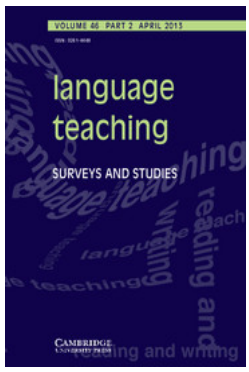

Computers and language learning: an overview

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Computers and language learning: an overview

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Recent years have shown an explosion of interest in using computers for language teaching and learning. A decade ago, the use of computers in the language classroom was of concern only to a small number of specialists. However, with the advent of multimedia computing and the Internet, the role of computers in language instruction has now become an important issue confronting large numbers of language teachers throughout the world.

This article will provide an overview of current teaching practices and research related to the uses of computers in the language classroom. It will be divided into four main parts: (1) a brief history of computer-assisted language learning (CALL), (2) a survey of current practices and research, (3) a prospectus toward the 21st century, and (4) a list of resources for further information.

1. The History of CALL

Computers have been used for language teaching since the 1960s. This 30+ year history can be roughly divided into three main stages: behaviouristic CALL, communicative CALL, and integrative CALL. Each stage corresponds to a certain level of technology as well as a certain pedagogical approach.

Behaviouristic CALL, conceived in the 1950s and implemented in the 1960s and 1970s, could be considered a sub-component of the broader field of computer-assisted instruction. Informed by the behaviourist learning model, this mode of CALL featured repetitive language drills, referred to as drill-and-practice (or, pejoratively, as 'drill-and-kill'). In this paradigm, especially popular in the United States, the computer was viewed as a mechanical tutor which never grew tired or judgmental and allowed students to work at an individual pace. Though behaviourist CALL eventually gravitated to the personal computer, it was first designed and implemented in the era of the mainframe. The best-known tutorial system, PLATO, ran on its own special hardware consisting of a central computer and terminals and featured extensive drills, grammatical explanations, and translation tests at various intervals (Ahmad, Corbett, Rogers, & Sussex, 1985).

The next stage, communicative CALL, emerged in the late 1970s and early 1980s, at the same time that behaviouristic approaches to language teaching were being rejected at both the theoretical and pedagogical level, and when new personal computers were creating greater possibilities for individual work. Proponents of communicative CALL stressed that computer-based activities should focus more on using forms than on the forms themselves, teach grammar implicitly rather than explicitly, allow and encourage students to generate original utterances rather than just manipulate prefabricated language, and use the target language predominantly or even exclusively (Jones & Fortescue, 1987; Phillips, 1987; Underwood, 1984). Communicative CALL corresponded to cognitive theories which stressed that learning was a process of discovery, expression, and development. Popular CALL software developed in this period included text reconstruction programs (which allowed students working alone or in groups to rearrange words and texts to discover patterns of language and meaning) and simulations (which stimulated discussion and discovery among students working in pairs or groups). For many proponents of communicative CALL, the focus was not so much on what students did with the machine, but rather what they with each other while working at the computer.

Though communicative CALL was seen as an advance over behaviouristic CALL, it too began to come under criticism. By the late 1980s and early 1990s, critics pointed out that the computer was still being used in an *ad hoc* and disconnected fashion and thus 'finds itself making a greater contribution to

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marginal rather than central elements' of the language learning process (Kenning & Kenning, 1990, p. 90). This corresponded to a broader reassessment of communicative language teaching theory and practice. Many teachers were moving away from a cognitive view of communicative teaching to a more social or socio-cognitive view, which placed greater emphasis on language use in authentic social contexts. Task-based, project-based, and content-based approaches all sought to integrate learners in authentic environments, and also to integrate the various skills of language learning and use. This led to a new perspective on technology and language learning, which has been termed integrative CALL (Warschauer, 1996b), a perspective which seeks both to integrate various skills (e.g., listening, speaking, reading, and writing) and also integrate technology more fully into the language learning process. In integrative approaches, students learn to use a variety of technological tools as an ongoing process of language learning and use, rather than visiting the computer lab on a once a week basis for isolated exercises (whether the exercises be behaviouristic or communicative).

If the mainframe was the technology of behaviouristic CALL, and the PC the technology of communicative CALL, the multimedia networked computer is the technology of integrative CALL. The multimedia networked computer–with a range of informational, communicative, and publishing tools now potentially at the fingertips of every student–provides not only the possibilities for much more integrated uses of technology, but also the imperative for such use, as learning to read, write, and communicate via computer has become an essential feature of modern life in the developed world.

Many of the changes in CALL paradigms flow from economic and social changes. The shift to global information-based economies has meant a dramatic increase in the need to deal with large amounts of information and to communicate across languages and cultures. Memorisation is less important in this information-rich time than effective search strategies, and students need the ability to respond and adapt to changes rather than training in a single way to approach a task. Teacher roles have also changed with the times. Teachers are rarely the sole source of language information in these days of global interconnectedness, and the literary corpus that may have been the basis of their foreign language training is not the only body of knowledge worth learning. The assumption from cognitive theory is that teachers do not pour information from their store into the heads of waiting and willing students, but that students actively interpret and organise the information they are given, fitting it into prior knowledge or revising prior knowledge in the light of what they have learned (Dole *et al.*, 1991; Van Dijk & Kintsch, 1983). As a result of all these changes, the teacher has become a facilitator of learning rather than the font of wisdom, and will find, select, and offer information in a variety of ways on the basis of what the students must learn in order to meet diverse needs.

Having and manipulating language data in multiple media provides learners with the raw material they can use to re-create the language for themselves, using their own organising schemes. Activities that encourage students to explore and be creators of language rather than passive recipients of it further the idea of the learner as an active participant in learning (Brown, 1991). While both teachers and learners see some utility in basic language drills, such as of irregular verb forms, repetitive practice only fits into a small part of language learning when the goal is communication in the target language.

As facilitators, teachers must in many ways know more than they would as directive givers of information. Facilitators must be aware of a variety of material available for improving students' language skill, not just one or two texts. They also need to know how to teach learners to use the material effectively. Teachers as facilitators have to be able to respond to the needs that students have, not just what has been set up ahead of time based on a curriculum developer's idea of who will be in the classroom. Teacher training is a key element to success in this more flexible language classroom, so that teachers can use multimedia and other resources effectively.

2. Current Practices and Research

The three stages mentioned above do not fall into neatly contained timelines. As each new stage has emerged, previous stages continue. Current uses of computers in the language classroom correspond to all three of the paradigms mentioned above. We will begin this examination by looking at the teaching practices and research on the use of stand-alone CALL software programs. We will then analyse practices and research on the uses of the Internet in language learning and teaching.

2.1 CALL Software Teaching Practices

One of the reasons that administrators buy software is with the thought of providing an integrated teaching solution–something that will:

1. provide realistic, native-speaker models of the language in a variety of media
2. offer a language learning curriculum
3. do a needs assessment
4. determine the best next step for the learner and provide practice with that skill area
5. record what the student has done, along with an evaluation

6. be available at any hour and require no additional pay or benefits.

A number of high-end packages have been designed to come as close as possible to meeting those needs in terms of English language teaching. These include CALI's *Ellis*, DynEd's *Dynamic English*, Berlitz's *English Discoveries*, Jostens' *English Language Development* and *STEPS*, and Hartley's *Project Star. ESL 2000* from HRB Systems incorporates software from some of these and other vendors into a comprehensive system that includes management software. What distinguishes these from many other multimedia programs is that they include a curriculum, not just distinct elements for practice. The quality of the curriculum and its relevance to the target learners is a matter for each institution to determine, since each of the packages is designed with a somewhat different group of learners in mind. Some, like the Jostens and Hartley products, are made for a North American English as a Second Language audience; others, such as the CALI and DynEd offerings, are geared more toward an English as a Foreign Language setting.

Another similarity in these high-cost products is their relative immutability. There is little or no provision for teacher-customised content. After all, it would be difficult to incorporate teacher-generated lessons into a fixed curriculum. Some of the programs have teacher's guides and suggest ways to incorporate the lessons into a regular classroom, but the assumption is that students will tend to work through the computer-based curriculum independently of what goes on in the classroom. The most stand-alone of these also tend to be the least open-ended in the activities they provide; a human teacher is needed to evaluate free responses, where they occur.

