Computers and More: Creative Uses of Technologyfor Learning a Second or Foreign Language

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The following are four perspectives on the use of educational technology. The first two deal with learning in general, while the last two specifically address the learning of a second or foreign language (L2):

- «. . . after more than 50 years of research on instructional media, no consistent effects from any media have been demonstrated. . . . The key to promoting improved learning . . . appears to lie in how effectively the medium is exploited in the teaching and learning situation.» (Owston, 1997, p. 29)
- «Technology is motivational, but it should not become a crutch. If a teacher has a boring, monotonous teaching style, technology will not save him [or her]. Teachers have to be conscious of student needs and interests at all times.» (From a high school teacher's written statement about technology, University of Alabama, 1997)
- «There is no justification for further comparisons of human language instruction vs. computer-assisted language instruction. Rather, it is more appropriate to initiate research on those aspects of language learning that can be implemented effectively using technological resources.» (Doughty, 1992, p. 129)
- «Multimedia offers some effective solutions for language teachers nurtured in the

> proficiency movement who have inherited the daunting challenge of making their classes rich and varied sources of 'comprehensible input' through authentic communication.» (Taylor, Feyten, Bogard, & Green, 1996-1997, p. 32)

We believe that each of these positions is correct. Technology is a helpful and sometimes even transformative addition to the L2 classroom (Taylor et al., 1996-1997). However, the effectiveness of technology depends on (a) how well the selected technology deals with students' needs and interests (according to the anonymous teacher, 1997); (b) which aspects of L2 learning are addressed and by which kind of technology (Doughty, 1992); and (c) how well the technology is exploited in the particular instructional situation (Owston, 1997). Technology itself is not a «miracle cure» for all instructional problems.

In this article, we discuss creative uses of educational technology for L2 learning. Although the client group on which we are focusing consists of adolescents and adults, the suggestions presented here might also be applicable to elementary-school L2 learners, when proper modifications are made to the specific content and activity patterns.

Educational technology includes but is not limited to computers. As applied to learning and teaching, technology spans the gamut from the low range (the chalkboard and the old-fashioned, wall-decorating bulletin board) to the middle range (overhead projectors, audiotapes, videotapes, television, and radio) to the high range (computer-assisted L2 games and puzzles, intelligent computer-assisted L2 learning, desk-top publication, intranet, internet, and distance education of many types). Here we focus on a few of the most flexible and interesting middle-range and high-range technologies for L2 instruction.

The main issues addressed here are:

- rationale from theory and research for using technology to enhance L2 learning;
- technology as a provider of a meaning-focused, communicative learning environment;
- technology geared to students' learning styles;
- technology as a guide to structured practice;
- technology as a means of obtaining corrective feedback; and
- barriers to technology use and ways to overcome them.

Rationale from theory and research for using technology to enhance language learning

Although many L2 teachers around the world have jumped on the bandwagon of technology-assisted instruction, probably few of them have read research findings about the effectiveness of such instruction. The right research question is neither «Does technology increase L2 learning?» nor «Is use of technology better than non-use of technology for L2 learning?» At a minimum, such questions should be broadened to the following: «Which forms of technology enhance students' L2 learning with reference to particular educational goals?» Educational goals might include expanding access through distance learning to potential learners who would not otherwise be able to take a given course; increasing student interest and motivation; facilitating the development of particular kinds of skills; and creating greater flexibility of learning. Research evidence exists to show that technology contributes to

meeting all of these educational goals (Owston, 1997).

Yet educational goals are not the only factor concerning the effectiveness of technology in language instruction. The research question should be expanded still further to include other variables, to wit: «Which forms of technology enhance L2 learning (a) with reference to which broad educational goals, (b) with application to which language skills and subskills, (c) for which kinds of learners, (d) with which kinds of teachers, and (e) in what social and physical environments?» Spolsky's (1988) and Brown's (1994) concepts of conditions for optimal L2 learning might contribute to a framework for designing future research on the effectiveness of technology in enhancing such learning. This research framework would be strengthened by focusing specific attention on ways to increase the motivation of L2 learners and other learners (Dörnyei, 1990, 1994; Oxford, 1996a; Oxford & Shearin, 1994; Raffini, 1996) and on ways to deal effectively with the difficulties encountered by individual L2 learners (Ehrman, 1996).

