internet resources in their classrooms. Sufficient exposure to meaningful structured input in various digital media formats, in particular streaming media through RealPlayer and QuickTime, has been shown to be both positive and effective in student evaluations.

“Despite its overwhelming acceptance and great potential for the future, digital multimedia must be used with specific pedagogical ends in mind and not just as a novel diversion if it is to help facilitate second language learning and acquisition.”

No one disputes that our world is characterized by unprecedented rapid technological changes. Many second language instructors are already convinced of the immense value that multimedia technology can have for their teaching. Nevertheless, the potential benefits of using multimedia technology in the classroom cannot be realized unless instructors master the challenges of digital technology and pedagogy. Admittedly, the initial investment of time and energy required simply to learn the basics of such technology, not to mention the time and energy later required to develop digital multimedia teaching materials, can be overwhelming. Many instructors may be willing to embrace multimedia for teaching but may be understandably reluctant to experiment with specifically digital technology in the curriculum. Those of us who have done so can attest to the painful fact that converting course material into interactive digital multimedia formats is an enormously time-consuming activity with no guaranteed outcome.

This reality aside, emphasis should be placed on coherence and production values, which are best assured through collaborative effort and skilled use of technology. Thanks to recent technological advancements in computer hardware and software engineering, course material can now be converted into digital formats without one's having to learn a programming language. While authoring material with predesigned templates such as the state-of-the-art Macromedia Director still requires a great investment of time and energy to learn the program, software such as Microsoft's PowerPoint or even Apple's old HyperCard allows the user to create digital multimedia materials more easily and affordably, if with notably less flexibility and without the built-in functions of a template.

Despite its overwhelming acceptance and great potential for the future, digital multimedia must be used with specific pedagogical ends in mind and not just as a novel diversion if it is to help facilitate second language learning and acquisition. By extension, the greater the multiplicity of media forms integrated in the programming of reading software for multilevel computer-managed instruction, the greater our responsibility to support learners in becoming more aware of the variety of meanings inherent in these forms. Digital technology is a step in the right direction but is still in its infancy. Whether our profession will be able to go beyond the bells and whistles of hyper-texts and pop-up windows to forge a deeper understanding about what multimedia annotations can and cannot accomplish for specific learners in specific learning environments remains to be judged by those who are willing to

develop and use digital technologies in the classroom. The future of digital technology is within our reach. It is up to our profession to begin to realize this technology's untapped potential. ♦

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