A number of software programs offer practice in a variety of skills, but without extensive management systems or prescriptive curricula. Most expect the learner, often with the help of a teacher, to decide what skills to work on and what media to use. These can range from comprehensive to limited, very expensive to quite affordable. On the high end for English language teaching are programs like Davidson's *English Express* and *Story Club* and American Language Academy's *ALA Lab System*. The Davidson products in particular offer extensive teachers' manuals to help teachers incorporate the software into their classrooms. In the intermediate price range and with more limited but still extensive content are *MacEnglish* from DynEd and *MacESL* from Hacienda La Puente Adult Education for English language teaching, and The Learning Company's *Learn to Speak* series and Syracuse Language System's *Spanish/French Your Way* for multimedia language instruction in a variety of languages. Most of these products have some sort of record-keeping, though not as extensive as that of the more expensive systems.

Where the computer is not seen as a substitute for a teacher, schools may purchase smaller, more limited, but more flexible software that individual teachers will use as an add-on to instruction or that will be placed in libraries as language references and resources. Language teachers have been especially blessed in this category of software, with hundreds of programs available. The benefits of adding a computer component to language instruction are many, and include:

1. multimodal practice with feedback
2. individualisation in a large class
3. pair and small group work on projects, either collaboratively or competitively
4. the fun factor
5. variety in the resources available and learning styles used
6. exploratory learning with large amounts of language data
7. real-life skill-building in computer use.

One of the great benefits of the growth of multimedia is that software vendors (and language teachers) no longer feel bound to grammar practice as the main goal of computer use in the language classroom. While the process has taken longer in the foreign language arena than in English language teaching, the movement toward integrative use of computers is clearly taking place. There are still a great many grammar and vocabulary drill programs available, but at least the vocabulary ones have started to be contextualised and to incorporate graphics, audio recording and playback, and video. Drills do have a place in language learning, particularly in the first stages of vocabulary acquisition where giving the same information in multiple modes, such as visual plus aural plus textual, enhances recognition and recall. More sophisticated error-checking can provide students real help in the feedback they receive, directing them to further practice or moving them to the next stage. Those who do need extra help with those aspects of language that improve with practice can use small, focused programs to give them additional time and assistance outside of regular class time.

Pronunciation work in particular has benefited from multimedia. Most pronunciation programs now incorporate some sort of voice recording and playback to let students compare their recording with a model. Many of the English pronunciation programs, such as *Ellis Master Pronunciation* from CALI, *American Accent Program* from Ford Language Institute, and *American SpeechSounds* from Speech Communication, have video clips and animations of the mouth making specific sounds. Some vocabulary programs, such as *Practice Makes Perfect* and *Vocabulary Builder* from The Learning Company, *See It, Hear It,*

Say It! from Courseware Publishing International, and *Triple Play Plus* from Syracuse Language Systems, use speech recognition technology to help students see how close they come to the target pronunciation in several languages. A few programs, such as *Speech Viewer* from IBM and *Video Voice* from MicroVideo, let students try to make the graphical representations of their speech overlap a teacher-recorded template. These visual cues work in conjunction with aural cues to provide sophisticated feedback.

Most drills now include games as well, using the power of the computer and competition for or a collaboration toward a goal– the fun factor–to motivate language learning. Notable among the drill-as-game are *Blackbelt Japanese* from Educorp; English, French, Spanish, and German versions of Hangman (*Hangman, La Guillotine, La Corrida de Toros*, and *Apfelschuss*) from Gessler; *Matchmaster* from Wida; and *Word Attack!* from Davidson. These programs provide a varying amount of instruction along with the games, but all expect the teacher to do most of the work in introducing the concepts that students will practise.

Games and the fun factor are not only for drills. A large panel in the tapestry of language learning software is made up of programs designed for collaborative work, where the language that takes place in the pair or small group of students in front of the computer is as, if not more, important than the language on the computer screen. Early examples of this are Chris Jones's *Kingdom* and *Fast Food*, text-based simulations of staying in power and making money on a food booth, respectively. The computer served as the dice-roller, deciding whether natural disasters or scarce supplies would occur to affect the results of the decisions the students had made. A multimedia version of the same type of program is found in the *Carmen Sandiego* series from Broderbund and *Who Is Oscar Lake?* from Gessler, available in a variety of languages. *Traci Talk* from Courseware Publishing International has added a speech recognition element to the multimedia mystery story it provides, encouraging students to speak to the computer as well as to each other. One of the most sophisticated simulations is *A la Rencontre de Philippe* from Yale University Press. This interactive video program has the learner help Philippe find an apartment by reading ads, listening to answering machines, looking at maps, and using a wide variety of authentic resources in French. The high quality of the video in this program is in part due to its use of videodisc, so the pictures can be larger and clearer than digitised video would provide. Dunkel (1991) and Crookall *et al.* (1990) describe in detail some of the many advantages of using simulations for language learning.

Collaboration and competition can be built into almost any type of language learning activity, on and off the computer. The classic strip story, where each student adds a sentence to that of the immediately-preceding student without seeing anyone else's sentences, can take an electronic turn with any word-processor that includes the facility for hiding text. Text reconstruction programs such as cloze activities and sentence jumbles or crossword puzzles will become less frustrating and more satisfying when students are collaborating to find the missing words; their partnership against the machine motivates them to keep trying. Even drills are more interesting when students can discuss their answers and try to figure out their mistakes. As the title of an article by Chris Jones (1986) so aptly states, 'It's not so much the program, more what you do with it'. While software can build in a great deal of language data and many possibilities for learning, the teacher has a very important role to play in furthering language acquisition by encouraging productive strategies at the computer.

Although much of what is done at the computer can be done in other ways, some activities are far more productive with the resources that the computer can bring to bear. Text reconstruction is a good example. A teacher can create a sentence jumble by cutting up pieces of paper, but programs such as *NewReader* from Hyperbole can do it painlessly. With a paper cloze, students who get stuck on a word have to give up completely and look at the whole text (or ask the teacher individually for a specific answer); on the computer, they can get a letter or word as a hint and go on. Both *NewReader* from Hyperbole and *Text Tanglers* from Research Design Associates can create a variety of text reconstruction activities for a plain-text word-processed document, greatly expanding any classroom reading that the teacher has prepared.

Crossword and word search puzzles are examples of activities that take a great deal of time to prepare by hand, but very little time to do on the computer. The teacher types in a series of words, and the machine formats them appropriately. With a crossword puzzle, the teacher is then prompted for each clue, and the machine formats the whole crossword with clues on the page to be worked on the computer or printed out. Because the process is easy, students can create crosswords for each other. A program like *Crossword Creator* from Centron adds a thesaurus, making it even easier for students and teachers to formulate clues.

The writing process is another area where computers have added a great deal of value. Some programs, such as *IdeaFisher* from IdeaFisher Systems and *Inspiration* from Inspiration Software, help students in the pre-writing stage to generate and outline ideas. Most word-processors now come with spelling checkers, giving weak spellers some help in finding their errors and recognising the correct spelling from a list of options. Dictionaries, both translating ones like the *Collins On-Line Dictionaries*

from Harper/Collins and monolingual ones like Softkey's *American Heritage Dictionary*, the *Longman Dictionary*, and the *Oxford English Dictionary* for English, and Gessler's *Key into French/German/Spanish* for those languages, can run in the background and be accessed with a keystroke. Many dictionaries incorporate some grammar help, and some, like the *Longman Multimedia Dictionary*, have sound and video clips to help learners recognise a word when it's spoken and put it into context. For beginning literacy students, Hartley's *My Words* and Teacher Support Software's *Language Experience Recorder*, as well as a number of word-processors, have text-to-speech capability. The quality of text-to-speech software has improved dramatically over time, but the speech is still not particularly natural-sounding. For accurate translation into speech, the computer also generally needs to be running the appropriate language-specific operating system.

Computers are very good at storing, manipulating, and retrieving large amounts of information, making them particularly useful in the area of 'data-driven learning'. This concept, popularised by Tim Johns, refers to giving students a mass of language data and the tools to examine it. Students can then build their own explanations of how language works. Having discovered the linguistic rules themselves, students are more likely to remember and use them. Where a teacher may be able to come up on the spur of the moment with a few sentences showing, for example, the use of the past perfect, a concordance program such as Oxford's *MicroConcord*, Longman's *Longman Mini-Concordancer*, and Athelstan's *Monoconc for Windows* could generate hundreds from a large quantity of source text (a 'textbase'). Corcordancers, programs that scan large quantities of text for specified words or phrases and present the target words or phrases with a bit of context, have moved gradually from the realm of Biblical and linguistic research into the language classroom. Intermediate and advanced students can use the concordancer themselves to research the usage of a particular word or grammatical structure, while teachers of beginning students can look through the concordancer's results to select appropriate examples for use in class. Domain-specific textbases can be compared to show how usage can change, depending on the setting. Current computers with the processing power to work quickly through thousands of words have made classroom use of concordancers practical.