As intimated by Owston (1997), flexibility of learning is a key to understanding the possible contributions of technology in L2 learning. Technology can offer greater flexibility and variety in terms of scheduling of classes, pacing of individual learners, choice of activities to match different learning styles, and selection of content. Greater flexibility creates a situation in which classroom control is shared between teachers and students (Johnson, Dupuis, Musial, Hall, & Gollnick, 1996). However, theory and research on teaching styles indicate that not all teachers might like this amount of flexibility in the classroom. Some instructors, particularly those who adopt the teaching styles of Teacher as Expert, Teacher as Mind Controller, and Teacher as User of Repetitive Routines, attempt to maintain total or almost total classroom control through the use of rigid classroom patterns (Oxford, Barcelos, Saleh, Longhini, & Elmore, 1997). Changes in attitude and behavior are needed for some teachers to accept educational technology in the classroom (Owston, 1997).

Some instructional psychologists and others consider that learning is a process by which an individual, with the proper assistance and modeling, moves upward from level to level: novice, advanced beginner, competent, proficient, and expert (Berliner, 1988; Leinhardt & Greeno, 1986). Novices focus on rules and surface features but lack any rational sense of the overall organization of the subject. Advanced beginners determine in which situation a given rule works differently from another. Competent-stage learners cope with problems through step-by-step, analytic decision making. Proficient learners add intuitive leaps to the analytic decision-making process. Experts act and react smoothly, automatically, and fluently. The student's progress toward expertise does not necessarily occur evenly across all skills in a given domain (Engeström, Engeström, & Kaärkkainen, 1995).

Educational technology in L2 learning can enhance this movement toward expertise if the proper conditions are present. For instance, as stated by Oxford (1993), intelligent computer-assisted language instruction—or any other technology-aided language instruction—must possess several features. It must have communicative competence as the cornerstone, offer appropriate error correction and other L2 assistance suited to the student's changing needs over time, provide an abundance of authentic L2 input, and use interesting and relevant themes and meaningful L2 tasks. Furthermore, it must be designed for use by students with different learning styles, teach students to become better learners via explicit training in L2 learning strategies, use a variety of interaction types, and involve multiple language skills.

The concepts of assistance and interaction infuse another learning theory as well. Vygotsky's social constructivist learning theory emphasizes that learning occurs with the help of a teacher, classmate, or other concerned person, who is more expert in the subject or skill than the learner. This person provides assistance («scaffolding») to the learner at the right times and in

the right ways and removes this assistance as the learner's performance indicates it is no longer needed. In so doing, this individual guides the learner through his or her own «zone of proximal development,» or range of potential under optimal circumstances (Vygotsky, 1987; for L2 learning applications, see Scarcella & Oxford, 1992).

We accept these Vygotskyian concepts about assistance from a «more capable other.» We define this concept broadly to include not only a teacher or an advanced classmate but also an L2 native speaker involved in an interactive e-mail exchange with the learner (Warschauer, 1997). In addition, L2 learners can sometimes progress through their zones of potentiality by practicing in pairs or groups with others who might not necessarily be «more capable» than the given learners themselves, as long as a growth-oriented, supportive situation has been established to provide structured learning tasks.

Educational technology, when designed well and applied appropriately for a given L2 learner (Pennington & Stevens, 1992), can provide significant assistance, even without the immediate presence of a teacher or other human. For example, a challenging multimedia program can offer learning strategies, cultural hints, and some forms of branching according to the needs and interests of the learner (Oxford, 1993).

Technology as a provider of a meaning-focused, communicative learning environment

Chun and Brandl (1992) created the matrix in Table 1, which we have slightly adapted for the current article, to classify the degree of communicativeness of various L2 learning activities using technology:

TABLE 1
Degrees of communicativeness of L2 learning activities using technology

FEATURE OF THE ACTIVITY	COMMUNICATION BASED ON LIMITED FORMS	MEANING-ENHANCING BUT RESTRICTED COMMUNICATION	FULLY MEANIGFUL COMMUNICATION
Basis	Grammar	Guided communication	Free communication
Degree of context	Minimal: single, isolated words or sentences	Somewhat restricted: interrelated sentences, but limited in terms of grammar, semantics, and pragmatics	Full: interrelated sentences with no restrictions in terms of grammar, semantics, or pragmatics
Sample tasks	Fill-in-the-blank, multiple choice, cloze	«Information gap» tasks requiring negotiation of meaning	Artificial intelligence with parsing and speech recognition
User's contribution	Letters or single words	Whole sentences but limited in the ways noted above	Unrestricted, complete, original sentences

As seen above, technology can be used for different degrees of communicativeness for L2 instruction. It can focus on grammar and vocabulary, involve strictly minimal communication restricted to particular forms, and require the learner to contribute only letters or single words. Alternatively, it can strongly guide communication through information gap activities but limit that communication syntactically, semantically, and pragmatically. Finally, it can encourage free communication with no restrictions using complete, original discourse.

