ReCALL **13** (1): 3–14. Printed in the United Kingdom

© 2001 Cambridge University Press

Innovative language learning: achieving the vision

CAROL A. CHAPPELLE
TESL/Applied Linguistics, 203 Ross Hall, Iowa State University, Ames, IA 50011 USA.
(*e-mail: carolc@iastate.edu*)

Abstract

The technologies demonstrated at the InSTIL and EUROCALL 2000 conferences were very inspiring. They gave participants the sense that the technologies of their wildest imaginations are at last materializing, particularly in long awaited advances in speech technologies. Some challenges, however, remain ahead as attempts are made to put these technologies to use in CALL. Past experience demonstrates for example that software designed for recognition of a proficient speaker's language is different than that required for learner language. It is also evident that while language use may be critical for language acquisition, language use does not necessarily indicate language acquisition. These points were made by Marty, who was working with speech software for French teaching a few years before the current excitement:

> ...[W]e should keep in mind that the present research and development is aimed only at producing speech easily understandable by natives (e.g., English for native speakers of English) and that the potential markets are industrial (e.g., replacing visual indicators or visual alarms with audio warnings) and in home products (especially toys). Until our needs for improved FL instruction are better understood, it is not likely that those devices will have the voice quality we need. (Marty, 1981:52).

If Marty had attended the InSTIL and EUROCALL conferences in 2000, no doubt he would have been very, very impressed. Even though plenty of work remains, we do seem to have very good voice quality in speech synthesis. The question today is how can we best use these emerging technologies, and so Marty's suggestion that we must better understand our needs in foreign language teaching remains very relevant. What are the needs for foreign language teaching in the 21st century? The papers at EUROCALL 2000 as well as other work in technology, business, and language teaching suggest that we should be prepared for change in the coming years, but what kind of change? The turn of the century seems an appropriate time to examine some of the speculation on the future of language teaching in general, as well as how technology fits into that future. This paper considers these general questions, and then suggests ways in which links might be made between work in second language acquisition (SLA) and CALL in order to put technologies to use for L2 teaching.

1 The future for language teaching

As the profession looks to the future of language teaching, two possible scenarios for language use are usually mentioned (Crystal, 1997). One is that the large majority of people in the world will be learning and using English. This scenario suggests that the

https://doi.org/10.1017/S0958344001000210 Published online by Cambridge University Press

utilitarian motives of those needing to conduct business will prevail, resulting in a decline in the widespread teaching of a variety of languages. The second scenario predicts that the needs for expression of local cultural identity will override economic concerns, and as a consequence linguistic diversity will continue, as will the need for foreign language teaching. Crystal's futuristic view mentions but fails to take seriously technology in this picture, but Cribb (2000) adds technology to the picture of a linguistically diverse world, suggesting it as an additional factor that may influence the future of language teaching. He supplements the profession's mainstream vision of technology enhancing language teaching and learning with a less orthodox vision of technology empowering language users through machine translation. He points out that despite the less-than-smooth history in machine translation, progress in this area compares favorably to that of second language acquisition research:

> "A comparison between progress in computer technology and that in Second Language Acquisition (SLA) dramatically favors the former. Progress in computer technology follows Moore's law... In comparison, new breakthroughs in SLA and teaching methodology are few and far between. There are no prospects for SLA to be significantly quicker or less painful 50 years from now" (Cribb, 2000: 561).

A look at the history of intellectual development in second language acquisition theory supports Cribb's point. From the 1950's an array of constructs, research methods, and results have been introduced such as the language acquisition device, interlanguage, the natural order, integrative motivation, comprehensible input, intake, interaction, strategies, zone of proximal development, identity, voice and design. These constructs and their associated research provide stimulating reading and have offered some advances toward an understanding of SLA that proves useful to L2 teaching. At the same time, however, one cannot help but associate the diverse perspectives in this domain with the 'chaos' that Raymond Kurzweil wrote about in his book *The Age of Spiritual Machines*. Explaining the rapid advances in the speed and efficiency of technology today, Kurzweil argued that increasing order in understanding of some scientific phenomena have made it possible for ever-decreasing time intervals between significant events. In other words, orderly understanding prompts speed of progress. The complementary principle is one that he calls the "Law of increasing chaos" which he defined as follows: "As chaos exponentially increases, time exponentially slows down (that is the time interval between salient events grows longer as time passes." (Kurzweil, 1999:29). Applied to SLA, the law of increasing chaos would probably suggest that the broad spectrum of approaches to SLA (i.e. chaos, some might argue) contributes to the slowness of progress in language teaching.