A related way of examining usage, also using a large textbase, is in finding collocations for words–the words most likely to occur in conjunction with or quite close to a target word. For example, common collocations of the word 'charge' would be 'in' (in charge) and 'take' (take charge), as well as 'of' (charge of) and 'with' (charge with). Students could also see that 'office chair' was a possibility, but not 'chair office'. *Adam and Eve* from Oxford University Press finds collocations and helps teachers create different kinds of exercises from a textbase.

A somewhat serendipitous effect of using multimedia, the Internet, and collaborative tasks in language learning is the real-world benefit to students of becoming more sophisticated in using computers and more experienced with a group approach to projects. Computer use is taken for granted in modern companies, and more and more businesses feel the need for an Internet presence, especially as they grow larger. Schools of business in the United States now routinely have students work in groups on case studies and other problems to prepare them for the team approach required of executives in many businesses. Collaborative language learning with computers fits right into this real-world model.

Research on Software-Based Learning Activities

Research on the effectiveness of new technologies in education, including the use of computers in language teaching, has been an ongoing process. A graduate student who set out to show the effectiveness of books in the classroom would quickly be counselled to refine the topic in order to make it meaningful, and the same advice would be given to someone trying to measure computer effectiveness in the classroom. Chapelle and Jamieson have long suggested that research on computers incorporate the areas known to be relevant in language acquisition (1986, 1989, 1991; and Chapelle, 1990 and 1995), such as learner field dependence/independence and learning strategies. With the rapid changes in computer technology, too, zeroing in on whether and in what ways computers can be used to enhance learning has been aiming at a moving target. Research on student behaviour at text-based DOS or Apple II computers, for example, may have little relevance to what students do at multimedia machines with graphical interfaces. As both teachers and students become more familiar with the technology, they respond to it in different ways.

Still, research can give some insight into how technology can and should be used, even if there are no definitive answers. The changes or lack thereof over time in what teachers and students do with and think about technology provide a perspective in viewing the role of computers in education, and maybe even some ideas about activities that motivate students and encourage learning. Proof is elusive, but as more research is performed, we come closer to having a sense of the role that technology can and should play.

Some of the major areas of software-related research in CALL have been the amount and types of interaction at the computer; effects of skill-building software, particularly writing; responses to multimedia; and attitudes toward computers and CALL. Basena

and Jamieson provide an excellent overview of recent research (1996) and an annotated bibliography of ESL CALL research (1996/1997). Basena and Jamieson point out that while the proliferation of studies is a 'healthy trend for a growing field' (1996: 19), there is no clear research agenda for the field as a whole and that the wide variations in designs and measures 'do not lend themselves to reproduction or generalisability' (p.19). Other excellent bibliographies are online: a brief annotated bibliography by Ridwan Sedgwick (1997), Sharp and Liu's (1997) 1990-1997 annotated bibliography, John Higgins's (1997) overview of the literature, and Athelstan's (1997) 1300-item bibliography.

The question of how students interact at and with the computer has been addressed in a number of studies, with Piper's (1986) one of the earliest. In her study, as in many others later (cf. Abraham & Liou, 1991; Dudley, 1995; Dziombak, 1991; Levy & Hinckfuss, 1990; Meskill, 1993; Murillo, 1991; Pujol, 1995/96), the type of software and the tasks teachers set for students had a large effect on the type and quality of student interaction with each other when working in pairs or small groups. Overall, software that requires a minimum of verbal interaction generates very little, while having students write a joint report or otherwise produce something collaboratively results in a substantial amount of interaction.

Research on specific skills other than writing has tended to focus on student attitudes toward drills and effectiveness of drills (Abraham, 1985; Al-Juhani, 1992; Botiono, 1992; Dalgish, 1991; Evans, 1993; Kleinmann, 1987; Robinson, 1989; Schaeffer, 1981; Van der Linden, 1993; Wang, 1993). The results have been mixed, largely because the types of software, teacher roles, and student tasks have been quite diverse. A recent exception to the focus on drills is Hsu *et al.* (1993), who looked at what students did in an exploratory environment. Other non-empirical research has described the use of concordancers (Johns & King, 1991; Tribble, 1990; Tribble & Jones, 1990) as a tool for exploration of vocabulary and grammar. One skill area where research is just beginning is listening, probably because sound-capable computers were not in widespread use until fairly recently.

Research on writing has traditionally explored how students felt about and performed with word-processors. Daiute's (1985) *Writing and Computers*, while not empirical research, set the stage for much of what teachers did with writing in the classroom, in the language arts as well as in foreign language teaching. Studies by Neu and Scarcella (1991) and Phinney (1991) found that students had positive attitudes toward writing with computers and less apprehension about writing, respectively. Thaipakdee (1992) found better attitudes toward writing and computers corresponded with better writing. Writing now includes research on e-mail correspondence as a way of improving motivation and writing skills. The broad area of writing with computers is often referred to as 'computer mediated communication', and it has its own journals, including the *Computer Mediated Communication Magazine* and the online *Journal of Computer Mediated Communication* (http://jcmc.huji.ac.il/), as well as the more established *Computers and Composition*.

Chen (1997) points out an interesting result in her study on the use of a grammar checker specifically designed to help Taiwanese students with their writing. She found that students who got computerised error feedback did more editing and improved their writing, but those who received more detailed and personalised error feedback improved their writing more than those who received only generalised feedback. This fits with work done by Johanesen and Tennyson (1983) in the general area of feedback.

Interactive video research gave some of the first results about multimedia effectiveness in language teaching. Verano's (1989) study of interactive video for Spanish teaching, for example, found that the more interactive the video work, the more students retained. De Felix *et al.* (1990) also had favourable results, showing that ESL students in a fourth grade class were motivated by the use of interactive videodisc. Liu (1992) found that computer-based hypermedia enhanced vocabulary learning, while Engelsberg (1997) had mixed results from a multimedia program. In Englesberg's study, students enjoyed the multimedia courseware a great deal for the first five weeks of the term but became increasingly dissatisfied and did not perform as well as time went on. Here, as in other areas of effectiveness research, the variables are complex.

Some questions regarding student attitudes toward computers seem to be part of most studies, including many of those cited here. Students tend to like using computers, even when they may not make much progress (Stenson *et al.*, 1992)–and when they may feel that computers do not necessarily improve their language learning (Schcolnik *et al.*, 1995/96). Given the number of variables associated with language learning and the difficulty in controlling those variables, particularly in a second language learning setting, it is not surprising that those who design studies prefer to research the easier area of student attitude. Teacher responses to computer use are also mixed; for example, Walker (1994) describes teacher attitudes to the introduction of CALL in Saudi Arabia as generally positive, but with hesitation on the part of some teachers about turning over control to students.

At this point, what is most clear as a result of research is that students tend to enjoy using computers, and that we need much more work to identify the factors involved in using software effectively for language teaching. Teachers will continue to refine their techniques with CALL over time and, it is hoped, continue to contribute to research being done in the area.

2.2 The Internet

It is the rise of computer-mediated communication and the Internet, more than anything else, which has reshaped the uses of computers for language learning at the end of the 20th century (Eastment, 1996). With the advent of the Internet, the computer–both in society and in the classroom–has been transformed from a tool for information processing and display to a tool for information processing and communication. For the first time, learners of a language can now communicate inexpensively and quickly with other learners or speakers of the target language all over the world. This communication can be either synchronous (with all users logged on and chatting at the same time) or asynchronous (with a delayed message system such as electronic mail). Finally, with the World Wide Web, learners of many languages have access to an unprecedented amount of authentic target-language information, as well as possibilities to publish and distribute their own multimedia information for an international audience. We will examine each of these aspects in turn: synchronous communication, asynchronous communication, and the World Wide Web.

