Optimal Foreign Language Learning
The Role of Technology

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Executive Summary

Purpose
In 2002, the Department of Defense mandated higher minimum proficiency scores for military linguists. The Defense Language Institute Foreign Language Center (DLIFLC) responded to this challenge with a number of initiatives, including an increase in the role of technology in language learning and teaching.

DLIFLC is currently integrating new technologies into its learning environment. To facilitate this process, the University of Maryland Center for Advanced Study of Language (CASL) was tasked with reviewing the literature on the use of technology for foreign language learning and teaching, and recommending best practices for technology use. We ultimately reviewed over 200 publications, including both peer-reviewed research articles and descriptions of teaching practices.

Conclusions
We identified four categories of technologies that are relevant for foreign language education:

- Classroom-based tools, such as course management systems and interactive white boards
- Individual study tools, such as electronic dictionaries, glossed and annotated texts, and computer-assisted pronunciation training
- Network-based social computing tools, such as chat, blogs, wikis, and virtual worlds
- Mobile/portable, network-capable devices, such as tablet PCs and personal media players

We concluded from our review of the literature that technology use has the potential to enhance five primary functionalities of foreign language learning and teaching:

- Organization—Technology can enable learners and teachers to organize learning and instruction outside of the classroom and can enable learners to reflect on and take control of their own learning.
- Input—Technology can expand access to a broader range of rich target language input than is available in the classroom or provided by the curriculum, and it creates opportunities to individualize input.
- Output and interaction—Technology creates opportunities for learners to create their own output and to interact synchronously or asynchronously with native speakers and more proficient peers outside of the classroom.
- Feedback—Technology creates opportunities to give and receive individualized, maximally effective feedback.
- Collaboration—Technology can enable collaborative, social learning synchronously or asynchronously outside of the classroom.

Although technology use for education is widespread, scant evidence exists to support its effectiveness for enhancing foreign language learning.
and teaching. The strongest empirical support for the impact of technology on foreign language learning emerged from the research on written chat and computer-assisted pronunciation training; evidence for the effectiveness of other technologies was generally weak or nonexistent. Therefore, we relied on key principles of learning to recommend best practices for technology use.

From the field of second language acquisition, we identified three crucial principles of language learning:

- Provide rich target language input to learners
- Engage learners in interactive tasks using the target language
- Provide feedback to learners so that they notice and correct their own target language errors

Additionally, from the field of cognitive psychology, we identified four crucial principles of learning that facilitate long-term retention of knowledge and transfer to real-world contexts:

- Test frequently with minimal retrieval cues
- Distribute practice across several small sessions rather than in a single large session
- Vary the characteristics of learning activities
- Introduce difficulty factors that make learning challenging and require students to process information deeply

The best practices listed in Table 1 exemplify technology uses supported by crucial learning principles and empirical evidence.

### TABLE 1

<table>
<thead>
<tr>
<th>Best practices for technology use in the classroom</th>
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<td><strong>To . . .</strong></td>
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<td>Maximizing target language practice</td>
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<td>Maximizing the efficiency of classroom contact time with the teacher</td>
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<td>Enable customization, shareability, reusability, and anytime/anywhere access to target language content and instructional materials</td>
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<td>Archive and analyze interaction, learner output, and incorporation of feedback, and to individualize subsequent input and feedback</td>
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<td>Motivate students and engage them in meaningful target language use</td>
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<td><strong>Use technologies such as . . .</strong></td>
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<td>Written chat, outside of the classroom</td>
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<td>Computer-assisted pronunciation training, outside of the classroom</td>
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<td>Course management systems, natural language processing tools, and mobile devices</td>
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<td>Intelligent tutoring systems, ePortfolios, and natural language processing tools</td>
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<td>Ad hoc networks and serious games</td>
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### RELEVANCE

Technology use can enhance foreign language learning and teaching by providing rich input, individualizing instruction and feedback, maximizing in-class time for interactive learning, and increasing student motivation. The recommended best practices offer the potential of improving foreign language learning outcomes and transfer to real-world contexts. Decision makers implementing technology for learning should consider the following caveats:

- Using technology will not make bad pedagogy good; conversely, the lack of novel technological tools will not necessarily inhibit effective learning.
- Key principles from second language acquisition and cognitive psychology must be integrated into technology use in order to fully optimize its potential for enhancing language learning and teaching.
- Users need appropriate training on how to incorporate and exploit technological tools to facilitate the attainment of learning goals.

### ENDNOTES

1 For a complete list of the reviewed technologies, see section 1 of the technical report.

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Literature Review on Technology Use for Foreign Language Learning and Teaching

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1. INTRODUCTION

In this technical report we present a very high-level overview of the use of technology for foreign language (FL) learning and teaching. The use of technology for language learning and teaching goes by many names and acronyms, including computer assisted language learning (CALL), technology mediated language training (TMLT), technology enhanced language learning (TELL), network based language teaching (NBLT), and no doubt many others (Levy & Hubbard, 2005). There are currently at least half a dozen major peer-reviewed journals dedicated to CALL or in which CALL researchers publish. Dozens of book-length reviews of CALL-related research have been published in the last decade. In addition to Second Language Acquisition (SLA), the discipline that we consider central to the topic of this report, there are many other inter-related disciplines that play important roles in designing and implementing CALL: natural language processing (NLP), instructional design, cognitive science, information science, and educational technology. Each of these disciplines has its own extensive research literature with implications for CALL design and implementation, although research from these diverse disciplines has not yet converged. At least in the case of CALL and NLP, “the two disciplines seem to live in completely different worlds” (Borin, 2002).

We intend this technical report to serve as a comprehensive map to the use of technology for language learning and teaching, in order to orient readers how technology currently is being used, and how it may yet be used in order to take full advantage of its potential to enhance learning outcomes in blended learning environments. We take our cue from the collaborative series of reports on technology and learning from the New Media Consortium and the EDUCAUSE Learning Initiative, indicating what is in use now and what is on the horizon in the foreseeable future (Johnson, Levine, & Smith, 2007).

1 The authors would like to thank Barbara Forsyth, PhD, for reviewing early versions of this report.
2 We also use the term “target language” (TL) when referring to a particular language that is being learned.
3 In this report we will retain the usage of CALL for its usefulness and widespread recognition in the language teaching field.
5 Although various definitions of blended learning exist (Osguthorpe & Graham, 2003), we mean a “convergence of face-to-face classroom activities with activities carried out through distributed learning environments, facilitated through Internet connections” (Dooly, 2007, p. 60).
2007; Johnson & Smith, 2006). We believe that this technical report will be useful primarily for decision makers at
DLIFLC and other USG agencies and institutions with investments in language training, although we believe that our
findings and recommendations will also have implications for teachers in the classroom.

1.a. Focus of this report

The main body of this technical report describes how a spectrum of technologies is currently being used for adult
foreign language learning. We focus on four general categories of instructional and learning technologies where
technological enhancement has made, or has the potential to make, an impact on learning, referring to particular brands of
software or hardware in only a few cases. The categories of technology that we address are: (1) schoolhouse- or
classroom-based technologies; (2) self-contained applications used as individual study tools; (3) network-based social
computing for communication and collaboration; and (4) mobile or portable devices that enable anytime, anywhere
learning. Some of these technologies have been used in CALL for over three decades (e.g., intelligent tutors); some have
emerged in the last 15 years as a result of the Internet revolution (e.g., course management systems, computer-mediated
communication); and others have only recently been developed and are not yet widely used for foreign language learning
and teaching (e.g., virtual environments, blogs and wikis, mobile Internet-accessible devices). The technologies reviewed
include the following:

1. Schoolhouse- or classroom-based technologies
   a. Course management systems
   b. ePortfolios
   c. Interactive white board

2. Individual study tools
   a. Corpus-based materials
   b. Electronic dictionaries
   c. Electronic flashcards
   d. Glossed and annotated texts
   e. Learning objects
   f. Intelligent tutoring systems
   g. Grammar and spell check
   h. Automatic speech recognition and pronunciation programs
   i. Off-line handwriting recognition
   j. Virtual environments

3. Network-based social computing
   a. Virtual worlds and serious games
   b. Synchronous and asynchronous computer-mediated communication
   c. Blogs, wikis, and social networking

4. Mobile and portable devices
   a. Personal digital assistants
   b. Personal media players
   c. Mobile phones and smartphones
   d. Tablet PCs

In this technical report we have reviewed research that is grounded in many diverse disciplines and research
perspectives. However, the perspective through which we have synthesized the findings is that of Second Language
Acquisition, and the mechanisms and processes associated with target language learning. Primarily, that means the
Interaction Framework: the widely accepted position in SLA that the inter-related processes of input, interaction, feedback,
and output facilitate (although may not be sufficient for) psycholinguistic gains; i.e., changes in the learner’s cognitive
representation of the target language toward a target language norm (Gass & Mackey, 2006). In addition to cognitive

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6 For example, we discuss those technological enhancements that we know DLI has introduced, based on a previous study
(TTO 2103) and discussions with DLI faculty and staff.
7 We have specifically excluded the personal computer (desktop and laptop PC) and Internet connectivity, both of which
have become ubiquitous in education and beyond. Their near-total, if not total, use by faculty and students in post-
secondary education speaks for itself; at least, in terms of acceptance and adoption, if not effectiveness for instruction and
learning.
processes, we also attend to the mediating roles that social context (particularly collaborative learning) and affective factors (particularly motivation) play, as they arise in the research.