Chun and Brandl (1992) call for more meaning-enhancing programs that use information gaps and negotiation of meaning. Their assertion that computer-assisted language instruction must be as communicative as possible is echoed by Underwood (1993), Quinn (1990), and Lavine (1992). Each of these researchers has explored technologies which provide the opportunity for either meaning-enhancing communication or fully meaningful communication.

Technology can be used to create an L2 learning environment that offers meaning-enhanced communication or even fully meaningful communication. Technology can enhance L2 learning when teachers focus on the learning objectives and then choose the type of technology and the tasks that best suit the objectives.

However, it is easy to trivialize the effort by inserting technology into language classes without careful thought as to the instructional reason for using a particular kind of activity. Technology-mediated L2 tasks cannot aid learning if used merely as a Friday afternoon diversion, a play session, a rest period for the teacher, or a manipulative reward for students' accomplishing «more serious work.» Employing technology for baby-sitting one group of students in the classroom, while the teacher pays attention to a different group, is not a serious use of technology. In a recent German language course, the teacher was working with half of the class on oral activities while the other students were seated in pairs at computers, playing a German word game. Students were required to match the German word (spoken by the computer and printed on the screen) with the picture of the corresponding object. Some students were striking the keys at random, so they could hear the sound effects when they made mistakes and lost rounds. The game could have been useful, but some students employed it for killing time without learning any German, and the teacher never realized that this was happening. For some students, the use of technology-aided activities needs to be carefully monitored.

This section addresses the value of several middle-range and advanced technologies for providing a meaningful, communicative L2 learning environment: television and radio show production by students, simulations, e-mail exchange with students around the world or in the next classroom, publications and projects in the target language or about the target culture, and other forms distance language learning not mentioned earlier.

TV and Radio Program Production.

In an intensive English language institute at Pennsylvania State University (USA), the students themselves scripted, choreographed, directed, and produced a mini-series of television shows (described in Talbott & Oxford, 1991). Teachers acted as consultants, facilitators, and editors only when asked; they allowed the students to create their shows. The programs contained news, personal features, game shows like Pictionary, commercials (one was about the intensive English institute itself!), and the students' own night club acts with singing and dancing. To create the mini-series, the students had to learn how to use camera equipment, do film editing and splicing, write scripts, design and apply titles, provide and accept critiques, make revisions, and use a wide range of relevant English vocabulary and syntax. The concept

of TV program production is intuitively appealing to many language learners, who have been oriented from infancy toward the «video culture.»

Although the Penn State video-making was done totally from scratch with no computer assistance, computer programs now exist to help L2 learners create their own commercials (Operación Futuro, by Chiquito [no date] described in Chiquito et al., 1997) and make their own videos complete with graphics, audio, text, and various kinds of subtitling (¡Dime! Interactive by Samaniego et al., 1995; Juntos Interactivo by Chiquito et al., 1996; Discovering French Interactive by Heath, 1994). Most of these are for university students and secondary school students (Bush & Terry, 1997).

Language students can also create their own radio shows that they can transmit to other language students at home and abroad or to additional audiences. This can be just as motivating and language-enhancing as creating students' video programs. Winger (1997) showed the benefits of student involvement in radio production and describes the procedures used in a community-supported, student-led radio production project.

Multimedia Simulations

One type of communicative, meaningful, multimedia simulation is exemplified by the Philippe simulation by Furstenberg (1993) and the No Recuerdo simulation by Morgenstern and Murray (described by Oxford, 1990; see also Chiquito et al., 1997), produced by the Massachusetts Institute of Technology. This kind of simulation involves a full-scale story including lots of twists, turns, and options, depending on the student response. Students can control the flow of input (play, pause, repeat, etc.), control the flow of student-generated output (revise, reshape, reorder, add or eliminate parts), and deepen understanding and enrich language production by linking to relevant videoclips, audioclips, glossaries, learning strategies, texts, photos, and so forth. The story is designed to be exciting, and the student has a large role in helping to solve a problem posed by the story.