2.2.1 Synchronous Communication

Synchronous or 'real-time' communication can be accomplished either using special software programs for local area networks, such as Daedalus Interchange by Daedalus Inc. or CommonSpace by Sixth Floor Media, or via the Internet, using a variety of chat media such as MOOs (technically, 'Multi-user domains Object Oriented'), Internet Relay Chat, or Web chat programs.

Computer-assisted discussion over local area networks has been especially popular in the United States, in foreign language, ESL, and English composition classes. During synchronous computer-assisted discussion, each student sits at an individual computer. With programs such as *Daedalus Interchange*, the screen is divided into two parts. Students compose their messages on the bottom half of the screen. After students hit the send button, the message appears almost instantly on the top half of all the other computers in the class. The messages are listed in chronological order, with easy scrolling for re-examining previous messages. Such discussion can be carried out among the whole class or among smaller specialised conferences.

Research on the use of computer-assisted discussion for language teaching has focused on the questions of participation, language use, and writing improvement. Numerous studies have found that computer-assisted discussion features participation which is dramatically more balanced than face-to-face discussion, with far less domination either by the teacher or by particularly vocal students (Chun, 1994; Kelm, 1992; Kern, 1995; Sullivan & Pratt, 1996; Warschauer, 1996a). This is likely due to the fact that everyone can 'speak' at once, without having to seize the floor.

The language used in computer-assisted discussion has been shown to be more lexically and syntactically complex than in face-to face discussion (Warschauer, 1996a). This is likely due to the written nature of computer-mediated communication, which allows more planning time than oral communication and adopts more written syntactical features. For whatever reasons, computer-mediated discussion seems to be a good vehicle for helping students push their language to greater levels of complexity. Printed transcripts of computer-mediated discussions can also be used later for grammatical analysis or lessons (Kelm, 1992; 1995). Finally, there has been at least one study that claims that semester-long participation in computer-assisted discussion was more beneficial to the development of student writing than was participation in oral discussion (Sullivan & Pratt, 1996).

For these reasons, many teachers of general language classes have found computer-assisted discussion advantageous on an occasional basis as a supplement to oral discussion. Writing teachers have used it on a more frequent basis, even daily.

Synchronous communication at a distance can be carried out via MOOs, Internet Relay Chat, or Web-based chat programs. MOOs have been the most popular to date, but they will likely be supplanted by web-based chatting in the future. The particular interfaces of these programs tend to result in shorter, simpler sentences than does *Daedalus Interchange*, which allows users to easily write longer sentences or paragraphs. MOOs and chat seem most beneficial either when there is a particular need for long-distance partners to communicate, or as an out-of-class activity to give students additional time on task (Pinto, 1996).

2.2.2 Asynchronous Communication

Asynchronous communication is carried out most frequently via e-mail; other tools include bulletin boards, newsgroups (such as on 'USENET'), and web-based conferencing systems. E-mail is most direct in that messages go directly to students' individual mailboxes. The other systems, which require students to log on to sites to read messages, lack the convenience of e-mail; they do, however, allow messages to be threaded, thus facilitating more easy access to particular parts of long, complex discussions among many people.

E-mail and other forms of asynchronous computer-mediated communication have been used for a variety of purposes in second language classes. Many teachers in college and university writing classes have

used e-mail discussion groups within their classes to give students opportunities for authentic writing assignments (see, for example, a series of articles by Janda in Warschauer, 1995). Teachers at all levels, from primary to tertiary, have used long-distance e-mail exchanges to give students greater opportunities for authentic communication (either with native speakers or with other learners of the language) and for carrying out collaborative projects, such as comparisons of film and literature (Soh & Soon, 1991), compilations of folklore (Gaer, 1995), business simulations (Feldman, 1995), and survey-based research (Kendall, 1995).

Researching the uses of e-mail in the language classroom is complicated by the fact that much of the communication takes place outside class hours and in uncontrolled conditions. At least two ethnographic studies have attempted to describe the processes and results of using e-mail over the period of a semester. Tella (1991; 1992a; 1992b) followed several Finnish high school classes as they carried out an exchange with classrooms in England. He found that, compared to the ordinary English classes in Finland, these classes became much more learner-centred, with learners' time and effort devoted to authentic reading and writing tasks related to the authentic communication with partners in England. Warschauer (1997) looked at the use of e-mail between a teacher and her students in a graduate ESL writing class; he found that e-mail was a powerful medium for apprenticeship learning, with the teacher able to provide students with detailed and rapid feedback on the immediate problems and questions that they had. This benefit, though, seemed largely due to the teachers' willingness to put a lot of time and effort into reading and responding to students' e-mail messages, a luxury that many teachers might not have. Finally, a study by Wang (1993) compared dialogue journals written with paper and pencil (by one group of ESL students) and transmitted over e-mail (by a second group). She found that the e-mail group communicated more frequently, asked more questions, responded to more questions, and used a greater variety of language functions than did the paper-and-pencil group.

2.2.3 The World Wide Web

The most recent medium of computer-mediated communication used in the second language classroom is the World Wide Web. Part library, part publishing house, part telephone, part interactive television, the Web represents one of the most diverse and revolutionary media in human history. It is already starting to transform academia, business, and entertainment; there seems little doubt that it will eventually have a profound impact on education as well.

The World Wide Web can be used in a myriad of ways for language teaching. Published accounts have discussed the use of the Web for providing linguistic exercises (e.g., Li, 1995), for accessing authentic reading materials (e.g., Lixl-Purcell, 1995), for stimulating communicative exercises such as student discussion of trips or vacations (Rosen, 1995), and for a medium of student publishing (Bowers, 1995). Because of the relative newness of the Web, as well as the difficulty in investigating use of such a broad and complex medium, relatively little research has been conducted. An exception is an ethnographic study by Warschauer (1997), who examined the uses of the Web by four language and writing classes over the course of two years. Students in all four classes published their writings and multimedia documents on the World Wide Web. The study found that the impact of the Web-based work rested in large part on the social and cultural relevance of the writing assignments. When students perceived they were contributing something of value to the public arena, they put in a great deal of effort in the process and attention to the product, yielding positive results in their learning to write in a second language. When students did not see their work as having any particular social or cultural relevance, they showed little interest in Web-based publishing and the medium itself lent little extra legitimacy or authenticity to their writing assignments.

3. The Future of CALL

We can see that the use of computers has evolved tremendously in the past thirty years–from having students work on computer-fed drills to students' long-distance communication and collaboration in authentic research and multimedia publication. How do we see the use of computers in the language classroom in the next 30 years? It seems to us that there are two main directions worth exploring: (1) an increased emphasis on electronic literacy, and (2) the increased incorporation of *Intelligent CALL* into the classroom.

3.1 Electronic Literacies

As the developed world moves from the industrial age to the information age, economic activity and growth is based less on the input of more labour and capital and more on the exchange and interpretation of information and the development of knowledge (Castells, 1993; 1996). In such a society, it is safe to assume that the ability to read, write, and communicate effectively over computer networks will be essential for success in almost every sphere of life.

Given these circumstances, the question might become less 'what is the role of informational technology in the language classroom' and more 'what is the role of the language classroom in the information

technology society'. Preparing students to function in the networked society will become a major role of language instruction. This will most certainly be true for the English language classroom, with English likely to remain the *lingua franca* of the new global society. To a lesser extent it will be true in other language classes as well, as other cultures and languages begin to assert their presence on the Internet.

Some of our students will already have electronic literacy skills in their own languages which they can easily transfer to the second language classroom. But, especially in ESL and EFL classes, it will likely be the case that many of our students will have to develop new electronic literacy skills as they begin to confront for the first time the challenge of accessing and responding to the immense amount of English-language material available online. The following are two areas that we believe will be essential for language teachers to consider:

Finding, evaluating, and critically interpreting net-based information

When reading print materials, finding and evaluating sources is largely separated from the act of reading. In the 'old days', students went to the library, found some books, and read them at home–largely trusting what they read because, after all, it was in the library. Reading on the Internet, however, is a completely different phenomenon. Even to locate the information worthy of reading involves sophisticated skills of searching for material and evaluating it in mid-stream (to decide, for example, whether to continue or back-track). Students themselves create their 'texts' from their own selection of materials from a variety of sources. In teaching reading, we will have to go beyond how to decode texts, or understand them, and pay increasing attention to how to explore and interpret the vast range of online texts.