Despite slow progress in improvements in language teaching relative to those of machine translation, for the near term, it is probably reasonable to suppose that language learning will continue to be essential and that translation software will be used for some functions by some people, but it is unlikely to put language teaching out of business. Based on historical work on changing modes of communication, Murray (2000) points out that new communication potentials tend to complement existing practices rather than replace them. For example, e-mail has not replaced phone calls or letters; it has further specialized the functions of these two modes, as e-mail is ideal for

https://doi.org/10.1017/S0958344001000210 Published online by Cambridge University Press

some of the former functions of each, but not appropriate for all of the functions of either phone calls or paper. Similarly, machine translation may prove useful to some people for some things, but it is unlikely to take over all of the functions for which people learn a language.

2 Language teaching and technology in the future

Kurzweil makes a number of specific predictions about technological changes in the next thirty years based on his analysis of current technologies and the speed with which they have become available. He does not make predictions about L2 learning in particular, but does discuss technologies for communication and education, both of which offer a starting point for sketching a vision of L2 learning in the future.

2.1 Kurzweil's vision

The communications technologies Kurzweil predicts for 2009, consistent with Cribb's view, include translation of oral language: "Translating telephone technology (where you speak in English and your Japanese friend hears you in Japanese, and vice versa) will be commonly used for many language pairs." (*op. cit.*:193). He predicts that education in 2009 will recognize "the profound importance of the computer as a knowledge tool." This prediction is being realized about nine years early in many schools, businesses, and universities. He further predicts, "Intelligent courseware will emerge as a common means of learning. Recent controversial studies have shown that students can learn basic skills such as reading and math just as readily with interactive learning software as with human teachers, particularly when the ratio of students to human teachers is more than one to one..." Another part of the year 2009 vision is that "Learning is becoming a significant portion of most jobs. Training and developing new skills is emerging as an ongoing responsibility in most careers, not just an occasional supplement, as the level of skill needed for meaningful employment soars even higher." (*op. cit.*:192). In short, Kurzweil predicts a situation that most of us only dreamed of a decade ago: sophisticated language processing technologies are widely available, intelligent tutoring has become the norm, and societies are committed to learning.

Looking ahead even farther to 2029, the situation appears to remain very interesting for language teaching: "The majority of communication does not involve a human. The majority of communication involving a human is between a human and machine." (*op. cit.*:222). Ron Cole's (2000) work demonstrated the early prototypes for realizing this prediction. As for education:

> "Human learning is primarily accomplished using virtual teachers and is enhanced by the widely available neural implants. The implants improve memory and perception, but it is not yet possible to download knowledge directly. Although enhanced through virtual experiences, intelligent interactive instruction and neural implants, learning still requires time-consuming human experience and study." (*op. cit.*: 221)

These predictions suggest the importance of intelligent software for L2 learning in the

https://doi.org/10.1017/S0958344001000210 Published online by Cambridge University Press

future, but where is this software going to come from? The results of current research demonstrate great accomplishments for software that enhances communication, but how are strides being made toward software for language learning? We do not see a lot of courseware that we would consider truly 'intelligent' in use today despite some research. Moreover, little evidence would suggest that research in second language acquisition and CALL are moving us rapidly in that direction. Instead, it would be difficult to argue that any of the findings from SLA research have been fruitfully applied to the evolution of intelligent CALL. This is apparent when a vision from over ten years ago is revisited, and reanalyzed in view of current knowledge.