El Robo del Siglo (The Crime of the Century) is a cooperative mystery simulation requiring intermediate-level students of Spanish to work together on the World Wide Web to solve clues and write short compositions in Spanish. The simulation involves not only the language but also many cultural and geographic clues designed to heighten awareness (Taylor, Feyten, Bogard, & Green, 1996/1997). Drei tage in München (Three Days in Munich) is a Web-based activity for high school students that requires planning for a three-day trip to Bavaria through cultural knowledge and Internet research skills (Bogard, Feyten, Green, & Taylor, 1997).

E-mail

E-mail connections can provide L2 practice in a fully meaningful, communicative context. Through local area networks, e-mail allows communication among students in the same class and in other classes within the same school. Using wide area networks, e-mail permits communication over long distances—across states and countries. Communication with people living in a country or state where the target language is used as the primary medium of interaction can help L2 learners develop fluency. Even learners with a very limited L2 vocabulary can send brief messages to their international peers. In addition, learners who have a more developed capacity in the L2 can send increasingly complex messages, tell stories, share jokes, and send newsletters to their international friends.

Warschauer (1997) provided an exceptionally good research review and analysis of the value of e-mail for L2 learning. On-line, computer-mediated communication offers not just one-to-one interaction but many-to-many exchanges, occurring both locally and at great distances. Warschauer cited Kroonenberg's (1994/1995) research on synchronous, one-to-one, e-mail chat, which allows students to practice rapid interaction, produces more expression than ordinary written composition or oral conversation, and serves as a «thinking device» by allowing reflection in the midst of interaction. Warschauer's review showed greater participation by L2 students via e-mail communication than via face-to-face discussion (Kelm, 1992; Kern, 1995; Sullivan & Pratt, 1996). Participation is enhanced because e-mail communication reduces social context clues related to race, gender, handicap, accent, and status; reduces non-verbal cues that can intimidate; allows individuals to contribute at their own time and pace; encourages people to state their own opinions rather than rapidly concurring with others; and breaks the pattern of teacher-dominated discourse (Warschauer, 1997).

Not only can e-mail increase participation by L2 students, but it can also improve the quality of discourse (Warschauer, 1996). Comparing e-mail discourse with oral classroom discourse, researchers found that students used more complex language with a wider range of functions (Warschauer, 1996), were more accurate (Kelm, 1992), and produced stronger arguments (Kern, 1995). Contrasting e-mail dialogue journals with paper-based dialogue journals, Wang (1993) discovered that the e-mail group wrote more per session, asked and answered more questions, used language more flexibly, and were less formal and more conversational with the teacher. Warschauer's review indicated that e-mail can help L2 learners develop their analytical, narrative, and descriptive writing styles (Brammerts, 1996; Crotty & Brisbois, 1995; Kroonenberg, 1994/1995, 1995; Janda, 1995). Especially when used internationally, e-mail can greatly enhance the cultural awareness of L2 students (Barson, Frommer, & Schwartz, 1993; Kendall, 1995; Kern, 1996; Tella, 1991, 1992; Vilmi, 1995).

Collaborative Publication and Projects.

Desk-top publishing offers great possibilities for L2 learners. Many youngsters in the elementary grades and even in kindergarten have experience in making their own «Big Books,» consisting of self-created stories illustrated with large pictures drawn by the students. At university and secondary school levels, L2 learners can create stories, books, literary magazines, and newsletters of all sorts using the target language. Ordinary word-processing programs allow students to create texts, design formats, insert proper symbols, and use various sizes and styles of type. Many computers have clip-art programs that offer possible illustrations. In some computer-assisted foreign language instruction programs, such as those for Juntos and Operación Futuro, students can search catalogs of graphic images (culturally relevant photos, drawings, and so forth), titling options (single language or two languages), and text-creation aids.

Publishing a World Wide Web home-page in the target language or about the target culture is a step beyond desk-top publishing. Baldazo and Vaughn-Nichols (1995), Hall (1995), Monahan and Tomko (1996), and Randall (1996) offered guidelines for students who want to create their own Web pages using available tools. Such tools include Web-generating programs available from on-line services like America On-Line, Prodigy, or CompuServe; commercial authoring and page construction software like Pagemaker, Claris Works, Front Page, HAHTSite, and HTML Transit; commercial graphics software like MicroSoft Paintbrush, Paint Shop, and Paint Shop Pro; inexpensive or free shareware programs like Hot

Metal Pro and HTML Assistant Pro; and scanners and digital cameras. Thompson (1995) showed how efforts such as these can become community projects.