We must note, however, that the state of the CALL literature, although wide reaching in terms of topics, leaves much to be desired in terms of a unified research agenda (Chappelle, 1997; Felix, 2005) and durable, validated findings (Felix, 2005; Stockwell, 2007). Common problems in CALL research include: poor description of the research design; poor choice of variables to be investigated; lack of relevant data about subjects; studies based on untrained users of the technology; a nearly exclusive focus on Western European languages, especially English; and an overall lack of systematicity in investigating key factors (Felix, 2005; Hubbard, 2005; Stockwell, 2007; Zhao, 2003). Despite the shortcomings in the state of CALL research, our goal is to explore current uses of technology for learning and teaching, as well as potential and as yet unexplored uses, which have implications for long-term, durable retention of knowledge and transfer from language training contexts to performance contexts.

1.b. Review questions

In order to recognize the state of technology use in foreign language learning and teaching, we approached this literature review with two baseline questions. First, we asked whether any data exist concerning the degree of technology use in adult FL education. Second, we asked what technologies are used in adult FL learning and teaching. Realizing that other disciplines outside of CALL might be breaking new ground with some technologies or adapting technologies that were not originally designed to facilitate learning, we asked what effective technology use practices in other disciplines can be transferred to FL teaching. We address the two baseline questions, our third supplemental question (when relevant) for specific technologies, and descriptive information about identified technologies in section 2.

To determine whether technologies used in FL education made an impact on the learning process or learning outcomes, we searched the relevant literature for specific evidence of effectiveness of technology use in FL learning. We address this question in section 3.

To identify effective ways to use technology to enhance language learning, we first investigated how the best practices of technology use could be informed by insights from cognitive psychology and SLA. In addition, we sought information on the training that teachers and students need to ensure that they take full advantage of the technologies provided to them. Finally, we searched the literature for major cautionary notes about implementing technology for learning. We address this set of questions in section 4.

Below, we provide the full list of review questions addressed in this literature review:

1. To what degree is technology currently used in adult foreign language learning?
2. What technologies are used for adult FL learning and teaching and what are their capabilities?
3. What are some effective technology use practices in other disciplines that can be transferable to FL learning?
4. Is there specific evidence that technology use is effective for foreign language learning and teaching?
5. What are the best practices in using technology for foreign language learning and teaching?
   a. How are the best practices informed by cognitive psychology and SLA?
   b. What type of training do teachers and students need to ensure that they make the best use of the technologies provided to them?
   c. What are the major cautionary notes about implementing technology for learning?

1.c. Section overviews

In section 2 below, we discuss the state of technology in foreign language learning and teaching. In this section, we first present our findings about the degree of technology use in FL learning and teaching. Next, we give a comprehensive overview of technologies currently used for adult FL learning and teaching, focusing on four categories of technologies: (a) schoolhouse or classroom-based tools, (b) individual study tools, (c) network-based social computing, and (d) mobile/portable and network-capable tools. For each technology type, we provide a brief description followed by lists of its capabilities, limitations, functionalities, and examples of uses. Finally, we summarize the technology enhanced learning and teaching functionalities. Section 3 presents the evidence we found in literature that technology use is effective for FL learning. In section 4, we present best practices in using technology in FL learning and teaching, starting with a discussion on how SLA and cognitive psychology theory can inform these practices.
2. THE STATE OF TECHNOLOGY IN FOREIGN LANGUAGE LEARNING AND TEACHING

2.a. Degree of technology use in FL learning and teaching

Inarguably the degree of digital technology use in post-secondary education generally, and particularly in foreign language learning and teaching, has grown exponentially in the last three decades as a result of the decreasing costs of computing and the Internet revolution. The situation no longer exists in post-secondary education where classroom-based instructed foreign language learning involves only books, paper, overheads, analog recordings, and videotape. To some degree, technology is ubiquitous in education, at least in the form of word processing and Internet browsing. Attitudes towards technology use, expectations for its effectiveness, and pedagogical models have changed correspondingly.

Bush (1997, p. xii) cites examples from early CALL history of foreign language teachers’ attitudes about the potential of computer-assisted instruction (CAI) for language learning, based on Olsen’s (1980) survey of foreign language departments at 1,810 four-year institutions:

- “My advice is to stay out. Computers can now teach computer language, not a living language.”
- “CAI is a waste of time, energy, and money that should be used to buy library books.”
- “A waste of time; you are dehumanizing language instruction.”
- “Don’t do [computer-assisted instruction]. It is a very stupid idea… You must be really desperate to think of something so dumb.”

Of the 602 responses that Olsen received, 527 respondents (88%) “indicated that CAI was not in use and would not be considered in the near future,” 14 (2%) “planned to introduce it within two years,” and only 62 (10%) had already implemented CAI (Olsen 1980, p. 341).

Thirty years later, few data exist to document the current degree of implementation of technology in adult foreign language. Arnold (2007) appears to be the only survey of information and communications technology (ICT) use specifically for foreign language teaching in the post-secondary education context. 173 foreign language teachers at 32 universities in the southeastern United States responded to Arnold’s online survey. The respondents reported that technology use for language teaching has been essentially universally adopted: “99% of participants used at least one type of computer application at least once or twice a semester… on average, participants used about three different applications on a weekly basis or five applications once or twice a month” (p. 166). The three most commonly used applications were:

- posting materials online
- sending students to specific Web sites
- having students search the Internet (p. 168)

The least used applications were:

- MOOs: online virtual reality systems using computer-mediated communication, such as role-playing games
- Videoconferencing
- Student creation of blogs, video files or Web sites (p. 169)

As Arnold notes, these are the applications "requiring a considerable amount of time from both the teacher and the students" (ibid.). In addition to finding generally high levels of technology use, Arnold observed that teacher age was a larger factor than teaching experience in technology use: "...the older the participant, the lower his or her overall mean technology use... technology seems to be a generational issue rather than an issue related to teaching experience" (p. 168).

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8 “MOO” is an acronym for the unwieldy term “MUD (multi-user domain/dimension), object-oriented” application.
Arnold concludes that student convenience, rather than pedagogical goals, seemed to be the driving factor for teachers’ technology use (p. 170), and that teachers’ attitudes toward technology were "...utilitarian...[technology is] often used to assist instruction rather than to promote learning--two very different approaches" (p. 174).

Few data exist to illustrate technology use for instructional purposes in post-secondary education generally. Warburton et al. (2002) conducted a large-scale survey of technology use by post-secondary faculty in 1998. While not addressing foreign language faculty specifically, this study appears to be the most recent national survey of faculty ICT use. Similarly to Arnold (2007), they found that “...as the age of full- and part-time instructional faculty and staff increased, their use of e-mail [to communicate with students] decreased” (p. iv). Warburton and colleagues notably conclude that “Although the percentage of faculty who use e-mail and course-specific Web sites provides an important measure of the scope of faculty use of telecommunications technologies, it tells us little about the amount or quality of instruction they provide” (p. 31).

In contrast to technology use by faculty, current data do exist to illustrate technology use by students in institutions of higher education, thanks to a series of large-scale studies conducted by the EDUCAUSE Center for Applied Research (ECAR) (Katz, 2006; Kvavik, 2005). The ECAR studies employ quantitative and qualitative approaches to determine what information technologies students use, and how technology use contributes to their undergraduate learning experience. The results of the 2004, 2005, and 2006 surveys indicate that student ownership is nearly total for some technologies, and growing quickly for other technologies (although still far from ubiquity):

- 97.8% of students owned a PC (desktop or laptop) in 2006, up from 93.4% in 2004;
- 61.3% owned a digital personal media player, up from 38.6% in 2005;
- 14.7% owned a PDA (only up from 11.9% in 2004), but 19.8% own either a PDA or a smart phone, or both. (Katz, 2006; pp. 2-3)

Although students are avid users of technology for personal purposes, the focus groups in the 2004 study (Kvavik, 2005) illustrate students’ moderate attitudes toward and preferences for IT use for educational activities. Regarding technology use in the classroom, one student stated that “Information technology is just a tool. Like all tools, if used properly it can be an asset. If it is used improperly, it can become an obstacle to achieving its intended purpose. Never is it a panacea.” (ibid, p. 7.8) Other students were even less sanguine about classroom technology use, because “it undermines face-to-face [student-teacher] contact and has little impact on their learning.” (ibid, p. 7.9)

Kvavik (2005) asked students how technology impacted classroom activities. The highest rated student responses concerned communications, management of classroom activities, collaboration, and presentation: “resulted in prompt feedback from the instructor,” “helped me communicate and collaborate with my classmates,” “I primarily use information technology in courses to improve the presentation of my work.” In contrast, the lowest rated responses concerned comprehension of complex concepts in classroom materials. (ibid, p. 7.10)

Kvavik also asked students about their impressions of course [or class] management system (CMS) use on teaching and learning. Students ranked CMSSs highly for the added convenience of classroom management, and students generally perceived CMSSs positively. However, Kvavik notes that students were most enthusiastic about the interactive features that faculty used least frequently: “sharing materials with students, faculty feedback on assignments, and online readings” (p. 7.14). These findings echo Arnold’s (2007) comments that the least-used applications are those "requiring a considerable amount of time from both the teacher and the students" (p. 169).

The extant survey data on technology use for teaching and learning suggest that there is a generational gap between younger and older teachers, and that technology is used most commonly to assist instruction rather than to mediate learning. As Kvavik somberly concludes,

Software applications such as PowerPoint and Excel are tools, as is a classroom management system. But by themselves they do not contribute to an improved learning experience. It is incumbent upon the faculty member to understand the promise and performance of these tools in support of improved learning and to use them accordingly. Our data suggest that we are at best at the cusp of technologies being employed to improve learning (p. 7.13-14).