2.2 Underwood's vision for intelligent language teaching

Over ten years ago, Underwood (1989) suggested building the ideal CALL program through a combination of hypermedia, artificial intelligence, computational linguistics, and speech recognition technologies. He described this hypothetical invention for a student studying Spanish in the US as follows:

> The scene is the carrel of a multi-media lab. A student is sitting in front of a color video monitor connected to stereo headphones and a tiny microphone; at her fingertips are a computer keyboard and mouse. Out of sight is a powerful computer CPU and something which looks like a CD player with a stack of 5 1/4 inch disks. Using the mouse, the student points at a little square on the screen, clicks, and the screen fills with the sights and sounds of Madrid. A voice asks her (in Spanish) if she is ready to continue; speaking into the microphone, she answers, "Si" She asks to talk to Javier, one of the characters she had met before, because he might have some information she needs. The screen now shows the street in front of Javier's apartment. She rings the doorbell with a mouse-click and Javier appears on the screen. "Buenos dias," he says. The student begins to ask him questions. At times Javier seems reluctant to talk and she must rephrase her questions to get him to respond. at other times, he says that he is sorry, but he is unable to answer such questions, for political reasons (*op. cit*.: 80).

Today, the substance of this vision is likely to be expressed in about the same way. Why hasn't the vision changed in ten years? How does the profession know that this is what intelligent language tutors should consist of? Examination of the design of this intelligent tutor, one would hope, would reveal the basis of the decisions underlying the interaction with the learner. For example, the suggestion is that sometimes Javier is hesitant to respond so the learner has to rephrase the question. The question is whether or not random requirements for rephrasing are the best for SLA? Sometimes he says it is for political reasons, but are non answers for political reasons beneficial for SLA? One might also ask whether or not the learner wants to engage in this conversation with a Javier? Why does the learner need this information? Should she be able to understand everything that Javier says even if it is colloquial language? Does Javier understand the learner's non-native accent well enough to allow the conversation to proceed? How does the role of the inquisitive learner attempting to get information from the hesitant Javier character position her as an L2 user? Is the role of military interrogator one that she

https://doi.org/10.1017/S0958344001000210 Published online by Cambridge University Press

wishes to adopt? If the learner simply needs information, is talking to a shy politically-inhibited character the most viable way of getting it?

These types of questions, and the fact that it is difficult to answer them, help to point out the need for a better understanding of how to construct intelligent CALL. Intelligent CALL needs to construct interactions that will result in language learning, and so as Marty put it, our needs for foreign language teaching must be better understood. As Ron Cole (2000) said, this understanding is our "missing science."

2.3 The reality of intelligent language teaching

Is it really possible that the science of intelligent tutors of the past decade has been missing? In a 1995 volume on intelligent language tutors, McWhinney commented on projects included in the volume in a paper called 'Evaluating language tutoring systems:'

> "Up to this point, system design has proceeded on the basis of a series of hunches and guesses. For us to put foreign language tutor design on a firmer basis, we will need to have real tests of these hunches."

He points out that the systems described in the volume have been built on the assumption that one of the following features or approaches was beneficial for SLA: error diagnosis, parser technology, microworlds, learner models, naturalness, discourse context, exploration, interface and L1 and transfer.

> "The only way to evaluate these various common-sense-based hunches is by detailed evaluation of the instructional effectiveness of the principles being proposed." (McWhinney, 1995: 320–322)

In a volume a few years earlier, Swartz (1992) pointed out that there is "a need to investigate components of tutoring knowledge [i.e., how to teach] that are grounded in sound psychological and foreign language learning principles" (*op. cit*.:220). Yazdani's appraisal of his intelligent tutoring system in 1989 was the same: "our systems while strong on the knowledge of how to do grammar analysis, are weak on the representation of 'teaching skills' appropriate to language teaching" (Yazdani, 1989). Reflecting the state of the art, these summary comments reflect a disparity between the reality of existing technologies and predictions that intelligent courseware for language learning will play an important role in language teaching in the near future. Moreover, the majority of those who teach language and contribute to teacher education appear not to be engaged in discovering how to best use technology in language teaching. The minority who are interested in technology seem to be preoccupied with computer-mediated communication, (i.e. language use) more than with language learning.