Technology-assisted L2 class publications and productions can be shared internationally or can become international hypermedia projects, as shown by Warschauer (1997). Kern's (1995) students of French produced a multimedia introduction to the city of Berkeley, California, and shared it with peers in France. Sayers (1993) suggested three types of international, computer-mediated collaborative projects: (a) shared student publications, (b) comparative investigations, such as research into social and environmental issues; and (c) compendia of folklore and oral histories.

Other Forms of Distance Language Learning Not Mentioned Earlier

Distance education courses offer opportunities for authentic language learning when native speakers or trained foreign language teachers are not available, or when only a few students at a site want to study a particular language and it therefore cannot be offered by ordinary means. As just one example, the University of Alabama has provided long-distance delivery of Japanese language courses to high school students for close to a decade. These same courses are now becoming popular with university students and business people. The courses were originally delivered through interactive satellite TV, supplemented by printed manuals for students, in-class activities led by a facilitator, and required telephone tutoring by native Japanese speakers. In the interest of containing costs and providing greater flexibility in scheduling, the courses are now offered through asynchronous videotape, but they are still supplemented by student workbooks, in-class communicative activities, and native-speaker telephone tutoring. In both modes (satellite and videotape), these courses won top national awards for distance education programming, and students were highly motivated (see Oxford, Park-Oh, Ito, & Sumrall, 1993a, 1993b).

Effects of using radio (in non-student-created forms) for distance education in languages has been explored by Imhoof and Christensen (1986) and Crookall (1983, 1984, 1986). Providers in countries such as the U.K., the U.S., Canada, Australia, and New Zealand have created a multiplicity of distance education options, some of which are mentioned by Makulowich (1997) and Boettcher and Conrad (1997).

Technology geared to students' learning styles

Understanding the student differences known as «learning styles» (Reid, 1995) and «cognitive styles» (Sternberg & Grigorenko, 1997) can help teachers provide instruction that meets individual needs without having to create totally separate lesson plans for each learner. Sternberg and Grigorenko (1997) state that cognitive styles are important for several reasons. First, they represent a bridge between cognition and personality (see personality types in language learning, Oxford, 1996b). Second, they are helpful predictors of academic achievement in various educational settings. Third, styles are important in predicting occupational choice and successful work performance. Sternberg and Grigorenko presented an excellent literature review on cognitive styles, dividing the existing research into four approaches:

- the cognition-centered approach, including dimensions such as reflection and

impulsivity, concerning the tendency to respond slowly and reflectively versus the tendency to respond rapidly without sufficient forethought (reviewed by Block et al., 1974); and field-independence and field-dependence, referring to the degree to which the person cognitively separates the salient details from the background (Witkin, 1964; Witkin et al., 1971);

- the personality-centered approach, including Jung's theory of personality types, such as extroverted-introverted, sensing-intuitive, thinking-feeling, and judging-perceiving (Myers & McCaulley, 1985; Oxford, 1996b); and Gregorc's (1985) energic model of concrete-sequential, abstract-sequential, abstract-random, and concrete-random styles;
- the activity-centered approach, containing theories about preferences for certain teaching, learning, and occupational activities (Dunn et al., 1989; Henson & Borthwick, 1984; Holland, 1973; Renzulli & Smith, 1978); and
- the mental self-government/thinking styles approach of Sternberg (1997), which includes external (cooperative) and internal (solitary) «scopes,» conservative (rule-bound) and liberal (beyond-rule) «leanings,» and four «styles:» the monarchic style (one goal or task at a time), the hierarchic style (multiple goals with varied priorities), oligarchic style (multiple, equally important goals), and anarchic style (random treatment of goals or tasks).

Some students (including certain field-independent, sensing, judging, concrete-sequential, abstract-sequential, internal-scope, conservative-leaning, and monarchic- or hierarchic-style learners, for instance) thrive on particular kinds of L2 activities that might not seem communicative at all. Such learners need to have a very structured basis for their L2 learning, and many of these students might not be comfortable «creating» communicatively with the language unless and until they can use logical reasoning to analyze the language. Such students often prefer explicit feedback on grammatical accuracy, discussed later in this article. Computer programs with traditional L2 drills and analytic puzzles allow these students to do the exercises that they need for developing precision, accuracy, and analytical understanding.