Effective online writing

Online writing to date has been principally viewed as a way to get students to practise their writing. It is as if the 'real' writing takes place in the printed essay the students hand in to their teacher; the online writing is just a way to get practice so that students can then improve their real writing. In the networked society, though, much if not most real writing will take place on screen. Much of business and personal affairs gets conducted over e-mail. Teachers in many schools and universities are starting to have their students complete Web projects or other multimedia documents, rather than traditional essays. Indeed, the paper essay may become a 'marked' form in the next 10-20 years, studied principally for its historical relevance. In response to this situation, second language teachers will need to teach students effective online writing skills. This includes both the genres of electronic communication as well as the relationship of texts to other media. This will represent a natural evolution of the way we view the World Wide Web. At first, many teachers saw the Web as a distribution vehicle for student writing; students were assigned to write traditional print essays which were then posted on the Web. In the future, we need to think about the Web not only as a distribution vehicle, but as a medium in its own right; students will want to learn how to publish Web pages that are fitting for the multimedia environment. We will thus need to find ways to teach our students to combine a variety of media–texts, images, sounds, video–without diluting the attention we give to language.

Finally, before leaving the topic of the new networked society, we should mention change that the rapid expansion of networked computing is likely to bring about. We can expect, and are already beginning to see, increased resources devoted to Internet-based distance learning. This is especially the case in a field such as language teaching, where a high percentage of the programs and teachers are in certain (English-speaking) countries, and a high percentage of the potential students live in other (non-English-speaking) countries. While it is impossible to determine the directions that distance learning will take, it is likely that both teachers and students will have to struggle to ensure the quality and conditions of instruction, as fierce competition will unfortunately but undoubtedly arise in the effort by educational institutions to reach the largest number of new students at the lowest possible cost.

3.2 Intelligent CALL

Those who hope for 'Intelligent CALL', by and large, do not feel that a piece of software can be intelligent in the same way as a human being. Rather, the idea is to have software that uses the power of the computer to offer easy interaction with the material to be learned, including meaningful feedback and guidance; comprehensible information in multiple media designed to fit the learning style of individual students; and ways for students to carry communication beyond an individual computer screen.

In our information-rich time, having a way to navigate and manage all of the facts at our fingertips is essential. In the computer arena, 'user interface'–the way software is written so that people will understand what to do with it–is a perennial concern. While much has been made of the graphical user interface of the Macintosh and Windows, replacing text with graphical objects (icons) is not enough to make software intelligible, much less intelligent. The best new business software offers users help at every step; good CALL software should do no less.

Learners need help with more than the mechanics of operating a software program. They also need to

know how to make the best use of it for their own purposes. Research has indicated that learners don't always know how to fit new information into an appropriate framework (Dole, *et al.*, 1991; Gay, 1987; Van Dijk & Kintsch, 1983), so intelligent software has to give them context as well as data. CALL programs that respond to user input with nothing more than 'Right' and 'Wrong, try again' are clearly less helpful, thus less 'intelligent' in these terms than they should be. Far better is software that tracks learner answers and looks for patterns, responding not only with whether the answer was correct but also *why* it was right or wrong and offering suggestions for further study–going on to a more advanced level or doing some extra work at the current or a previous level.

Learners also often fall short in their ability to apply appropriate learning strategies to material (Healey, 1993; Oxford, 1990; Rubin, 1987), so intelligent software should be able to take naive learners in hand and help them along in figuring out how to use the software effectively, as a teacher would. This does not mean that learners give up all control over their path and rate through material. Quite a bit of research has explored the idea of learner vs. computer control in computer-assisted instruction (Gay, 1987; Johanesen, K.J. & Tennyson, R.D., 1983; Robinson, 1989; Schaeffer, R.H., 1981; *inter alia*). The general view is that learners, especially adults, feel better when they have a sense of control over the program. The most dictatorial programs are those that do not let the learner quit when he or she is ready to do so. The most flexible give learners the choice of what to do, when to do it, and for how long. Guided freedom would be a feature of intelligent CALL, where the program would make suggestions, but the learner would make the choices.

Another direction in current software is the integration of media. As computer storage and memory prices have dropped, software developers have been able to add in graphics, sound, animation, and video clips. Foreign language teachers are particularly helped by access to a variety of media to help make the language come alive to students for whom it is largely a distant abstraction. This trend can only accelerate, with faster and more powerful computers making longer video and sound clips practical. Intelligent CALL will fit the medium to the learner, ensuring that the media work in concert to enhance understanding. Developers need to restrain the urge to add anything and everything just to make a fancy-looking product, and instead focus in on selecting media to fit pedagogy, not vice-versa (Kozma, 1991).

The expansion of digital media has meant more data with which learners can create their own language hypotheses. A vast amount of information is available electronically in text form via the Web (see http://www.sil.org/linguistics/etext.html for a place to start in electronic collections of texts), and more high quality collections of text for linguistic analysis than ever are available for sale from Cobuild, Oxford, Longman, and other vendors. While current concordancers work only on text, intelligent CALL will be able to use video concordancing to help clarify vocabulary and grammar usage. Teachers or learners can query the video concordancer with a word or phrase, and it will cue up video clips containing that word or phrase for playback. Prototype video concordancing exists now, fed by products that capture the output from closed caption decoders (Price & Imbier, 1993; Spanos & Smith, 1990).

Many current businesses, especially high-tech companies, use a team approach that encourages collaboration on projects. It could be said that business is just catching up to language teaching in this regard. The benefit to language teachers is that software developed to make business collaboration easier, such as Lotus Notes for Workgroups, can also be used to help students within a class share their ideas and writing more easily. With networked computers increasingly common, software publishers are encouraged to market products that take advantage of the interaction a network offers. For example, there is no reason software on CD-ROM or on disk should not also link to the Web in order to add current content to a writing or grammar lesson, or to let students e-mail their writing for others outside the class to read. Intelligent CALL will not be limited to its self-contained information or interaction with a single user, but will take advantage of local network and online possibilities for information retrieval.

John Underwood's 'On the edge: Intelligent CALL in the 1990s' (1989) hoped for advances in artificial intelligence, hypermedia, and simulations to create new ways of approaching language teaching with computers. Natural language processing, or the computer's ability to extract something approaching meaning from text or speech, is one of the elements Underwood feels is essential to the intelligent tutoring systems, the hypermedia rich in helpful navigational aids, and the realistic interactive microworlds he describes. A computer able to parse a typed or spoken sentence and respond to it can allow learners much more flexibility in the types of activities they can do and get help with. In fact, a student using an intelligent tutoring system should be able to ask the computer for help in something approaching natural language rather than by choosing elements from a programmer-created menu. A system that could evaluate an answer and respond with guidance would be more teacher-like than anything currently available.

The key to CALL software that responds intelligently to what the learner speaks or types is high-quality natural language processing. This has been one of the key areas within artificial intelligence research for years, and much progress has been made. However, substantial challenges must be overcome before the computer can make sense of learner input. Sells *et al.* (1991: p. 1) point out that four related

areas of study are involved in natural language processing:

1. investigating the psychological processes involved in human language understanding;
2. building computational systems for analysing natural language input (and/or producing natural language output);
3. developing theories of natural language structure; and
4. determining the mathematical properties of grammar formalisms.

Bates *et al.* (1993) are optimistic that natural language processing, at least where the topics are somewhat constrained and users are careful about how they interact with the computer, will be advanced enough within the next ten years to make a 'revolutionary' impact on society. They feel that software systems will improve in three key areas: (1) '*Knowledge acquisition* from natural language (NL) texts of various kinds, from interaction with human beings, and from other sources' to create larger knowledge bases than those that currently exist (p. 1; italics in original); (2) '*Interaction with multiple underlying systems*' to make NL systems more flexible and user-friendly (p. 1; italics in original); and (3) '*Partial understanding* gleaned from multi-sentence language, or from fragments of language' because human input is typically imperfect (p. 2; italics in original).

Microsoft have been working on a system called MindNet that they hope to ship in the next couple of years. This system would work with Microsoft Office and allow users to translate documents into different languages, create executive summaries of documents, and do more efficient searches for information in stored documents. Whether it will do what it claims or not, Microsoft's interest indicates that businesses see the goal of natural language processing as a realistic one.