In short, Kurzweil's law of increasing chaos – the less understood in a domain, the greater the time intervals between advances – is contrary to the prediction that intelligent tutoring for language learning will play an important role in learning in the near future. What is needed to achieve the vision is a means of reducing the chaos in a way that allows for progress.

https://doi.org/10.1017/S0958344001000210 Published online by Cambridge University Press

3 Reducing the chaos: criteria, research and software

One way to bring some useful order to the study of CALL might be to identify what theory of SLA says that actually pertains to the design of CALL tasks, how research can support and refine these suggestions, and what kind of tools are needed to conduct such research. This is the approach taken in Chapelle (2001), which I outline briefly here.

3.1 Criteria from SLA

Examination of relevant theory and research in SLA suggests a number of ideals for designing CALL tasks. If these are interpreted within a framework for evaluation such as one that is used for evaluation of assessment tasks (Bachman & Palmer, 1996), the result is a set of criteria that can be used for evaluating CALL. The six criteria are outlined in Table 1. Each of these criteria identifies a characteristic of a CALL task, which refers to the activity that the learner engages in with the computer or with other learners through the use of the computer.

Language learning potential refers to the extent to which an activity can be considered to promote language learning rather than simply serving as an opportunity for language use. Suggestions for language learning potential are drawn from theory and research on attention, focus on form and negotiation of meaning in both classroom and CALL tasks (e.g., Doughty & Williams, 1998; Gass, 1997; Long, 1996; Pica, 1994; Robinson, 1995; Schmidt, 1990). Returning to the analysis of the learner's interaction with Javier, questions concerning the value of questioning a hesitant person for language acquisition would be raised through investigation of language learning potential. Second, research on individual differences (Skehan, 1989) offers tentative suggestions concerning learner fit, the opportunity for engagement with language under appropriate conditions given learner characteristics. Learner style, interests, age, ability level will all

Table 1. *Criteria for CALL tasks*

Language learning potential	The degree of opportunity present for beneficial focus on form.
Learner fit	The amount of opportunity for engagement with language under appropriate conditions given learner characteristics.
Meaning focus	The extent to which learners' attention is directed toward the meaning of the language.
Authenticity	The degree of correspondence between the learning activity and target language activities of interest to learners out of the classroom.
Positive Impact	The positive effects of the CALL activity on those who participate in it.
Practicality	The adequacy of resources to support the use of the CALL activity.

https://doi.org/10.1017/S0958344001000210 Published online by Cambridge University Press

influence learners' interest in asking Javier questions, and the learner's willingness to engage in this type of interaction is critical to the quality of the task (MacIntyre, Clément, Dörnyei & Noels, 1998).

Meaning focus denotes that the learner's primary attention is directed toward the meaning of the language during learning tasks (Pica, Kanagy, & Falodun, 1993). This has been supported in a number of ways, including research on CALL. Moreover, among many language teachers, the common sense notion of a good task is that it focuses the learner's attention on meaning, as the Javier task clearly does. Authenticity, a theoretical ideal in language learning activities, refers to the degree of correspondence between an L2 learning task and tasks that the learner is likely to encounter outside the classroom (Bachman & Palmer, 1996; Lewkowicz, 2000). Authenticity needs to be examined in its technical sense, as a correspondence to some other language use situation rather than as meaning focus. The concern with authenticity in the Javier activity, then, would be to what extent is interrogation of Spanish-speaking characters authentic to the learner's future use of the target language?

The importance of the positive impact of CALL, its effects beyond its language learning potential, is suggested by theory and research on language learning strategies (Oxford, 1990), and learners' identity (Pierce, 1995). Heppell (2000) described his observation of children's behavior when they were given cell phones – they had the positive impact of exciting the children to want to talk to each other, to learn how to use the range of functions the cell phones offered, and to become cell phone users. Finally, practicality – ease of use within the particular constraints of a class or language program – is critical to the success of a task. If the cell phones don't work, the children learn to trust only equipment that is plugged in to a wall. If Javier can't understand a word the learner says, the learner will stop talking to him. The other benefits to be had are only available to the extent that the technology is useable and is used.

4.2 Research

It is one thing to suggest some criteria, but it is another to demonstrate that criteria have been met, and so the question is what kind of evidence can be used to shed light on the criteria. As a consequence, research is needed. The topic of research methods for CALL is treated regularly on CALL discussion lists, where the tension is apparent between loyalty to the experimental paradigm and suspicion about the validity of its results. More recently, tensions are being constructed between SLA aligned approaches and those focused more on communication (Salaberry, 1999; Levy, 2000). In fact, however, a range of methods can be used for evaluating CALL because methods need to be chosen to address particular research questions. Table 3 shows the correspondences among the qualities outlined in Table 2 and the general research questions that would address each one.