On the other hand, certain intuitive, perceiving, concrete-random, abstract-random, cooperative-scope, liberal-leaning, and anarchic- or oligarchic-style students, and possibly some field-dependent students, might be able to jump directly into communicative activities, assisted by technology or not, without the compelling personal need for analysis and accuracy. Instead of explicit feedback on grammatical precision, such students often prefer contextualized clues or indirect suggestions about how to use forms appropriately (Oxford, 1993).

Knowing students' cognitive styles can help the teacher decide which students in the class need what kind of technology-based assistance (and when this assistance would be the most useful). A limited amount of research has been conducted on computer-assisted L2 instruction as related to field-dependent and field-independent cognitive style preferences. For example, Raschio (1990) conducted an experiment with students who used a computer-assisted language instruction program tailored to individual styles. He found no difference between field-dependent and field-independent learners' facility with the program, but he noted a pattern of learner preferences. Field-dependent students preferred an inductive approach to learning grammar (analyze language data to deduce or generate the rule), while field-independent students learned better with a deductive approach (state the rule explicitly and then give direct examples). Raschio stated that future technology-enhanced instruction will be able to diagnose students' preferences and tailor programs to their needs.

Leader and Klein (1994) conducted an experiment to examine students' facility with various

kinds of computer search tools for a program called Earth Quest. The search tools included: (a) browser, (b) index/find, (c) map, and (d) all tools (browser, index/find, and map). Significant interactions existed between the search tool and the students' cognitive style. For example, field-independent students performed significantly better than field-dependent students in using the index/find tool and the map tool. The attitude of field-independent students toward the index/find tool was significantly more positive than that of the field-dependent students. In addition, field-independent students accessed significantly more screens than did field-dependent students.

Learning strategies are the specific behaviors learners use to conduct and enhance their learning. According to research, the selection of these strategies is often directly related to cognitive styles of individual learners (Ehrman, 1996). Certain educational computer programs provide a tracking system that indicates students' choices of learning strategies (Bailey, 1996; Pennington & Stevens, 1992). Such information sheds light on learners' cognitive styles and on the effectiveness of particular learning strategies for given L2 tasks.

Technology as a guide for structured practice

Computers offer a range of tasks to provide practice with the L2 (see Crookall & Oxford, 1990; Pennington & Stevens, 1992). Menke (1989) found that as early as 1989, a majority of university English language institutes provided computer-assisted L2 practice, most of it for teaching writing and grammar. The market for L2 practice tutorials, mostly structure-oriented, was approximately $50,000,000 in 1995 (Desmarais, 1995).

Research comparisons of non-technology-based instruction versus technology-based instruction for L2 practice are mixed. As noted earlier, collaborative e-mail practice generates more discourse, a greater number of language functions, and more linguistic accuracy. The collaborative aspect appears to be highly influential in terms of student outcomes.

Noncollaborative, computer-mediated practice does not seem produce to better results than ordinary, paper-based practice for L2 writing (Ghaleb, 1993; Odenthal, 1993). These results suggest that unless computer-aided L2 composition involves adequate interaction, it is no more advantageous than the less expensive, traditional alternative. Nagata (1995) reminded us that the highest forms of educational technology are not required for all L2 tasks.

For L2 grammar and vocabulary learning, computer-based practice exercises show some gains over ordinary classroom tasks related to grammar and vocabulary (Avent, 1993; McCarthy, 1994; Millgren, 1984). It is possible that these topics lend themselves well to technological formats. Intelligent computer-based language instruction, which provides specific forms of corrective feedback about grammar, vocabulary, and other aspects of language, might offer even more consistently positive results, as shown next.

Technology as a means of obtaining corrective feedback

Corrective feedback is a form of consciousness-raising (Lightbown & Spada, 1990; White, Spada, Lightbown, & Ranta, 1991). Doughty (1991) specified levels of consciousness-raising, ranging from explicit rule explanations to examples relevant to difficult structure. The computer is ideally designed to provide individualized consciousness-raising through feedback

about errors in grammar, semantics, and pragmatics. Traditional computer-assisted language instruction notifies the user of a missing or incorrect word, while «intelligent» computer-assisted language instruction goes beyond simple notification of an error and offers detailed metalinguistic feedback about the type of error. Intelligent systems provide feedback that is not predetermined by the instructor.