Speech recognition has also made great advances in the last few years. Dragon System's *Naturally Speaking* and IBM's *ViaVoice* convert clear but continuous speech to text with an 80-90% accuracy rate. The higher accuracy rate comes after the programs have been 'trained' by listening to the user speak about 250 key words. Previous programs required users to pause after each word, making the speech highly unnatural. Girard and Dillon (1997) estimate that 30% of business users will be taking advantage of text to speech products by the year 2001 as a result of current developments in the technology. Several programs for language teaching now incorporate speech recognition, including The Learning Company's *Learn to Speak* series; *Triple Play Plus* from Syracuse Language Systems; Courseware Publishing International's *See It, Hear It, Say It*; *English Vocabulary*; and *Traci Talk*; and *Dynamic English* from DynEd. These programs are not capable of dealing with freely generated speech, but rather recognise a correct multiple choice answer. By limiting the domain, the speech recognition program can work with a relatively broad range of accent and speech styles. By all indications, the use of speech recognition technology will improve and increase as time goes on and computers become faster and more able to do the complex calculations required of natural language processing.

Electronic conversations with the computer, popularised by Joseph Weizenbaum's Eliza program, will become more sophisticated with spoken as well as typed input. Current adventure games have made great strides in their ability to process natural language in typed form, with games like Myst leading the way in setting up more natural interactions between the user and the computer. To be more useful in a language teaching context, an intelligent CALL form of these games could let the learner choose to have the program evaluate and comment on his or her grammar and vocabulary, as well as respond to the content of what was said or typed.

While we're coming closer, advancing in all the areas mentioned above–user interface, learner feedback, integrated media, communication within and outside the classroom, and natural language processing–we've still got a very long way to go before CALL can be accurately called 'intelligent'. What teachers can do now, however, is to work with each other to improve teaching with technology. Linking via the Web, workshops, or conferences, teachers can encourage the intelligent *use* of CALL. That will be a very large step forward.

Conclusion

The role of computers in language teaching has changed significantly in the last 30 years. Previously, computers used in language teaching were limited to text. Simple simulations and exercises, primarily gap-filling and multiple-choice drills, abounded. Technological and pedagogical developments now allow us to more fully integrate computer technology into the language learning process. Multimedia programs incorporating speech-recognition software can immerse students into rich environments for language practice. Concordancing software with large language corpora provide students with the means to investigate language use in authentic contexts. And the Internet allows for a myriad of opportunities to communicate in the target language, access textual and multimedia information, and publish for a global audience.

Future developments in networked communication, multimedia, and artificial intelligence will likely converge, creating a potentially more central role for the computer as a tool for authentic language exploration and use in the second language classroom. As our focus of attention gradually shifts from the computer itself to the natural integration of computers

into the language learning process, we will know that computer technology has taken its rightful place as an important element of language learning and teaching.

4. Selected CALL Resources

Recent Books

ATHELSTAN (1997). *Technology and language learning yearbook, vol. 8.* Houston, TX: Athelstan.

BOSWOOD, T. (1997). *New ways of using computers in language teaching.* Alexandria, VA: TESOL Publications.

BUSH, M. (1996). *Technology enhanced language learning.* Lincolnwood, IL: National Textbook Company.

DEBSKI, R., GASSIN, J., & SMITH, M. (Eds.) (1997). *Language learning through social computing.* Melbourne: Applied Linguistics Association of Australia.

HEALEY, D. (1995). *Something to do on Tuesday.* Houston: Athelstan.

HEALEY, D., & JOHNSON, N. (Eds.) (1997). *1997 TESOL CALL Interest Section software list.* Alexandria, VA: TESOL Publications.

LEVY, M. (1997). *Computer-assisted language learning: context and conceptualization.* Oxford: Oxford University Press.

PENNINGTON, M. (Ed.) (1996). *The power of CALL.* Houston: Athelstan.

SPERLING, D. (1997). *The Internet guide for English language teachers.* Upper Saddle River, NJ: Prentice Hall Regents.

THOMPSON, J. & PARSONS, J. (1995). *ReCALL software guide #4, 1995.* Hull, UK: CIT Centre for Modern Languages, University of Hull.

WARSCHAUER, M. (1995). *E-Mail for English teaching.* Alexandria, VA: TESOL Publications.

WARSCHAUER, M. (Ed.) (1995). *Telecollaboration in foreign language learning.* Honolulu, Hawai'i: University of Hawai'i Second Language Teaching and Curriculum Center (University of Hawai'i Press).

WARSCHAUER, M. (Ed.) (1996). *Virtual connections: online activities and projects for networking language learners.* Honolulu, Hawai'i: University of Hawai'i Second Language Teaching and Curriculum Center (University of Hawai'i Press).

Journals

CALICO Journal
The Computer Assisted Language Instruction Consortium
Southwest Texas State University
317 Liberal Arts
San Marcos, TX 78666
http://calico.org/

CÆLL (Computer-Assisted English Language Learning) Journal
1787 Agate St.,
Eugene OR 97403 U.S.A.
iste@oregon.uoregon.edu
http://www.iste.org/publish/caell.html

Computer Assisted Language Learning
P.O. Box 825
2160 SZ Lisse
The Netherlands
K.C.CAMERON@EXETER.AC.UK
http://www.swets.nl/sps/journals/call.html

Internet TESL Journal
http://www.aitech.ac.jp/~iteslj

Language Learning & Technology
http://polyglot.cal.msu.edu/llt

On-CALL
Language Centre
Bond University
Gold Coast
Queensland 4229
Australia
http://www.cltr.uq.oz.au:8000/oncall/ochome.htm
ReCALL Newsletter
http://www.cti.hull.ac.uk/pubs.htm#ReCALL Newsletter

SYSTEM
Elsevier Science Ltd, The Boulevard
Langford Lane
Kidlington, Oxford OX5 1GB, UK

TESL-EJ
http://www-writing.berkeley.edu/TESL-EJ/

Organisations

ATELL (Australian Technology Enhanced Language Learning Consortium)
http://adhocalypse.arts.unimelb.edu.au/~atell/

CALICO (Computer Assisted Language Instruction Consortium)
Southwest Texas State University
317 Liberal Arts
San Marcos, TX 78666
http://calico.org/

EUROCALL
CTI Centre for Modern Languages
University of Hull
HULL HU6 7RX, UK
cti.lang@hull.ac.uk
http://www.cti.hull.ac.uk/eurocall.htm

JALT CALL N-SIG (Japan Association for Language Teaching CALL National Special Interest Group)
JALT Central Office
Urban Edge Building 5th Floor
1-37-9 Taito
Taito-ku, Tokyo 110 Japan
http://langue.hyper.chubu.ac.jp/jalt/

MUESLI (Micro Users in ESL Institutions)
c/o IATEFL
3 Kingsdown Park
Tankerton
Whitstable, Kent
England CT5 2DJ
http://www.man.ac.uk/IATEFL/

TESOL CALL Interest Section
c/o TESOL
1600 Cameron St., Suite 300
Alexandria VA 22314 U.S.A.
tesol@tesol.edu
http://www.tesol.edu

Internet Resources

CALL & TESOL Links
http://tiger.coe.missouri.edu/~cjw/call/links.htm

Dave's ESL Cafe on the Web
http://eslcafe.com/

ExCHANGE
http://deil.lang.uiuc.edu/exchange/

LLTI (Language Learning and Technology International)
http://polyglot.lss.wisc.edu/IALL/LLTI.html

NETEACH-L (Using the Internet for teaching ESL)
http://thecity.sfsu.edu/~funweb/neteach.htm

OPPortunities in English
http://darkwing.uoregon.edu/~leslieob
TESL-L (Teachers of English as a Second Language)
TESLCA-L (Computer-Assisted sub-branch ofTESL-L)
listserv@cunyvm.cuny.edu
(send message *subscribe tesl-l yourfirstname yourlastname*)

The World of Language (British Council): ELT and the New Media http://www.worldoflanguage.com/elt-directory/index.htm

International Student E-Mail Discussion Lists
Nine lists for ESL/EFL college and university students
http://www.latrobe.edu.au/www/education/sl/sl.html

References

ABRAHAM, R. (1985). Field independence-dependence and the teaching of grammar. *TESOL Quarterly,* **20**, 689–702.

ABRAHAM, R. & LIOU, H-C. (1991). Interaction generated by three computer programs: analysis of functions of spoken language. In P. Dunkel (Ed.), *Computer-assisted language learning and testing*, 85–109. Rowley, MA: Newbury House.