An example of a study of language learning potential using an outcomes-oriented methodology would be the study conducted by Nagata (1993), who studies the effects of different methods of identifying learners' errors. Nagata (1993) found that learners of Japanese who received 'intelligent' feedback about their use of particles performed significantly better on both post-tests and end-of-semester tests than did those students who had received only an indication of where they had made an error. Another example

https://doi.org/10.1017/S0958344001000210 Published online by Cambridge University Press

Table 2. *Qualities of CALL, research questions and relevant data (based on Chapelle, forthcoming)*

Qualities	Questions	Relevant Data
Language learning Potential	What evidence suggests that the learner has acquired the target forms that were focused on during the CALL task?	Positive learning outcomes relative to other groups
	What evidence indicates that learners focused on form during the CALL task?	Records of interaction, introspective reports
Learner fit	What evidence suggests that the targeted linguistic forms are an appropriate level of difficulty for the learners?	Records of interaction, introspective reports Improvement shown in learning outcomes
	What evidence suggests that the task is appropriate to learners' individual characteristics (e.g. age, learning style, computer experience).	
Meaning focus	What evidence suggests that learners' construction of linguistic meaning aids language learning?	Positive learning outcomes relative to other groups
	What evidence indicates that learners use the language during the task for constructingand interpreting meaning?	Records of linguistic interaction, introspective reports
Authenticity	What evidence suggests that learners' performance in the CALL task corresponds to what one would expect the classroom to see outside the CALL task?	Comparison of the language and activities of CALL and those of interest beyond
	What evidence suggests that learners see the connection between the CALL task and tasks outside the classroom?	Questionnaire and interview data
Impact	What evidence suggests that learners learn more about the target language learning and about strategies for language through the use of the task?	Introspective reports from learners and , teachers ethnographic investigation of CALL use, and critical analysis
	What evidence suggest that instructors engage in sound second language pedagogical practices by using the task?	
	What evidence suggests that learners and teachers had a positive experience with technology through the use of the task?	
Practicality	What evidence suggests that hardware, software, and personnel resources prove to be sufficient to allow the CALL task to succeed?	Reports from learners and teachers, other qualitative investigation, and critical analysis

would be the study by Borrás & Lafayette (1994), who investigated the effectiveness of optional L1 (English) subtitles as a means of modifying interaction in L2 French. The outcome measure they used was a speaking test, on which they compared performance

https://doi.org/10.1017/S0958344001000210 Published online by Cambridge University Press

Table 3. *Functions needed in CASLA software tools and their purposes*

Software Function	Purpose
Estimate task difficulty	Select appropriate level of tasks for intended learners Provide feedback for task development
Analyze learners' language	Assess task authenticity Assign point values collect diagnostic data for language assessment Gather learner data for research
Analyse the language of objects (written text, audio, video)	Assess task authenticity Assess difficulty of input
Support objects ordered in a database	Store examples of a variety of content and genres to be used directly or as models for language tasks
Gather process-oriented data	Assess participation in learning condition Assess learner characteristics in specific tasks
Support a structure for a learner model	Store learner data for intelligent tutoring, assessment. Explore the nature of learner models for research
Author learning conditions	Develop tasks for instruction and research that operationalize SLA theory (e.g. providing intelligent help).

of learners who had used the computer-assisted video materials with and without subtitle options. Results of the speaking task, which required all learners to address some questions about the content of the video, clearly favored the use of subtitles.

A study that combined outcome and interaction methodologies was one conducted by Hsu (1994), who investigated ESL learners working on listening by conducting a focused analysis of interactions between learners and the computer to identify their requests for modified input of segments of the story they listened to. In addition, she assessed outcomes through pre- and post-tests which had been constructed specifically for the research to include the lexical phrases in the input. A study that investigated language learning potential through the study of interactions was conducted by Pellettieri (2000). Based on investigation of the language of L2 Spanish learners in synchronous written communication of a chat, Pellettieri (2000) concluded that this medium supported tasks in which negotiation of meaning could occur. Since negotiation of meaning is one of the processes believed to hold language learning potential, the research suggests possibilities for the design of chat tasks for language learning.