However, currently available intelligent systems do not typically offer the speaker's type of response to a learner's statement. That means they are not built for conversation, and they have very simple «communication modules» (Rypa & Feuerman, 1995). At this stage, intelligent systems help L2 students fine tune their linguistic accuracy rather than their fluency. Despite these limitations, the feedback offered by intelligent systems can be very useful to L2 learners.

Intelligent systems generally use a parser, which serves to «understand» language input, including novel utterances it has not encountered before. If the sentence or other input is well-formed, the parser produces a syntactic/semantic/phonological representation of it. However, if the input is ill-formed and incorrect, the parser can «understand» and explain the errors, using intelligent feedback about conversational rules, presuppositions, and situation-semantic concepts if incorporated into the program (Ellis, 1994). In contrast to the parser, the generator takes a set of rules, principles, or words as input and produces a sentence or another grammatically well-formed piece of discourse.

Nagata and Swisher (1995) proposed that computer-assisted L2 instruction should incorporate the full range of structure-related consciousness-raising options. With one group of learners of Japanese as a Second Language or JSL, these researchers used an intelligent computer-assisted L2 learning system with a morphological parser (Hausser, 1989), a syntactic parser (Tomita, Mitamura, Musha, & Kee, 1988), and three kinds of databases—a lexicon and sets of morphological and syntactic rules (Nagata, 1992). Another group of JSL students of JSL used a parallel computer program which provided only traditional feedback, not intelligent feedback. The two groups participated in six one-hour lessons on the passive voice. The group receiving intelligent feedback performed significantly better than the group receiving traditional feedback. Nagata found similar results in later studies (1995; personal communication, 1996), in which intelligent grammar feedback proved more effective than traditional grammar feedback, no detailed grammar feedback, or simple self-study grammar workbook sheets.

Nagata (1995) described the following intelligent computer applications for L2 learning: Grammar-Debugger, LINGER, Miniprof, ALICE-Chan, Syncheck, GPARS, Nihongo-CALI, and BRIDGE. Of these, BRIDGE (Weinberg et al., 1995) is an interesting case, because it responds in part to learners' affective needs by withholding information about errors from the novice student. The program is constraint-based and, like the others, focuses on improving linguistic accuracy. Students with field-independent styles might prefer such programs (Oxford, 1993). However, students with field-dependent styles might not find in these programs the opportunity to learn using their preferred approaches. Moreover, these programs pay little attention to conversational principles, schemata, and contextual clues that can be systematically used by intelligent systems to emulate proficient speakers.

An exception, however, is the CALLE program (Rypa & Feuerman, 1995), which allows comprehension well beyond the sentence level and uses contextual clues to «guess» a word's meaning. This experimental system uses a technological grammar base with functional structures that include co-indexation and can guess the meaning according to context. This is especially meaningful in the case of pronouns. However, the program still concentrates on providing explicit grammar explanations to the user.

A few intelligent systems avoid explicit grammar explanations and concentrate on conversational strategies (FLUENT, by Hamburger, 1995; LINGO, by Murray, 1995) and world information (LingWorlds, by Douglas, 1995). Learners who prefer contextualization and whose cognitive styles are intuitive, perceiving, concrete-random, or abstract-random might like this form of feedback.

Intelligent systems can potentially provide a range of explicit, implicit, positive, and negative feedback. Explicit positive feedback involves presenting the correct alternative with repetition and rephrasing of utterances for the learner, along with self-correction. Explicit negative feedback consists of directly indicating the error followed by overt correction and explanation, often using contrasts with the native language. Implicit positive feedback involves extensively using relevant, comprehensible input on the same theme. Implicit negative feedback consists of ignoring the learners' incorrect utterances and asking the learner for clarification. This amount of variety is impossible in conventional, fixed-answer systems (Beck, Schwartz, & Eubank, 1995).

However, at this point intelligent applications are usually limited to providing explicit negative feedback. Moreover, their ability to produce some types of feedback depends on their interactivity and their capability for responding appropriately during an interactive task with a student. Most current applications are not designed to interact at the level of a proficient speaker who has general background knowledge, ability to make inferences from the sociolinguistic context, and understanding of nonlinguistic features—all basic requirements for a truly interactive learning system (Oxford, 1995). Many intelligent systems lack even the basic grammatical and vocabulary-related expertise required of a proficient speaker, much less any in-depth sociolinguistic competence.