AHMAD, K., CORBETT, G., ROGERS, M., & SUSSEX, R. (1985). *Computers, language learning and language teaching.* Cambridge: Cambridge University Press.

AL-JUHANI, S. O. (1992). The effectiveness of computer-assisted instruction in teaching English as a foreign language in Saudi secondary school. *Dissertation Abstracts International, A: The Humanities and Social Sciences,* **52**, 2383–A.

ATHELSTAN. (1997). CALL bibliography. [Internet document] http://www.nol.net/~athel/athelbib.html. Accessed 10/20/97.

BASENA, D. & JAMIESON, J. (1996). CALL research in second language learning: 1990-1994. *CÆLL Journal,* **7** (1/2), 14–22.

BASENA, D. & JAMIESON, J. (1996/1997). Annotated bibliography of ESL CALL research: 1990-1994. *CÆLL Journal,* **7** (3), 12–19.

BATES, M., BORROW, R. J., & WEISCHEDEL, R. M. (1993). Critical challenges for natural language processing. In M. Bates and R.M. Weischedel (Eds.), *Challenges in natural language processing* (pp. 3–34). New York: Cambridge University Press.

BOTIONO, B. D. (1992). The effect of three feedback forms on learning through a computer-based tutorial. *CALICO Journal,* **10**, 45–52.

BOWERS, R. (1995). Web publishing for students of EST. In M. Warschauer (Ed.), *Virtual connections: online activities and projects for networking language learners*, 363–4. Honolulu, Hawai'i: University of Hawai'i Second Language Teaching and Curriculum Center.

BROWN, H. D. (1991). TESOL at twenty-five: what are the issues? *TESOL Quarterly,* **25**, 245–60.

CASTELLS, M. (1993). The informational economy and the new international division of labor. In M. Carnoy, M. Castells, S. S. Cohen, & F. H. Cardoso, *The new global economy in the information age: Reflections on our changing world*, 15–43. University Park, Pennsylvania: The Pennsylvania State University Press.

CASTELLS, M. (1996). *The rise of the network society.* Malden, MA: Blackwell.

CHAPELLE, C. (1990). The discourse of computer-assisted language learning: toward a context for descriptive research. *TESOL Quarterly,* **24**, 199–225.

CHAPELLE, C. (1995). A framework for the investigation of CALL as a context for SLA. *CÆLL Journal,* **6** (3), 2–8.

CHAPELLE, C. & JAMIESON, J. (1986). Computer assisted language learning as a predictor of success in acquiring English as a second language. *TESOL Quarterly,* **20**, 27–46.

CHAPELLE, C. & JAMIESON, J. (1989). Research trends in computer-assisted language learning. In M. Pennington (Ed.), *Teaching languages with computers*, 45–59. La Jolla, CA: Athelstan.

CHAPELLE, C. & JAMIESON, J. (1991). Internal and external validity issues in research on CALL effectiveness. In P. Dunkel (Ed.), *Computer-assisted language learning and testing*, 37–57. Rowley, MA: Newbury House.

CHAPELLE, C. & MIZUNO, S. (1980, December). Student strategies with learner-controlled CALL. *CALICO Journal*, 25–47.

CHEN, J. F. (1997). Computer generated error feedback and writing process: a link. *TESL-EJ,* **2** (3). [electronic document] Available at http://violet.berkeley.edu/~cwp/TESL-EJ/ej07/a1.html. Accessed 10/19/97.

CHUN, D. (1994). Using computer networking to facilitate the acquisition of interactive competence. *System,* **22** (1), 17–31.

CROOKALL, D., COLEMAN, D. W., & VERSLUIS, E. B. (1990). Computerized language learning simulations: form and content. In D. Crookall & R.L. Oxford (Eds.), *Simulation, gaming, and language learning*, 165–82. New York: Newbury House.

DAIUTE, C. (1985). *Writing and computers.* Reading, MA: Addison-Wesley.

DALGISH, G. M. (1991). Computer-assisted error analysis and courseware design: applications for ESL in a Swedish context. *CALICO Journal,* **9**, 39–56.

DE FELIX, J. W., JOHNSON, R. T., & SCHICK, J. E. (1990). Socio- and psycholinguistic considerations in interactive video instruction for limited English proficient students. *Computers in the Schools,* **7** (12), 173–90.

DOLE, J. A., DUFFY, G. G., ROEHLER, L. R., & PEARSON, P. D. (1991). Moving from the old to the new: research on reading comprehension instruction. *Review of Educational Research,* **61**, 239–64.

DUDLEY, A. (1995). Communicative CALL: student interaction using non-EFL software. *CÆLL Journal,* **6** (3), 25–33.

DUNKEL, P. (1991). Simulations and games in L2 learning. *CÆLL Journal,* **2** (2), 8–16.

DZIOMBAK, C. E. (1991). Searching for collaboration in the ESL computer lab and the ESL classroom. *Dissertation Abstracts International, A: The Humanities and Social Sciences,* **51**, 2296–A.

EASTMENT, D. (1996). *The Internet and ELT: the impact of the Internet on English Language Teaching.* London: British Council English 2000 Publications.

ENGLESBERG, R. (1997). An evaluation study of a multimedia package for learning English. *CÆLL Journal,* **8** (1), 15–20.

EVANS, M. (1993). Nicolas: Using HyperCard with intermediate-level French learners. *System,* **10**, 213–29.

FELDMAN, M. (1995). Import/export e-mail business simulation. In M. Warschauer (Ed.), *Virtual connections: online activities and projects for networking language learners*, 216–17. Honolulu, Hawai'i: University of Hawai'i Second Language Teaching and Curriculum Center.

GAER, S. (1995). Folktales around the world. In M. Warschauer (Ed.), *Virtual connections: online activities and projects for networking language learners*, 146–8. Honolulu, HI: University of Hawai'i Second Language Teaching and Curriculum Center.

GAY, G. (1987). Interaction of learner control and prior understanding in computer-assisted video instruction. *Journal of Educational Psychology,* **78**, 225–7.

GIRARD, K. & DILLON, N. (1997). Market grows for voice applications. *Computerworld,* **31** (32), 55–6.

HEALEY, D. (1993). Learner choices in self-directed second language learning. Ann Arbor, MI: UMI Dissertation Services.

HIGGINS, J. (1997). CALL: A bibliography. [Internet document]. http://www.stir.ac.uk/Departments/HumanSciences/EPD/celt/staff/higdox/callbib.htm. Accessed 10/20/97.

HSU, J. J., CHAPELLE, C., & THOMPSON, A. D. (1993). Exploratory

learning environments: what are they and do students explore? *Journal of Educational Computing Research*, **9**, 1–15.

JOHANESEN, K. J. & TENNYSON, R. D. (1983). Effect of adaptive advisement on perception in learner-controlled, computer-based instruction using a rule-learning task. *Educational Communication and Technology*, **31**, 226–36.

JOHNS, T. & KING, P. (Eds.) (1991). Classroom concordancing. *ELT Journal* **4**, 27–45.

JONES, C. (1986). It's not so much the program, more what you do with it: the importance of methodology in CALL. *System*, **14**, 171–8.

JONES, C., & FORTESCUE, S. (1987). *Using computers in the language classroom*. London: Longman.

KELM, O. (1992). The use of synchronous computer networks in second language instruction: a preliminary report. *Foreign Language Annals*, **25**(5), 441–54.

KELM, O. (1995). E-mail discussion groups in foreign language education: Grammar follow-up. In M. Warschauer (Ed.), *Telecollaboration in foreign language learning: Proceedings of the Hawai'i symposium*. Honolulu, Hawai'i: University of Hawai'i, Second Language Teaching and Curriculum Center.

KENDALL, C. (1995). Cyber-surveys. In M. Warschauer (Ed.), *Virtual connections: online activities and projects for networking language learners*, 97–100. Honolulu, HI: University of Hawai'i, Second Language Teaching and Curriculum Center.

KENNING, M.-M., & KENNING, M. J. (1990). *Computers and language learning: current theory and practice*. New York: Ellis Horwood.

KERN, R. (1995). Restructuring classroom interaction with networked computers: effects on quantity and quality of language production. *Modern Language Journal*, **79** (4), 457–76.

KLEINMANN, H. H. (1987). The effect of computer-assisted instruction on ESL reading achievement. *Modern Language Journal*, **71**, 267–76.