2.b. Overview of technologies currently used for adult FL learning and teaching

In this section, we present a comprehensive overview of technologies we found in the literature to be used in FL education. For each technology type, we first provide a brief description followed by a list of its capabilities. We define capabilities as specific features or qualities of hardware or software. Next, we follow with a list of functionalities for each technology type. We define functionalities as learning or teaching goals that are enabled by a single technological capability or a group of related capabilities. Then, we report on limitations of each technology type found in the literature.
Finally, we provide a handful of concrete examples of uses. Where there was an abundance of publications on the use of particular technologies in foreign language learning or teaching, we stayed within the field of CALL. However, where we found little research on a particular technology related to foreign language or teaching, we include publications from other disciplines as well.

2.b.i. Schoolhouse- or classroom-based technologies: curriculum-driven tools for instruction and assessment

Course/Learning management systems

Description
A Learning Management System (LMS), also known as a Course Management System (CMS) or Virtual Learning Environment(VLE), is a server-based application that a course designer or teacher uses to present all of the materials and services required for blended or distance learning. These materials and services may include syllabi, required readings, calendars, notices, assessment tools (including self-assessment), surveys, discussion tools, wikis and blogs. Teachers and students access a CMS/LMS over a network through a web browser, using a menu-driven interface.

Blackboard (http://www.blackboard.com) is one of the best-known commercial LMS and is widely used in higher education, having purchased its competitor WebCT in 2005. Moodle (http://www.moodle.org), a rival to Blackboard, is a free, open-source LMS project, also used in higher education. Another free, open-source LMS, Sakai (http://sakaiproject.org/portal), has begun to attract Blackboard clients. Other innovative LMS applications, such as Wimba (http://www.wimba.com/) offer voice over Internet (VoIP) and content development applications. Additionally, some textbook publishers have developed CMS applications to accompany their workbooks, including grade books and chat options.

Capabilities
- Provide broad accessibility to content and entire courses, anytime, anywhere.
- Save, reuse and export content.
- Allow for additions to courses as an iterative process, creating robust courses over several terms.

Functionalities
- Meet industry-wide standards for content reusability.
- Facilitate course content organization.
- Enable sharing of course materials.
- Enable testing (exams & quizzes and practice-exams to prepare for exams).

Limitations
- Impose a top-down, teacher-centered hierarchical structure and limit student opportunities for organization and tagging of content (Walker, 2008).

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9 More accurately, a Virtual Environment for Learning.
12 Known as the shareable content object reference model (SCORM), which is a specification of the DoD’s Advanced Distributed Learning initiative (http://www.adlnet.gov).
May slow down pedagogical innovation, via adherence to an “orthodoxy” in the use of CMS (Stiles, 2006).

Lack pedagogical motivation for many of their most widely-adopted uses; for example, Carmean and Haefner (2003) explain that CMSs are frequently used “to dump content quickly into an on-line shell, providing access to interactive assessment tools and grade-books, to make announcements easily, to respond to student pressure, peer pressure, and/or administrative pressure.”

Examples of uses

CMSs/LMSs lend themselves to innovative organization and distribution strategies:

Monachesi et al. (2006) describe a proposed project to use NLP for the “tedious task” of generating metadata tags to make content more retrievable in CMS. Such a tool would help language teachers to find content based on certain instructional parameters, and would help learners to find appropriate objects for learning.

A mobile phone-based CMS called “poodle” delivers a foreign language flash card program to learners’ phones, using distributed intervals to increase effectiveness of learning (Houser & Thornton, 2005).

ePortfolios

Description

While there is some disagreement as to the definition of an ePortfolio, the majority of the reviewed publications concurred on the following points: that an ePortfolio is a collection of student work, a product created by a learner that shows the evidence of the learner’s experiences, progress, achievements, and self-reflection. More practically, an ePortfolio is a digital archive, from which multiple portfolios for a single student can be created with different audiences in mind.

Portfolios existed before the digital era, when artists, architects, or writers prepared collections of their previous work with the purpose of showcasing them, often to a potential employer. Currently, showcasing is only one of the many uses of ePortfolios, and usually not the primary one. ePortfolios are a relatively new development, but one that is undergoing rapid growth. There are several recent publications on the topic (however, none of them consider FL learning per se) showing student and administrator perspectives ranging from practical instructions on how to design an ePortfolio (Klenowski, 2002; Mahoney, 2002), through some practitioners’ opinions (Henry, 2006; Plater, 2006), to more structured research studies (T. Dornan, Carroll, & Parboosingh, 2002; T. Dornan, Lee, & Stopford, 2001; Paoletti, 2006). The enthusiasts claim that ePortfolios will “bring radical transformation of learning systems”(Jafari & Kaufman, 2006, p. xxvii). They propose campaigns such as “ePortfolio for all” and advocate offering an ePortfolio to every citizen, e.g., in Wales (Jafari & Kaufman, 2006). Skeptics highlight caveats and challenges related to ePortfolios; these voices are usually based on more systematic research studies (Paoletti, 2006). In any case, the use of ePortfolios promises to be one of the developments on the horizon in the near future. ePortfolios will most likely expand very quickly – already several universities around the world have adapted them and are encouraging or even requiring their students to develop and use ePortfolios.

Capabilities

Provide options to aggregate and store all materials relevant to the learning process materials in one location (Jafari & Kaufman, 2006).

Allow cross-referenced portfolio contents.

Allow automatic updates.

Include opportunities to share different parts of the portfolio with different users.

Operate within a network and permit links to administrative and academic resources.

Enable access to ePortfolio anytime and anywhere (because of web connectivity).

13 For the impact of distributed intervals, see section 4.a, “How do second language acquisition and cognitive psychology principles inform best practices for technology use in language learning and teaching?”
Functionalities

- Assist learners in information management.
- Support learner autonomy and self-assessment.
- Enhance reflective learning; particularly important for adult learners (Doig, Illsley, McLuckie, & Parsons, 2006).
- Enhance self-regulation; facilitate setting learning goals, monitoring and regulation of progress, develop self-assessment skills (Blackburn & Hakel, 2006).
- Enhance collaboration and cooperation including fostering peer assessment (Stevenson, 2006).
- Serve as a learner organization tool.
- Complement a student-centered environment.
- Emphasize process of learning, rather than product.
- Support lifelong learning.

Limitations

- Necessitate faculty engagement, including time commitment.
- Add to student and faculty workload.
- May generate anxiety and/or ambivalence regarding the new technology, especially regarding its portability and persistence into the future.
- Can be costly to implement on a large-scale basis at universities.

Examples of uses

- Zellers and Mudrey (2007) describe the use of ePortfolios at the Lorain County Community College in Ohio as a tool for raising student reflection and metacognition.

- ONNI-The Learning Journal was introduced as a component of student ePortfolios at the University of Kuopio, Finland. The authors claim that an e-learning journal can facilitate metacognitive processes during the process of learning: conscious regulation of learning and thinking, self-evaluation, and profound reflection (Haapaniemi & Karvonen, 2006).

- ePortfolios were used to support teacher education and to facilitate teacher professional development (Bartlett, 2006; Ring & Foti, 2006).

- Bowling Green State University implemented ePortfolios for its students with the goal to improve learning. One of the features of this particular ePortfolio is the matrix, or the developmental framework for learning. According to the authors, the matrix has potential to document student learning on the university’s learning outcomes, for example, on mastering specific skills, such as writing and presentation (Hakel, Gromko, & Blackburn, 2006).

- Montana State University-Northern implemented future-focused ePortfolios with the goal to get students to think systematically about what they prefer or what’s possible to achieve in their professional lives while still being university students (Richter, 2006).
Greenberg (2006) describes the Northwestern University Collaboratory Project, which provides collaborative learning spaces for K-12 students in Illinois. ePortfolios are used to support mentoring, peer communication, reflection, and feedback.

**Interactive white board**

**Description**

An Interactive white board (IWB) comprises three pieces of equipment: a computer, a projector, and a display panel, which is a large free-standing or wall-mounted touch-sensitive screen. The projector displays the image of the computer screen on the large touch-sensitive screen, which is easily viewable to all the students in the classroom. The IWB can function with other devices, as well, for example, with a voting system (Schmid, 2006, 2007). Various brands of IWBs are available. The most popular is the SMART Board provided by SMART Technologies; others include IWBs offered by Promethean TM, Hitachi, and Easiteach. Various software applications specifically designed for the IWBs are available commercially (e.g., Lesson Activity Toolkit for SMART Board or ACTIVStudio for Promethean).

**Capabilities**

- Offer touch-sensitive screen: the users can control the computer applications with the touch of a finger on the screen, just like they would use a mouse.
- Serve as writing surface: the IWB screen can also be used as a writing surface using an electromagnetic pen.
- Possess repository qualities: class work, including individual student work, can be captured and saved on the computer for future reference, e.g., users can capture, save, and print class notes which can be used during the next class.
- Incorporate internet connectivity: a wider variety of input is easily available (through Internet searches, simulations).
- Networkable with students’ computers in classroom: can enable students to write on IWB without leaving their seats, and can display work on students’ computers.

**Functionalities**

- Help with content and course organization.
- Enable access to rich, authentic input.
- Promote interactive activities: (a) student-content interaction - using simple functions, such as drag and drop (can move objects on the board), hide and reveal (can remove objects placed over others), highlight, animation (rotate, enlarge, replace, move objects); and (b) student-student interaction, e.g., prompt discussion, develop hypotheses; (c) teacher-student interaction, e.g., provide feedback.
- Engage students and teachers in collaborative work: (collaboration during the lesson; joint preparation of materials by teachers; sharing materials on the school network can save time).
- Draw students’ attention: enhance motivation, attract attention, and improve attitudes towards learning and teaching.