Future intelligent systems should be developed to provide a wide array of context-related feedback to the user (Plough, 1995). For this to happen, sociolinguistic competence—ability to use language appropriately in relevant cultural environments—must be incorporated into intelligent systems, as LingWorlds (Douglas, 1995) shows us. This competence can include contextualized sentence interpretations, conversational implications (Grice, 1975), and knowledge of utterances that function only in certain social settings (like the use of «I do» during a wedding, Austin, 1975). Goodman (1989) proposed that an intelligent system can reason and can «learn» meanings progressively, based on the physical context and the linguistic context. Connectionist models of reasoning and learning via intelligent systems incorporate context, schemata, associated memory weights, and spreading activation over connections (Dinsmore & Moehle, 1990). The goal is for intelligent systems to use sociolinguistic competence strategies to consider various interpretations of the learner's utterance and give the most appropriate kinds of corrective feedback, depending on the learner's needs and cognitive style.

Barriers to technology use and ways to overcome them

Some challenges to the use of educational technology for L2 learning include: inadequate technology-related skill levels of language teachers, negative or indifferent attitudes of faculty members toward technology, and lack of funds for appropriate and varied technologies. Because of national and regional differences in funding situations, the last issue is beyond the scope of this article. We choose to focus on faculty development as a means of addressing the first two issues: technology skill levels and attitudes.

Faculty development should address L2 teachers' technology skills and attitudes toward technology. Negativity and indifference must be overcome before teachers can improve their technology skills. To deal with such attitudes, teachers should learn ways in which technology can help them improve their language instruction. Those instructors whose teaching style involves a large amount of teacher control should learn the advantages of sharing control a bit with their students. Instructors should also learn the degree to which teachers can, if they desire, remain in control of the learning environment even when technology is used. For an insightful examination of the broad significance of control, see Shapiro, Schwartz, and Astin (1996).

Once negativity and indifference are handled, teachers' technology skills can be addressed. These skills should be viewed in terms of levels of competence, with beginning, intermediate, and advanced abilities delineated. A matrix of teacher technology skills should be developed to address different technology levels. This matrix should be cross-indexed by the educational goals or objectives. General goals can be based on national or international standards for learning language and culture (see, e.g., Lafayette, 1996). Specific objectives can come from the stated curriculum, if one exists, provided by a given state, province, university, or professional language teachers' association.

Teacher training should encompass not just computer use but should also deal, when necessary, with using overhead projectors, audiotapes, and videotapes effectively; grouping students for the best learning; and incorporating varied forms of physical movement into a technology-assisted class (very important for tactile and kinesthetic learners of any age). In the area of computers, we suggest that teachers should learn how to use computers for student desk-top publishing, projects, e-mail, simulations, and individual and group activities such as games or drills. Teachers should also learn which cognitive styles fare best with which kind of classroom activities and with which technological applications.

Teachers should develop competence in teaching students how to use technology, so that technology-assisted instruction becomes a vehicle for meaningful learning, not just an exercise in operating software or hardware or a trivial encounter with noise and images. The goal of faculty development should be to empower teachers to make intelligent choices, so that their students can learn more effectively through a variety of media. Helpful frameworks for designing, selecting, and using computers (and other relevant technology) for L2 instruction are found in Pennington and Stevens (1992) and Bush and Terry (1997), and these should be part of faculty development at various levels.

Conclusion

Educational technology holds significant potential for language instruction. If used properly, technology can interest and motivate learners, expand access to a greater number of learners, provide flexibility of instruction, and develop learners' competence and expertise in certain aspects of language. Using certain applications, current technology can to some extent promote communicative and meaningful language learning, assist in tailoring instruction to learners' cognitive styles, offer a balance of guided practice and free expression, and provide corrective feedback. In the future, more flexible and intelligent systems will be able to fulfill these functions much more effectively. However, technology is not a panacea or a «magic bullet» that suddenly transforms all learning. The effectiveness of educational technology depends on how it is employed to meet educational goals for particular kinds of students in specific language learning environments. Faculty development is needed to overcome

teachers' hesitations and to enhance teachers' technology skills.

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