KOZMA, R. B. (1991). Learning with media. *Review of Educational Research*, **61**, 179–211.

LEVY, M. & HINCKFUSS, J. (1990). Program design and student talk. *CÆLL Journal*, **1** (4), 21–6.

LI, R.-C. (1995). English as a second language home page. In M. Warschauer (Ed.), *Virtual connections: online activities and projects for networking language learners*, 349–50. Honolulu, Hawai'i: University of Hawai'i, Second Language Teaching and Curriculum Center.

LIU, M. (1992). The effect of hypermedia-assisted instruction on second language learning: a semantic-network-based approach. *Dissertation Abstracts International, A: The Humanities and Social Sciences*, **53**, 1134–A.

LIXL-PURCELL, A. (1995). German area studies on the net. In M. Warschauer (Ed.), *Virtual connections: online activities and projects for networking language learners*, 292–4. Honolulu, Hawai'i: University of Hawai'i, Second Language Teaching and Curriculum Center.

MESKILL, C. (1993). ESL multimedia: a study of the dynamics of paired student discourse. *System*, **21**, 323–41.

MURILLO, D. (1991). Maximizing CALL effectiveness in the classroom. *CÆLL Journal*, **2** (2), 20–25.

NEU, J. & SCARCELLA, R. (1991). Word processing in the ESL classroom: a survey of student attitudes. In P. Dunkel (Ed.), *Computer-assisted language learning and testing*, 169–87. Rowley, MA: Newbury House.

OXFORD, R. L. (1990). *Language learning strategies: what every teacher should know*. Boston: Heinle & Heinle.

PHILLIPS, M. (1987). *Communicative language learning and the microcomputer*. London: British Council.

PHINNEY, M. (1991). Computer-assisted writing and writing apprehension in ESL students. In P. Dunkel (Ed.), *Computer-assisted language learning and testing*, 189–204. Rowley, MA: Newbury House.

PINTO, D. (1996). What does 'schMOOze' mean?: non-native speaker interactions on the Internet. In M. Warschauer (Ed.), *Telecollaboration in foreign language learning: proceedings of the Hawai'i symposium*, 165–84. Honolulu, HI: University of Hawai'i, Second Language Teaching & Curriculum Center.

PIPER, A. (1986). Conversation and the computer: a study of the conversational spin-off generated among learners of English as a foreign language working in groups. *System*, **14** (2), 187–98.

PRICE, K. & IMBIER, E. (1993). A videodisc project for ESL: 'Who should do the housework?' In J. Boettcher (Ed.), *101 success stories of information technology in higher education: The Joe Wyatt challenge*. New York: McGraw-Hill, Inc. (also online at http://educom.edu/stories.101/Videodisc-Project-for-ESL.txt)

PUJOL, M. (1995/96). ESL interactions around the computer. *CÆLL Journal*, **6** (4), 2–11.

ROBINSON, G. L. (1989). The CLCCS CALL study: Methods, error feedback, attitudes, and achievement. In W.F. Smith (Ed.), *Modern technology in foreign language education: applications and projects*. Lincolnwood, IL: National Textbook Company.

ROSEN, L. (1995). City net: travel the world from your desktop. In M. Warschauer (Ed.), *Virtual connections: online activities and projects for networking language learners*, 308–9. Honolulu, HI: University of Hawai'i, Second Language Teaching and Curriculum Center.

RUBIN, J. (1987). Learner strategies: theoretical assumption, research, history, and typology. In A. Wenden and J. Rubin (Eds.), *Learner strategies in language learning*, 15–30. Englewood Cliffs, NJ: Prentice-Hall.

SCHAEFFER, R. H. (1981). Meaningful practice on the computer: Is it possible? *Foreign Language Annals*, **14** (2), 133–7.

SCHCOLNIK, M., KOL, S., ABARBANEL, J., FRIEDLER, J., HEYMANS, Y., & TSAFRIR, Y. (1995/96). Multimedia reference materials in advanced EFL courses: a project report. *CÆLL Journal*, **6** (4), 34–8.

SEDGWICK, R. (1997). Annotated bibliography of the effectiveness of CALL. [Internet document]. http://www.cltr.uq.oz.au:8000/interest/biblio.html. Accessed 10/20/97.

SELLS, P., SHIEBER, S. M., & WASOW, T. (Eds.) (1991). *Foundational issues in natural language processing*. Cambridge, MA: MIT Press.

SHARP, S. K. & LIU, P. (1997). Computer-assisted language le arning bibliography [Internet document]. http://www.inform.umd.edu/EdRes/Colleges/ARHU/Depts/langctr/flit/biblio/bibliography.html. Accessed 10/20/97.

SOH, B.-L., & SOON, Y. P. (1991). English by e-mail: creating a global classroom via the medium of computer technology. *ELT Journal*, **45** (4), 287–92.

SPANOS, G., & SMITH, J. (1990). Closed captioned television for adult LEP literacy learners. ERIC Digest. Washington, DC: National Clearinghouse for ESL Literacy Education. (ED 321 623)

STENSON, N., DOWNING, B., SMITH, J. & SMITH, K. (1992). The effectiveness of computer-assisted pronunciation training. *CALICO Journal*, **9** (4), 5–19.

SULLIVAN, N., & PRATT, E. (1996). A comparative study of two ESL writing environments: a computer-assisted classroom and a traditional oral classroom. *System*, **24** (4), 491–501.

TELLA, S. (1991). *Introducing international communications networks and electronic mail into foreign language classrooms* (Research report No. 95). Department of Teacher Education, University of Helsinki.

TELLA, S. (1992a). *Boys, girls and e-mail:a case study in Finnish senior secondary schools*. (Research report No. 110). Department of Teacher Education, University of Helsinki.

TELLA, S. (1992b). *Talking shop via e-mail: a thematic and linguistic analysis of electronic mail communication*. (Research report No. 99). Department of teacher education, University of Helsinki.

THAIPAKDEE, S. (1992). Relationships among writing quality, attitudes toward writing, and attitudes toward computers in a computer-mediated technical writing class for English as a foreign language students. *Dissertation Abstracts International, A: The Humanities and Social Sciences*, **53**, 1135–A.

TRIBBLE, C. (1990). Small scale corpora in ELT: an investigation into vocabulary use. *CÆLL Journal*, **1** (4), 13–20.

TRIBBLE, C. & JONES, C. (1990). *Concordancing in the classroom*. Harlow, Essex: Longman.

UNDERWOOD, J. (1984). *Linguistics, computers, and the language teacher: a communicative approach*. Rowley, MA: Newbury House.

UNDERWOOD, J. (1989). On the edge: intelligent CALL in the 1990s. *Computers and the Humanities*, **23** (1), 71–84.

VAN DER LINDEN, E. (1993). Does feedback enhance computer-assisted language learning? *Computers and Education*, **21**, 61–65.

VAN DIJK, T. A. & KINTSCH, W. (1983). *Strategies of discourse comprehension*. Orlando, FL: Academic Press.

VERANO, M. (1989). USAFA interactive study in Spanish. In W.F. Smith (Ed.), *Modern technology in foreign language instruction*. Lincolnwood, IL: National Textbook Company.

WALKER, B. (1994). EFL teachers' attitudes about CALL. *CÆLL Journal*, **5** (3), 12–15.

WANG, X. (1993). A CAI tutorial: teaching the English simple past tense to native speakers of Chinese. *Dissertation Abstracts International*, **51**, 2354–A - 2355–A.

WANG, Y. M. (1993). *E-mail dialogue journaling in an ESL reading and writing classroom*. Unpublished Ph.D. dissertation, University of Oregon at Eugene.

WARSCHAUER, M. (Ed.) (1995). *Virtual connections: online activities and projects for networking language learners*. Honolulu, Hawai'i: University of Hawai'i, Second Language Teaching and Curriculum Center.

WARSCHAUER, M. (1996a). Comparing face-to-face and electronic communication in the second language classroom. *CALICO Journal*, **13** (2), 7–26.

WARSCHAUER, M. (1996b). Computer-assisted language learning: an introduction. In S. Fotos (Ed.), *Multimedia language teaching*, 3–20. Tokyo: Logos.

WARSCHAUER, M. (1997) *Electronic literacies: language, culture, and power in online education*. Unpublished doctoral dissertation, University of Hawai'i.