**Limitations**

- Can foster a teacher-centered model of instruction, which is recently regarded as a more traditional, less desirable and less effective approach to FL teaching than the learner-centered model. In fact, a number of studies reviewed showed that the introduction of the IWB in some classrooms caused changes in pedagogy; in particular, teachers increased the amount of whole-class time and decreased the amount of group work in their classrooms (Miller, Averis, Door, & Glover, 2005).
May distract some students if they depend on the IWB so much that they forget to follow an instructor’s guidelines and instructions.

Can slow a lesson as only one student can work on the IWB at a time.

 Might require frequent recalibrating.

 Pen tool is not always dependable.

**Examples of uses**

The most widely discussed use of the IWB is for presentations and demonstrations. IWBs can provide multimedia and multi-sensory presentations, easily available and visible on the large screen. For FL teaching, IWB use for in-class presentations and demonstrations is discussed mostly in secondary school FL classes (Gerard, Widener, & Greene, 1999; Miller, et al., 2005) and EFL in several British Council centers around the world (Orr, 2008). Interestingly, PowerPoint is the most commonly used application for the IWB, which can be used independently of the IWB (C. Gray, Hagger-Vaughan, Pilkington, & Tomkins, 2005; Tanner & Jones, 2007).

IWBs have been shown to promote interaction; Glover et al. (2007) and Miller et al. (2005) describe the ‘enhanced interactive’ stage of the use of the IWB in FL teaching, which includes using the IWB to promote discussion, develop hypotheses, or explain processes as opposed to the ‘supported didactic’ stage, in which the IWB serves typically as a visual support.

Tozcu (2008) discusses the use of IWB to teach non-roman scripts (Hindi, Pashto, Dari, Persian, and Hebrew) to students of various languages at DLIFLC through multimedia presentation.

Schmid (2006, 2007) describes the use of the voting system (ACTIVote) in EFL university-level classes. The voting system was perceived as useful for self-assessment: students received immediate feedback during class activities and could check their progress in relation to others.

**2.b.ii. Individual study tools: self-contained programmed applications**

**Corpus-based materials**

**Description**

While a corpus may refer to any large body of text (McEnery & Wilson, 1993), we define a corpus, after Godwin-Jones (2008), as a collection of authentic language in spoken and written forms. Corpora vary in terms of a number of relevant distinctions, including design, type, size and content. Regarding design, as classified by Gabrielatos (2005), corpora of fixed size are called reference corpora (e.g., British National corpus), whereas monitor corpora are expandable (e.g., Bank of English). In terms of content, general corpora include all contexts of use, whereas specialized corpora focus on specific contexts or users (e.g., geographic or social restrictions). Corpora may also differ with respect to medium (e.g., written or spoken), whether the language recorded is native or non-native, monolingual or multilingual, planned or spontaneous. Parallel corpora are a particularly useful kind of multilingual corpus which includes the same texts translated into different languages.

**Capabilities**

- Perform concordancing: analyze and reference individual words or series of words in terms of their frequencies and the environments in which they occur.

- Enable broad access to linguistic data, particularly via the Internet.
Functionalities

- Provide rich, abundant, and authentic input; and if corpora are pedagogically mediated – provide elaborated input (Braun, 2005).

- Enable storage, sharing and reusing.

- Promote data-driven learning, where the emphasis is on induction (Bernardini, 2004; Leech, 1997). Data-driven learning views the teacher as a coordinator or research facilitator, and the learner as a researcher or observer. While studying real-language data, the learner can be given choices about which texts to use, how to organize them, and what to investigate (Leech, 1997).

- Encourage discovery learning. Discovery learning is usually applied in open-ended, exploratory ways (Bernardini, 2004), and corpora can provide such an environment. Both data-driven and discovery learning can be useful for linguists and learners with higher levels of proficiency and experience. However, as described in section 3 of this report, corpora make less effective tools for less proficient, less experienced learners.

- Support learner autonomy.

- Improve translation skills, via multilingual parallel reference corpora.

Limitations

- May generally lack situational or communicative context (e.g., recorded speech includes deictic references impossible to interpret from audio alone).

- Because most corpora are compiled for research, and not instructional purposes, corpus data may appear overwhelming and not accessible to learners, if not pedagogically mediated (e.g., through glosses, annotations).

- Corpus data differs significantly from the language presented in language textbooks, and many corpus linguists argue that corpus data is the superior, more authentic resource for learners (Bernardini, 2004; Holmes, 1988; Mauranen, 2004). However, if the balance between authenticity of texts and the need for elaborated input is not maintained, it will most likely be a disadvantage for the learner.

Examples of uses

- A German-English INTERSECT corpus was used with a beginner German student in the UK to determine usability of corpus data at the beginner level. While the author claims such usability, the evidence she provides is very weak (St. John, 2001).

- Kennedy and Miceli (2001) investigated the type of training students need to undertake to maximize the use of the corpus data (CWIC Italian). The authors claim that the Intermediate-level students needed skills such as awareness of logical principles in addition to an understanding of how to research the corpus data in order for it to reach its full potential.

- Yoon (2008) describes the use of a large corpus for English (COBUILD) in college-level EFL writing classes to determine its effectiveness. The participants’ writing process changed after the introduction of the corpus data in that subjects checked their writing more often while composing.

- Braun (2005) used the ELISA corpus in EFL classes in Germany and concluded that in order for the corpus to be useful in FL learning and teaching, it needs to be first pedagogically mediated, that is, suited for language learners. The author gives examples of how annotations can help with pedagogic mediation of the corpus data.
Electronic dictionaries

Description

Electronic dictionaries, which provide definitions at the single-word level, primarily come in two varieties: handheld and online. Some examples of handheld, non-web-based electronic dictionaries include the Pleco software for Chinese (http://www.pleco.com/), and the CASIO EX-word XD-R8100 and XD-R9000, which includes an electronic version of Taishukan’s Genius English-Japanese Dictionary (for Japanese speakers). Examples of online bilingual dictionaries include Longman English-Chinese Dictionary of Contemporary English. A listing of over 50 languages’ worth of bilingual and monolingual dictionaries can be found at www.foreignword.com.

Capabilities

- Speed searches such that looking up words does not interrupt the reading process dramatically.
- Can maintain a log of searched words to generate a study list for review later.

Functionalities

- Enable individualized and elaborated input.
- Combine features of both monolingual and bilingual dictionaries in one resource, in order to address different lookup preferences and learning styles.

Limitations

- May require accurate spelling to retrieve an entry, which can frustrate learners who are searching for an inflected form.
- May, in the case of handheld dictionaries, be limited by screen-size and “hierarchical nature of data display” (Koyama & Takeuchi, 2004, p. 34).

Examples of uses

- Electronic dictionaries were used to increase efficiency (speed) when reading in a foreign or second language (Japanese-speaking learners of English: (Koyama & Takeuchi, 2007); English-speaking learners of Spanish: (Aust, Kelley, & Roby, 1993)).

- Electronic dictionaries were used to increase comprehension when reading (English-speaking learners of Spanish: (Knight, 1994); Chinese-speaking and Hebrew-speaking learners of English: (Laufer & Hill, 2000)).

Electronic flashcards

Description

While many electronic flashcard programs are currently available (e.g., Mental Case, Flash my Brain), we limit this review to Pleco and Rapid Rote as a representative sample of flashcard programs designed specifically for vocabulary learning in a second language. These programs provide a number of advantages over their paper counterparts, including multimedia capabilities and automatic presentation-order adjustment. Pleco 2.0 is, in the manufacturer’s words, a tool that “gives you everything you need to look up and study Chinese vocabulary: content from seven different dictionaries, handwriting input, flexible Pinyin searches, audio recordings for over 34,000 words, stroke order diagrams, a built-in document reader, and one of the most advanced and customizable flashcard systems ever invented.” The program is self-contained, with its own Chinese font system, such that it can be run on English-language handheld and smartphone devices without additional support. For languages besides Chinese, there is Rapid Rote.
Rapid Rote is a flash card presentation program aimed at allowing learners to gain “perfect recall” of the target vocabulary in the “shortest possible time.” Available alone or in conjunction with CL-150’s LanguagePro platforms,14 Rapid Rote’s content is completely customizable; learners can click on words in LanguagePro to create word lists, select word lists saved by other learners and instructors and archived on the CL-150 download center, or create their own word lists. Learners are able to customize their flash cards, with photos, graphics, audio, transliterations and notes. They can also adjust color and font to make specific words/items more salient.

Once a word list has been created, the Rapid Rote training regimen consists of three steps. In the Preview step, learners simply view both sides of each flash card – one side has a word or phrase in the target language while the other has its English translation. The cards can also be annotated to include audio files and/or pictures. In the Recognize step, learners review the target language sides of the cards they saw in the Preview step. They can choose to either self-report (i.e., click a button to report whether or not they remember the target word) or write the English translation. In the Produce step, learners must type the target language translation of an English prompt (this step likewise has a self-report and a written mode). The software uses an algorithm that keeps track of student performance and quizzes students on the words with which they are having the most difficulty.

Capabilities
- Adjust training regimen to meet learners’ needs.
  - Learners customize their own vocabulary lists.
  - Programs “automatically optimize” presentation order to focus on the words learners are least familiar with.
- Support sharing and reuse of study materials.
- Enable multimedia enhancement of input (e.g., audio files, pictures).
- Allows for, in the case of Pleco, mobile, online handwriting recognition of a non-roman script.