It is possible to cite some research that provides evidence about some of the qualities for CALL, but if intelligent tutoring is going to be widely used within the next eight or nine years, much work remains to be done. The criteria and research methods listed in Table 2 offer some conceptual direction, but research requires more than clear goals; it requires the basic tools for developing software for research.

https://doi.org/10.1017/S0958344001000210 Published online by Cambridge University Press

4.3 Software tools

What is needed for conducting research is specific purpose software targeted directly to the needs of CALL for teaching and research. Without such tools, software is prohibitively difficult and time-consuming to author, as seen in many projects dedicated to developing intelligent tutoring systems over the past decades (e.g., Holland, Kaplan, & Sams, 1995). Many authoring systems have been developed for CALL with varying degrees of sophistication; however, work remains in putting these to use in addition to strengthening the theoretical and empirical bases for decisions about the capabilities built into authoring tools. Starting from the criteria and the research methods that would provide evidence about them, one might identify a number of features that should be built into an authoring system for CASLA as summarized in Table 3.

A more complete description and rationale for these software features is provided in Chapelle (2001), but a few examples can be spelled out to demonstrate how the qualities motivate the software features. The features of learner fit and authenticity suggest that the difficulty of the language in the CALL tasks should be analyzed in terms of both level and linguistic characteristics. Of course, this implies the need to draw from research in applied linguistics that can help to inform the detail of these analyses. The suggestion that language learning potential can be investigated through process-oriented methods indicates the need for software to include a mechanism for gathering such data. In fact, the types of capabilities identified here have been implemented in various software for authoring and language analysis, but to make progress on a focused research agenda, it seems that a single evolving system is needed for the profession.

5 Implications and challenges for the 21st century

The prospects for language teaching and technology outlined here point to several implications and challenges. First, as language teaching professionals, we are challenged to grasp the potentials and opportunities offered by emerging technologies and, at the same time, to recognize the nature of the 'missing science' that they imply. In other words, success in technologies such as speech recognition is not equivalent to success in technologies for second language learning. Second, to move toward more successful second language technologies, it seems that it will be necessary to minimize the chaos in the moving toward some articulated criteria. I have suggested some criteria, research and software as a means of increasing the orderliness of some aspects of our work. Each of these in addition to the thinking that underlies them are based on assumptions about ideal ways of approaching academic pursuits, and therefore both their content and their underlying premises.

Perhaps the most important lesson that comes from thinking about the future at the turn of the century is that language professionals need to consider their contributions at a level that goes beyond each person's own classroom. Our profession is changing rapidly in ways that are likely to change our jobs, and our students' experiences in and outside of the classroom. The issues of technology and learning that may affect language professionals are tied to the political processes of education. It seems that organizations such as EUROCALL and CALICO are in a key position to provide a message to the

https://doi.org/10.1017/S0958344001000210 Published online by Cambridge University Press

political process that is responsible for funding a useful agenda. Heppell suggested that the window for doing so may be open for about five years during this period of rapid changes in technology.

References

Bachman, L. F. and Palmer, A. S. (1996) *Language Testing in Practice*. Oxford: Oxford University Press.

Borrás, I. and Lafayette, R. C. (1994) Effects of multimedia courseware subtitling on the speaking performance of college students of French. *The Modern Language Journal*, **78**, 61–75.

Chapelle, C. A. (2001) *Computer Applications in Second Language Acquisition: Foundations for teaching, testing and research*. Cambridge: Cambridge University Press.

Cole, R. (2000) Plenary paper given at *EUROCALL 2000*, University of Abertay Dundee, Dundee, Scotland, August 31–September 2.

Cribb, V. M. (2000) Machine translation: The alternative for the 21st Century? *TESOL Quarterly*, **34**(3), 560–69.

Crystal, D. (1997) *English as a Global Language*. Cambridge: Cambridge University Press.