Limitations
- May provide vocabulary in isolation from context; unclear whether such practice generalizes to more communicative use of vocabulary.
- Could support rehearsal of erroneous information via user-created/-modified lists.
- Can, in the case of Rapid Rote at least, confuse users with lack of organization of user-created lists.15

Glossed and annotated texts

Description
Electronic glosses and annotations16 provide information about words or concepts encountered in a foreign language text, usually via hyperlinks. Such links allow learners to access glosses (word- or sentence-level, context-specific translations) or annotations (explanatory or background information) while reading an electronic text, so that searching for this information does not greatly interrupt the reading process itself.

Capabilities
- Provide many of the same benefits as electronic dictionaries, in terms of efficiency, adaptability and multimedia potential.

14 In the manufacturer’s words, “The CL-150 is a constantly growing suite of applications and content dedicated to the efficient acquisition and sustainment of language for specialized government purposes.” LanguagePro, in particular, is intended as a platform supporting language study for military professionals preparing for deployment. Rapid Rote is available as an integrated component of LanguagePro, but it can also be downloaded in isolation, directly from the CL-150 download center.

15 This is an issue with the CL-150 download center, not the Rapid Rote software itself.

16 We limit this review to teacher-created glossed and annotated written texts and do not include tools for creating annotated media files, such as Synchrotext.
• Target glosses and annotations according to appropriate context, saves learners the trouble of searching through a dictionary (e.g., in a case where a given word has several definitions).

**Functionalities**

• Enable elaborated input and input tailored to the individual learner.

• Facilitate reading comprehension.

• Facilitate incidental and intentional vocabulary learning.

**Limitations**

• May distract learners if links are highlighted/marked, encouraging them to click excessively on words for which they might not need annotations.

• May, in the case of L1 glosses, prevent learners from developing reading skills in L2, if learners can rely on glosses alone.

**Examples of uses**

• Glosses and annotations were used to assist foreign language learners increase reading comprehension of authentic material (for example, by English-speaking learners of German (Chun & Plass, 1996); English-speaking learners of French (Lomicka, 1998); and English-speaking learners of Chinese (Hong, 1997)).

• Audio glosses were used to aid learners of non-alphabetic languages with associating sound as well as meaning with new vocabulary items (English-speaking learners of Chinese (Hong, 1997)).

**Learning objects**

**Description**

The literature on learning objects (LOs) provides a number of possible definitions. These include, “self-contained study materials” (Armitage & Bowerman, 2005); “a group of learning activities using content materials linked to a particular pre-defined learning goal or functional objective” (LangNet website http://www.langnet.org) and “asynchronous learning resources delivered through distributed learning environments such as Learning/Course Management Systems (L/CMS) (Bennett & McGee, 2005). While there is some disagreement regarding the requisite characteristics and design of LOs, for the purpose of this report we adapt a definition from AliveTek, a company specializing in the development of LOs. A true LO is defined by three characteristics: it must be instructional, extractable, and reusable. (An object lacking one or more of these characteristics may be informational, but not a true LO.) For an LO to be instructional, it must facilitate learning or foster certain skills in the learner (as opposed to merely providing information). In terms of extractability, the LO must “stand alone” in the sense that it can be removed from a given environment and used in another, independent of, for example, a specific course, textbook or instructor. Overlapping with extractability is the criterion of reusability; that is, if the LO is extractable, it is more likely to be reusable.

**Capabilities**

• Provide highly specialized/targeted materials, e.g. business Russian.

• Save time and money through share-ability and reusability.

• Can stand alone and not be associated with a specific course or textbook.

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**Functionalities**
- Enables out-of-classroom practice and time-on-task.
- Enables access to instructional content in least-commonly-taught or never taught languages (e.g., Chechen), for which courses and textbooks may be sparse or unavailable in the US.

**Limitations**
- Cannot provide an instructor’s input and feedback.
- Depend on a large volume of materials (Armitage & Bowerman, 2005).
- Demand time and expertise in their design; language LOs are particularly difficult to design and require piloting.

**Examples of uses**
- LangNet (http://www.langnet.org) is a free, online language learning system developed by the National Foreign Language Center (NFLC). It provides materials to improve reading and listening skills in several languages.
- Global Language Online Support System (GLOSS) (http://gloss.lingnet.org) is an online resource for language learning developed by the Curriculum Development Division at DLIFLC and available through the LingNet website.
- Multimedia Educational Resource for Learning and Online Teaching (MERLOT) (http://www.merlot.org) is a free, peer reviewed online resource that offers LOs in several disciplines, including world languages. Materials include tutorials, simulations, drills, tests, and lectures.
- Cowles et al. (2002) describe the design of a 10-week survival Portuguese language course offered online for students at universities where regular Portuguese classes are not offered. In addition to LOs, the course (EU/BrazilNet), which operated within the WebCT course management platform and enabled online communication among students, tutors, and teaching associates.
- Monthienvichienchai (2001) describes the MALTED (Multimedia Authoring Language Teachers and Educational Developers) project, a database system, which allows teachers to create, store, and share materials for language teaching.

**Intelligent tutoring systems**

**Description**
An intelligent tutoring system is a program that simulates a tutor by providing direct, customized instruction and/or feedback to a learner (Freedman, 2000). Such a system is generally comprised of four components: an interface, an expert model, a student model, and a tutor model. The interface is the platform through which the student interacts with the program, and may take the form of a question-and-answer dialogue, or a simulated task such as repairing an automotive engine. The expert model represents the domain of knowledge the student is intended to acquire (e.g. the correlations between various symptoms and the engine malfunctions to which they correspond, the measures necessary to fix a given malfunction, etc.). The student model represents the current state of a student’s knowledge, which the tutor model can then compare to the expert model in order to identify misconceptions and knowledge gaps that the student has. The tutor model uses these identified misconceptions and gaps to provide appropriate feedback and instruction, in order to bring the state of knowledge represented by the student model more into line with that encompassed by the expert model.

**Capabilities**
- Tailor instruction to individual learner.
- Provide immediate, specific feedback, systematically and tirelessly.
**Functionalities**

- Can implement task-based interfaces in language instruction (e.g., Tactical Iraqi) so that students can benefit from learning-by-doing.

- Address individual learners’ needs in terms of target knowledge as well as developmental trajectory.

- Many ITS’s are designed to accommodate cognitive styles of learners (Crosby & Iding, 1997; Dodigovic, 2007).

**Limitations**

- Cannot yet encompass a native-speaker’s full linguistic competence with an ITS’s expert model, partly due to the state of the art in NLP, but also because of the lack of communication between the fields of NLP and CALL (Borin, 2002).

- Must focus model on a more narrowly defined domain:
  - verb-preposition correspondences (Eeg-Olofsson & Knutsson, 2003)
  - formulaic, metalinguistic spelling rules (Shahrour & Bull, 2008)
  - common misconceptions of advanced learners (Dodigovic, 2007)

**Examples of uses**

- Dodigovic (2007) trained an ITS on learner corpora to target most common learner errors.

- Dodigovic (2007) designed an ITS to provide corrective feedback in a number of formats, in order to suit learners’ preferences.

- The ITS used in Dodigovic (2007) implemented language instruction within a communicatively focused exercise (question and answer dialogue regarding a medical document about malaria).

**Grammar checkers**

**Description**

Grammar checkers are programs designed to evaluate a written text’s well-formedness in terms of grammaticality. Such programs are often packaged, along with spellcheckers, within a larger word-processing program. Whereas a spellchecker uses only the surface features of individual words to verify accurate spelling, a grammar checker must be able to identify more complex relationships among a number of words. The literature on Natural Language Processing calls this problem syntactic parsing, and different grammatical checkers approach it with varying degrees of sophistication.

**Capabilities**

- Identify lower level morphosyntactic inconsistencies:
  - Agreement between adjacent items, e.g. subject-verb, determiner-noun
  - Fragmentary sentences, e.g. lack of inflected verb

- Correct common prescriptive concerns:
  - Split infinitives
  - Questions ending in prepositions
Functionalities

- Provide immediate input.
- Serve as pedagogical tools to illustrate the complexity of some grammatical errors, and the simplicity of others.
- Encourage active learning, in that the program’s own limitations require learners to engage with the text to ensure accurate assessments.
- Automate lower level proofreading (if program is sufficiently sophisticated) so that learners can focus on more advanced grammatical issues.

Limitations

- Fail to identify errors that span longer surface distances, e.g. subject-verb agreement across an intervening relative clause.
- May falsely flag grammatical sequences as errors for similar reasons.
- Cannot address errors or inconsistencies that derive from semantic meaning or idiomatic usage.
- Focus on written text.

Examples of uses

- Grammar checkers have been shown to consistently correct low-level morphosyntactic errors (Burston, 2001; Jacobs & Rogers, 1999).
- Burston (2001) suggests using a checker’s limitations as a prompt for pedagogical intervention about different degrees of complexity in grammatical, as well as syntactic versus semantic errors, thereby clarifying these distinctions and encouraging active learning.

Spell checkers

Description

A spell checker is a program designed to identify misspelled words in a written text. Generally, such a program is comprised of three parts: a procedure for scanning through a text and isolating words, a procedure for comparing these words with a built-in dictionary, and a user interface which allows users to approve corrections and direct the program’s operation. A spell checker may be included in a larger program like a word processor, email client, electronic dictionary or search engine.

Capabilities

- Identify non-words.
- Suggest corrections for misspellings that deviate by few (often no more than one) character(s).
- Might (in some cases) be capable of morphological stemming.
- Can be used in conjunction with morphological references/ paradigms to cover more error types.

Functionalities

- Promote learner autonomy, in the sense that learners must learn to correct their own errors when these are morphology-based or L1-specific.
- Enable immediate feedback.
Limitations

- Built for native speaker writers, thus they often fail to suggest corrections for misspellings that deviate by several characters (the sort of misspelling to which L2 learners are prone).\(^{18}\)

- Cannot address morphological overgeneralization (i.e., cannot instruct learners that a given root takes irregular morphology) (Rimrott & Heift, 2008).

- May mislead learners with false positives (e.g., not mark incorrect compounds).

Examples of uses

- Alert learners to their spelling errors through flagging (Rimrott & Heift, 2008).

- Correct spelling errors made by L2 learners (Hovermale, 2008; Rimrott & Heift, 2008).

- Rimrott & Heift (2008) suggested that generic spellcheckers could be used to encourage active learning in the sense that learners be encouraged to use dictionaries and morphological paradigms in conjunction with the checker to correct errors deriving from morphological and lexical misconceptions.

Automatic speech recognition and computer assisted pronunciation training

Description

Automated speech recognition (ASR) is a technology that allows a computer to identify the words a person speaks into a microphone. This technology can be divided into two main forms: discrete and continuous. Discrete ASR works with a closed set of utterances, so the programmer must identify all possible responses that could be given in a particular situation. Continuous ASR is more complex, and is designed to recognize all possible response in the target language (Levy & Stockwell, 2006). This form of ASR generally works using Hidden Markov Models (HMMs), statistical models that use the phonemes of a target language in their phonological contexts with phonemic word lists to recognize spoken vocabulary (Precoda, 2005). ASR programs such as Dragon, and ViaVoice have been used with transcription software such as ViaScribe to provide a real-time verbatim transcript of lectures for deaf students (Wald, 2006).

ASR is often one component of speech pronunciation software, also called Computer Assisted Pronunciation Training (CAPT). These programs identify particular parameters of the learner’s output, such as prosody and other suprasegmental features or specific sounds or segmental features, and provide feedback on these aspects of performance.

Capabilities

- Compare learner’s pronunciation acoustically with a target pronunciation.

- Can be adapted to engage the learner in simulated dialogue with a computerized agent.

- Provide feedback on pronunciation.

Functionals

- Provide a means for learners to work privately to gain confidence in their speaking ability.

- Allow learners to practice at their own pace.

- Give automatic, retrievable feedback (with caveats, see below).

\(^{18}\) However, full automaticity of suggestions for correct spellings may limit learners’ practice at retrieving the correct form; see section 4.a, “How do Second Language Acquisition and Cognitive Psychology principles inform best practices for technology use in language learning and teaching?”
Limitations

- Can frustrate or mislead learners when feedback is erroneous or inconsistent.
- Can require specific training for learners and instructors to effectively use spectrograms and other acoustic displays (Holland & Fisher, 2008).
- Require native and non-native speakers from whom to generalize pronunciation targets. A great deal of data from many such speakers is necessary if the software is to generalize across speech styles and physiological differences to recognize linguistic targets. If a sufficient number of speakers is not available, the program may not be able to recognize the “standard” dialect and therefore the target accent, complicating any measure aimed at providing meaningful feedback (Precoda, 2005).
- Often necessitate phonetic transcriptions for each lexical item in a language. Without a standard written form, the creation of this lexicon is significantly more difficult. Pashto, for instance, does not have a standardized written form so designing software that accurately reflects dialect-independent pronunciation would require making “seemingly arbitrary decisions” for the transcription of certain vowels (Precoda, 2005).

Examples of uses

- Simulate job-relevant situations through guided dialogue with a discrete ASR system (e.g., Military Language Trainer) (Holland, Kaplan, & Sabol, 1999).
- Harless, Zier and Duncan (1999) examined the use of a Virtual Conversations™ program by DLIFLC students participating in a refresher course in order to maintain Arabic proficiency through simulated dialogue with virtual interlocutors using the speech-activated software Conversim™.
- Approximate communicative contexts (again, with caveats: generally the student hears a question and then chooses a predetermined response from a prescripted set) (e.g., the Tell Me More, Talk to Me, Language Pro, and Tactical Language Series software).
- If used with transcription software, lectures can be printed and reviewed by instructors to improve teaching methods (Wald, 2006).
- Captioning of lectures provides an additional mode of input that may benefit visual learners.

Off-line Handwriting Recognition

Description

Applying (artificial) handwriting recognition to languages with non-roman alphabets poses a number of problems, many of which vary according to the language in question. The Perso-arabic script is one particularly difficult case, which will serve to illustrate the more general difficulty faced by researchers in this area.

Beyond the more general factors that complicate handwriting recognition in all scripts (e.g., variability in (and sometimes lack of) spaces, overlapping characters, writer-specific differences in character shapes), Perso-arabic script is made difficult by its complex morphology, the presence of ligatures, and the fact that many of its letters change shape according to the surrounding context (e.g., a preceding letter to which the letter in question attaches). Infixing, circumfixing and ligatures make deciding if and how to segment words a less than straightforward question, while context-dependent variability in the shape of the characters can complicate the feature-extraction methods often employed in character recognition (Cheriet, 2006; Izadi, Sadri, Solimanpour, & Suen, 2006).

In spite of such difficulties, the field of Natural Language Processing continues to develop resourceful new approaches that are yielding promising results. For example, Cheriet (2006) presents a multi-level approach that pursues global, grapheme and pseudo-word segmentations sequentially in recognizing Arabic words, while Natarajan, et al.(2006) present a method based on the Hidden Markov Models (HMMs) originally developed for speech recognition, demonstrating that the flexibility of HMMs (i.e., in theory, they can be trained on any kind of handwriting data) make their functionality
independent of the script in question. Accordingly, Natarjan, et al. test the method on Chinese and Arabic scripts alike and yield results of 86% and 88% accuracy at the word-level, respectively.

The endeavor to generalize the above-mentioned offline methods to online handwriting recognition (useful for PDAs and tablet PCs) is still in its infancy, making its application to CALL difficult.

**Functionalities**

- Convert handwriting to text.
- Increase share-ability and reuse-ability of handwritten documents.
- Allow handwritten documents to be integrated with other technologies (e.g., word processors for editing, searching, spellchecking; Pleco enables one-click dictionary-lookup).

**Limitations**

- May frustrate learners, as accuracy rates of most state-of-the-art methods for non-roman script recognition are still low enough to cause difficulty.

**Example of use**

- Pleco 2.0 enables Chinese character recognition using mobile platforms, such as PDAs.

**Virtual Environments**

**Description**

The Institute for Creative Technology (ICT) is a research center affiliated with the University of Southern California. They specialize in developing interactive media to facilitate education and training. Among their many projects, two are particularly relevant to language learning: Mixed Reality Research and Development (MRR&D), and Cultural and Cognitive Combat Immersive Trainer (C3IT-D). MRR&D builds mixed reality environments, combining physical and virtual components to provide an immersive context with which participants can interact. In the developers’ own words,

> Within MRR&D’s mixed reality environments, participants can speak, move, and gesture as readily as they would in everyday life. In preserving this sense of physical presence while presenting scenarios otherwise unavailable due to safety and cost, the MRR&D group seeks to advance the believability of immersive systems and enhance the training and education experiences delivered.

One application for this kind of mixed reality technology is the C3IT-D, a training environment which allows trainees to interact with virtual characters in order to develop knowledge of the target culture. According to the developers,

> C3IT-D depicts placing soldiers in highly realistic, critical decision-making situations that require cultural awareness to afford making the best judgments... The objective is to portray a one-on-one exchange between the trainee and an interactive character wherein cultural awareness is of primary importance. The trainee engages with interactive characters projected at full human scale in real-time graphics on digital flat displays using a natural language speech recognition interface... One such scenario presents investigative questioning after an IED explosion in a public market, and was temporarily installed and demonstrated at Ft. Benning in December 2006.

While no information is currently available regarding the application of this technology to language learning and instruction, the use of mixed reality and NLP in an immersive context has enormous potential for such purposes.

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19 http://www.pleco.com/products.html
20 http://ict.usc.edu/projects/mixed_reality_research_and_development_mrrd/ [Retrieved December 16, 2008]
21 http://ict.usc.edu/projects/c3it_cultural_cognitive_combat_immersive_trainer/ [Retrieved December 16, 2008]
Capabilities

- Simulate immersion environment.
- Respond to learners’ needs and actions.
- Allow for rapid incorporation of new lessons into the system.

Limitations

- Lack of data regarding application to language learning.

2.b.iii. Network-based social computing technologies: tools for communication and collaboration

Synchronous and asynchronous computer-mediated communication

Virtual worlds and serious games

Description

Virtual worlds are those programs that allow learners to navigate a representation of a character, or “avatar”, through a 3-D graphical environment. Examples of virtual worlds include Second Life and Active Worlds, both of which have been used by educators for teaching and learning activities. These environments may also be referred to as multi-user virtual environments or MUVEs. Unlike games, virtual worlds do not involve a set goal for the user. Instead, users are able to explore the space and create their own purposes and activities. Serious gaming refers to those virtual environments in which activities are guided or restricted by the program and users have a specified goal or set of goals to complete. These may include massively multiplayer online role-playing games (MMORPGS) that involve communication and coordination among players (e.g. World of Warcraft) or simulation games in which one player interacts with virtual agents controlled by the computer (e.g. Tactical Iraqi). The line between virtual worlds and serious games is, however, not always clear. For example, games may be created within virtual worlds, and players of games may develop additional goals or activities not “scripted” by the developers. The following functionalities and limitations have been reported in the literature for specific virtual worlds or games. No one program incorporates all of these functionalities or shares all of these limitations.