Doughty, C. and Williams, J. (1998). Pedagogical choices in focus on form. In: Doughty C. and Williams J. (eds.), *Focus on Form in classroom Second Language Acquisition*. Cambridge: Cambridge University Press, 197–261.

Gass, S. (1997) *Input, Interaction, and the Second Language Learner*. Mahwah, NJ: Lawrence Erlbaum.

Heppell, S. (2000) Plenary paper given at *EUROCALL 2000*, University of Abertay Dundee, Dundee, Scotland, August 31–September 2.

Holland, V. M., Kaplan, J. and Sams, M. (eds.) (1995) *Intelligent Language Tutors: Theory shaping technology*. Hillsdale, NJ: Lawrence Erlbaum.

Hsu, J. (1994) Computer assisted language learning (CALL): The effect of ESL students' use of interactional modifications on listening comprehension. *Unpublished doctoral dissertation.* Department of Curriculum and Instruction, College of Education, Iowa State University, Ames, IA.

Kurzweil, R. (1999) *The Age of Spiritual Machines: When computers exceed human intelligence*. New York: Viking.

Levin, L. S., Evans, D. A. and Gates, D. M. (1991) The Alice system: A workbench for learning and using language. *CALICO Journal*, **9**(1), 27–56.

Long, M. H. (1996) The role of linguistic environment in second language acquisition. In: Ritchie W. C. and Bhatia T. K. (eds.), *Handbook of Second Language Acquisitio*n, San Diego: Academic Press, 413–68.

MacIntyre, P. D. , Clément, R., Dörnyei, Z. and Noels, K. A. (1998) Conceptualizing willingness to communicate in a L2: A situational model of L2 confidence and affiliation. *The Modern Language Journa*l, **82**, 545–62.

Marty, F. (1981) Reflections on the use of computers in second-language acquisition. *Studies in Language Learning*, **3**, 25–53.

Murray, D. (2000) Protean communication: The language of computer-mediated communication. *TESOL Quarterly*, **34**(3).

Nagata, N. (1993) Intelligent computer feedback for second language instruction. *The Modern Language Journal*, **77** (3), 330–39.

Oxford, R. L. (1990) *Language Learning Strategies: What Every Teacher Should Know.* New York: Newbury House.

Pellettieri, J. (2000) Negotiation in cyberspace: The role of chatting in the development of grammatical competence in the virtual foreign language classroom. In: Warschauer M. and Kern R.

https://doi.org/10.1017/S0958344001000210 Published online by Cambridge University Press

(eds.), *Network-based Language Teaching: Concepts and practice*, Cambridge: Cambridge University Press, 59–86.

Pica, T. (1994) Research on negotiation: What does it reveal about second-language learning conditions, processes, and outcomes? *Language Learning*, **44**(3), 493–527.

Pica, T., Kanagy, R. and Falodun, J. (1993) Choosing and using communication tasks for second language instruction. In: Crookes G. and Gass S. (eds.), *Tasks and Language Learning: Integrating theory & practice*. Clevedon, England: Multilingual Matters.

Pierce, B. (1995) Social identity, investment, and language learning. *TESOL Quarterly*, **29**, 9–31.

Robinson, P. (1995) Review article: Attention, memory and the 'noticing' hypothesis. *Language Learning*, **45**, 285–331.

Salaberry, R. (1999) CALL in the year 2000: Still developing the research agenda. A commentary on Carol Chapelle's CALL in the Year 2000: Still in search of research paradigms. *Language Learning & Technology*, **3** (1), 104–07.

Schmidt, R. W. (1990) The role of consciousness in second language learning. *Applied Linguistics*, **11** (2), 129–58.

Skehan, P. (1989) *Individual Differences in Second Language Acquisition*. London: Edward Arnold.

Swartz M. L. and Yazdani M. (eds.) (1992) *Intelligent Tutoring Systems for Foreign Language Learning*. Berlin: Springer-Verlag.

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

Yazdani, M. (1989) Language tutoring with Prolog. In: Cameron K. (ed.), *Computer Assisted Language Learning: Program structure and principles*, Norwood, NJ: Ablex, 101–11.

https://doi.org/10.1017/S0958344001000210 Published online by Cambridge University Press