Capabilities

- Provide virtual meeting spaces.
- Enable learners to move through virtual space, manipulate virtual objects, and share a virtual environment/referential space with other learners.
- Enable learners to navigate within simulated environments, including environments modeled after target language locales and incorporating culturally-relevant objects.
- Provide learners with a low-risk environment to attempt communication, including the use of anonymous voice communication to reduce speaking anxiety.
- Enable real-time communication and interactive dialogues through text and/or voice chat or instant messaging with other learners or virtual agents (bots).
- Provide a sense of “presence” and a social community for students in distance learning courses.
- Offer a central access point for linking to other learning resources – (e.g., websites, videos, audio files, documents) and for the distribution or submission of class assignments.
• Simulate specific military, medical or other training scenarios that may be difficult or costly to recreate in the real world.

• Present learners with dual mode versions of the same foreign language input - (e.g. subtitled video; speech chat contemporaneous with voice chat).

• Allow students to practice use of language (including pragmatics) and receive positive or negative feedback in the form of virtual agents’ or other avatars’ behaviors, gestures, and emotional reactions – without the risk that errors will offend real speakers of the target language.

• Record learner interactions and errors for future analysis and provide consistent, automated feedback in response to students’ errors.

Functionalities

• Facilitate interaction and collaboration with other learners, teachers or tutors, and native speakers, including those located in distant parts of the world.

• Facilitate experiential, exploratory, constructivist, and collaborative learning.

• Encourage role play through the ability to embody different characters within a scenario.

• Promote learner creativity and the use of narrative for learning.

• Improve student engagement, encourage emotional attachment to the scenario/environment, and promote motivation.

Limitations

• Technological glitches or limitations can delay learning or cause frustration (e.g., audio problems for voice chat; speech recognition system does not recognize student’s input; students who type slowly frustrated by text chat) (Eschenbrenner, Nah, & Siau, 2008; Surface, Dierdorff, & Watson, 2007).

• Instructor has reduced ability (or no ability) to judge students’ emotions or physical cues indicating understanding or attentiveness (Eschenbrenner et al., 2008).

• Students and instructors must get support and training to master skills needed to use new software effectively (e.g., navigation, communication) (Boulos, Hetherington, & Wheeler, 2007; de Freitas, 2006; Eschenbrenner, et al., 2008).

• Development time, infrastructure, training and software incur costs for the school (Eschenbrenner et al., 2008).

• Policy needed to address health and safety issues in virtual worlds (e.g., harassment; other forms of inappropriate behavior; privacy concerns) (Eschenbrenner et al., 2008).

Examples of uses

• Create a 3-D “virtual immersion” classroom and have learners complete collaborative tasks (e.g. scavenger hunt) (Shih & Yang, 2008; Zheng, 2008).

• Enable learners to speak with automated virtual agents to complete foreign language tasks, such as ordering food in a café, and receive feedback from the agents in the form of recasts (Morton & Jack, 2005).

• Train advanced learners in pragmatics by providing “behavior-based corrective feedback” within a virtual environment (Sykes, Oskoz, & Thorne, 2008).
• Encourage students to create content within a virtual world, such as creating an avatar\textsuperscript{22} to match a foreign language description such as “tall man with brown hair, wearing blue pants and a red shirt”, or writing and recording a foreign language document to accompany in-world movies (Johnson, et al., 2007).

**Chat**

**Description**

One form of synchronous computer mediated communication is chat. Chat can either be text-based or include audio. Chat is accomplished between two users who are online at the same time having a conversation. The real-time, collaborative features of chat have made it an attractive technological addition to foreign language education. Like face-to-face conversation, participants in a chat room must negotiate meaning by processing input, creating output and responding to feedback. Chat sessions can be open or closed to only invited participants. They can be part of a set curriculum where the instructor arranges the topic for conversation and selects the conversational partners. Alternatively, a learner can participate in an open chat room as a supplement to classroom learning (Levy & Stockwell, 2006). When used as part of a classroom curriculum, chat can be referred to as Computer Assisted Classroom Discussion (CACD).

**Capabilities**

• Traditionally, chat is text-based, but audio and video conferencing platforms are available to enhance chat sessions.

• Record logs of chat interactions, which can be printed for review and used as an assessment tool as for analysis of the learner’s developing L2 knowledge (Tudini, 2003).

• Use “emoticons” (emotional icons) which can convey some meaning that would traditionally be nonverbal during face-to-face communication.

**Functionalities**

• Enable communication and collaboration, which can occur between students without constraint of distance or location.

• Enable communication with native speakers and other learners of the target language.

**Limitations**

• Lack visual input in the form of non-verbal cues (present in face-to-face communication) which often aid in the negotiation of meaning.

• Require that users must be online at the same time. This can be challenging to coordinate when users are located in different time zones.

**Examples of uses**

• Encourage participation, particularly for students who are reluctant to participate verbally in classroom discussion, and increase learner productivity. Language in these electronic discussions also tends to be more complex and formal while remaining interactive as in face-to-face communication (Ortega, 1997).

• Providing a text-based medium in order to draw attention to the form of a language to a greater extent than face-to-face communication (Warschauer, 1997).

• Negotiation of meaning through clarification requests, confirmation checks, self-correction, and compensatory reception strategies (Lai & Zhao, 2006; Smith, 2008; Vandergriff, 2006).

\textsuperscript{22} An avatar is a computer user’s virtual representation of himself or herself, or of that person’s alter ego.
Fora/asynchronous chat

Description

Bulletin boards or forums are asynchronous systems in which messages are sent to multiple recipients. The messages are threaded according to topic and a notification is often sent to a user’s email address when an update is posted to a thread. Bulletin boards allow for collaborative work among members of the forum, and often will not allow non-registered members to join the discussion. Bulletin boards can be used to discuss a topic in the target language or they can be used to discuss issues about a target language or for a cultural exchange (Levy & Stockwell, 2006).

Capabilities

• Increase the number of interlocutors engaged in the discussion by enabling anytime, anywhere participation (Kitade, 2008).
• Allow instructors to restrict access to the bulletin board via password protection and user registration.
• Organize discussion by topic thread.

Functionalities

• Facilitate reflection and interaction in classroom curriculum.
• Enable information exchange online without constraints of time and distance in threaded format.

Limitations

• Students participating in a bulletin board discussion do not receive immediate feedback on their posts. This can be detrimental to learning especially if an unclear post was not questioned by peers or the instructor for clarification (Kol & Schcolnik, 2008).
• The instructor must monitor contributions to provide feedback and have clearly defined instructional goals for the use of technology resulting in an increased workload (Arnold & Ducate, 2006; Kol & Schcolnik, 2008).

Examples of uses

• Arnold and Ducate examined a semester-long online discussion between students in foreign-language methodology classes at two different universities looking at the cognitive activity present in the transcripts. They noted that technology should be included in teacher training to promote interactive learning and to provide teachers the necessary exposure to technology to evaluate its uses and benefits from a user-perspective (Arnold & Ducate, 2006).
• Students learning English as part of an English for Academic Purposes (EAP) course were found to use bulletin boards to express reaction to ideas and arguments more often than to discuss texts or seek explanation for fine points. One advantage bulletin boards hold to other forms of dialogue is their asynchronous nature which allowed students time to reflect on their output and encouraged thoughtful interchange without slipping into their native language (Kol & Schcolnik, 2008).
Web 2.0 tools for “the people formerly known as the audience”

Blogs

Description

A blog or weblog is a web application that presents entries authored by the blog owner with time and date stamps. The most recent entry is typically presented first. The blog owner can choose to allow visitors to post a response to a particular entry in the comments section. In recent years blogging has become a cultural and informational phenomenon (Thorne & Payne, 2005). Technorati Media tracks the number of blogs created each day as well as the number of updates posted each day. Approximately 175,000 new blogs are created each day with an estimated total of 112.8 million blogs in existence (posted November 7, 2008). Bloggers create over 1.6 million blog posts per day (“Technorati Media,” 2008). One reason for the recent explosion of information available in the blogosphere is the elimination of the use of HTML and FTP from the user’s end, which extended accessibility and usability to the non-tech-savvy (Thorne & Payne, 2005).

Capabilities

- Support user customization with graphics, color themes, hyperlinks.
- Link to additional media.
- Enable personal journaling or blogging focused on cultural issues related to the target language.
- Other readers can comment on specific blog posts for collaborative learning.

Functionalities

- Encourage collaborative learning.
- Facilitate reflection.
- Enable communication with native speakers and learners of the target language.

Limitations

- Require regular participation from class members for effectiveness. Without a specific goal or common theme, the writing produced on blogs may not be interesting to other members of the class or online community. This will reduce the amount of collaboration through commentary.
- Place responsibility on language learner. The original author of the blog post must continuously read and respond to comments posted by other users in order for the collaborative capability to reach its potential (Ducate & Lomicka, 2008).
- Demand basic computer literacy skills of users for blog design. While knowledge of HTML is no longer necessary, some students may require an introductory tutorial on blogging (Armstrong & Retterer, 2008; Ducate & Lomicka, 2008).
- Tend to be limited in the way their content is organized. Typically, content is ordered by reverse chronology, rather than by topic, which may not be ideal for the goals of the instructor (Godwin-Jones, 2003a).

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Examples of uses

- Within an educational context, blogging can be used as an alternative writing assignment. Researchers have found that the writing produced by students reflected both academic and nonacademic narrative features. Students are not writing to specifically fulfill a class requirement, they also are writing for other members of the class (Godwin-Jones, 2003a).

- Link students with class members studying abroad: the website http://www.blogabroad.com features three students studying abroad (currently in Taipei, Taiwan, Seoul, South Korea, and Paris, France). This project has created an additional functional use for blogs by providing predeparture cultural information to students still at their home university planning to going abroad and by allowing the students who are abroad a way to catalog their own linguistic experiences (Thorne & Payne, 2005).

- Link students with native speakers of the target language: the Tridem project connected students of French from Carnegie Mellon University in the United States, adult learners of French from the Open University in the United Kingdom and native French speakers studying at the Université de Franche-Comté through synchronous and asynchronous computer mediated communication including several collaborative blogs (Hauck, 2007).

Wikis

Description

A wiki is another web-based environment that allows a user to post information. Unlike blogs, wikis are more suited to collaborative projects. They are formed from a set of pages loosely structured by content with an open-editing system which allows multiple authors to contribute to one page (Thorne & Payne, 2005). An individual wiki page can be password protected to only allow designated users to modify the content. However, this conflicts with the original premise of universal access and the goal to provide shared storehouses of knowledge. This concept is best illustrated in Wikipedia, an online encyclopedia built by contributors from around the world (http://www.wikipedia.org).

Capabilities

- Support open-editing of content with option of password protection.

- Most wikis now have the capability to identify the author, providing the instructor the capability of providing individual feedback (Godwin-Jones, 2003a).

- Help students and instructors to easily find information through organization by topic.

Functionalities

- Enable collaboration on in-class projects.

Limitations

- Increase workload for instructor. Information posted to the wiki must be monitored by the instructor to ensure that instructional goals are being met.

- Complicate providing individual feedback, since multiple authors may contribute to one page.

- May frustrate students because others can edit their content. Students may feel more pressure writing for an audience beyond their classmates. The instructor must also be aware that users outside of the classroom may edit content which adds an additional challenge when providing feedback (Guth, 2007).

Examples of uses

- Several wiki projects for foreign language learning are in place in academic settings. L*Wiki at Pennsylvania State University’s Center for Advanced Language Proficiency Education and Research (CALP-ER) unites a variety of
language courses ranging from ESL to Russian and Chinese (Thorne & Payne, 2005). The 21st century Teaching and Learning project at Texas A&M University uses a wiki for collaboration among members, and the TESOL CALL interest section uses a wiki for its conference planning (Godwin-Jones, 2003a).

- The instructor of a Spanish as a Foreign Language class incorporated wikis by having students create individual pages on topics of their interest in Spanish and then cross-linked the pages. (Martinez-Carrillo & Pentikousis, 2008).

**Social networking**

*Description*

Social networking, of which Facebook and MySpace are the best-known examples, enables peer-to-peer communication and collaboration. Users develop their own presence on social networking by creating profile pages about themselves, and then joining networks based on geography, interests, associations or friendships. Users can create their own networks by connecting to other users’ profiles, or can join existing ones. Social networking sites incorporate many of the one-to-one and one-to-many communication features enabled by blogs, chat, and to a lesser extent, wikis, by letting users post their content on their own profiles, leave comments on others’ profiles, chat with other users either synchronously or asynchronously, and subscribe to receive updates through RSS (Really Simple Syndication). Many social networking users (especially younger users) now use the communication tools embedded in their social network profiles, rather than separate chat (IM) or email applications (Kearney, 2008).

*Capabilities*

- Enable user customization of page.
- Support extensive networking among users and ability to find and communicate with users who have common interests.
- Allow for asynchronous and synchronous communication.
- Popular social networking sites are available in many languages, for example, Russian (moikrug.ru), Chinese (xiaonei.com), and Persian Farsi (mypardis.com, cloob.com, and bahaneh.net).

*Functionality*

- Enable interaction with native speakers and learners of the target language.

*Limitations*

- May lead to unreasonable expectation of user-willingness to participate, including the expectation that learners will want to join existing networks or even create their own. As one technology pundit (Ingram, 2007) notes, “What makes a social network function isn’t so much the tools as it is the attitude. You gotta have the “want to.” And that isn’t something you can get out of a box.”
- Decrease instructor involvement through monitoring and feedback.

*Examples of uses*

- As the Johnson, et al. (2007) states, “[s]tudents learning another language can join a community in that language, where they will be exposed to conversational and colloquial reading and writing, learn about daily life, and establish friendships with native speakers” (p. 9). Bryant (2006) cites the example of Mixi (mixi.jp), a Japanese social networking site, as a place for Japanese language learners to “to interact with Japanese culture by reading profiles and blogs, joining groups, and speaking with native Japanese speakers” (p. 63).
- Social networking sites such as MIXXER, hosted at Dickinson College (http://www.language-exchanges.org), also exist for “foreign language learners to find conversational partners and connecting them using voice-over-IP software” (Johnson, et al., 2007, p.9).
2.b.iv. Mobile/portable networkable devices for anytime, anywhere learning

Converging mobile technologies

PDA

Description

A PDA is a hand-held mobile computing device that combines many features now common to other mobile devices: a calendar, contacts list, word processing, and depending on the OS, applications such as Excel, PowerPoint, and Adobe Reader. Some mobile devices also have Internet access (iPod Touch, Palm T|X), digital audio and video players, and digital cameras. Some have both Internet and telephone access, and are known as Smartphones (iPhone, Treo, BlackBerry). PDAs with Internet access are also known as mobile Internet-accessible devices (MIADs; (P. Anderson & Blackwood, 2004)).

Capabilities

- Possible Internet connectivity.
- Run software for language learning, such as electronic flashcards and dictionaries.

Functionalities

- Provide immediate feedback from the instructor.
- Support collaboration though network connectivity.
- Facilitate vocabulary learning.

Limitations

Gilgen (2005) and Samuels (2005) noted a number of limitations concerning PDA use in the classroom for foreign language learning, some of which related to the general state of the technology at the time, and others to the particular state of their home institution’s infrastructure:

- Limited wireless bandwidth can make it difficult for PDAs to connect to a strong wireless signal.
- In terms of form factors, the small size of the PDA screen, the need to constantly recharge the devices, and the lack of a microphone input for recording all limited PDA usability.
- The lack of language learning/recording software for PDAs and the difficulty of foreign character input using PDA keyboards further reduced their efficacy as learning devices.
- Finally, the fact that many previously distinct handheld devices, such as PDAs, personal music players, and mobile phones, are now converging toward a unified platform or device known as a Mobile Internet Accessible Device (MIAD), has clouded the future of PDAs in education. The Joint Information Systems Committee (JISC), a UK organization for IT in education, predicts that “although much research has been conducted within schools on the use of PDAs to enhance education, it is more likely that future versions of smartphones… will form the basic technical platform” (Anderson & Blackwood, 2004, p. 3).

24 Anderson and Blackwood (2004), citing Livingston (2004), further refine the definition of mobile devices as being 'small enough to fit comfortably into a purse, pocket or holster, so you can conveniently keep it with you at all times,' comparing them to Swiss army knives (p. 3).
Examples of uses

- As part of mobile language labs: PDAs using the Windows PocketPC operating system were augmented by add-on keyboards. Students used the PDAs for a variety of purposes, including text-based chat, accessing target language TV programs, and accessing a database of target language texts (Gilgen, 2005; Samuels, 2005).

- As part of English as a Foreign Language (EFL) classes: In a pilot project at a group of Spanish universities, EFL students used a PDA-based application to support networked, collaborative target language writing; teachers also used PDAs to track students’ progress (Paredes, Sanchez-Villalon, Ortega, & Velazquez-Iturbide, 2007). Chen and Hsu (2008) investigated the use of networked PDAs by Taiwanese EFL learners for target language reading, using fuzzy Item Response Theory to recommend news texts of appropriate difficulty.

- Provide immediate feedback in-class: PDAs were used as a personal response system for immediate feedback on in-class quizzes and concept questions in engineering classes (J. C. Chen, Kadlowec, & Whittinghill, 2008).

- Vocabulary learning: Ogata et al. (2006) coupled radio frequency identification (RFID) readers with PDAs for a game-based approach to vocabulary learning. Learners used their PDAs to read RFID tags of physical objects in their environment and to answer fixed-pattern questions (“Where is…?”) intended to reinforce target language vocabulary knowledge.

iPod

Description

An iPod is a portable media player produced by Apple, Inc. While Apple markets iPods primarily as digital music players, these devices can also serve as external data storage devices with a wide range of memory capacities. iPods can be used to play downloaded television shows and movies and have a small screen for viewing this media. Users can easily access all forms of downloadable media through the software, iTunes. For a small fee, individual songs, albums, television shows, and movies can be downloaded onto the user’s personal computer and transferred to the iPod for portable access. Podcasts, or audio and video digital-media files, can also be downloaded for use with the iPod or other digital media player. Students can “subscribe” to podcasts to enable automatic downloads. Authors of podcasts originally created these files exclusively for the iPod, but recently more devices have become capable of synchronizing with podcast feeds including Microsoft’s Zune, Mediafly SyncClient, Juice, WordPress’ Doppler, Podget and Podracer, ZenCast, and many others.

Capabilities

- Feature portable, easy to use format with generally free access to podcasts.

- Incorporate audio and video capability, including still pictures.

- May include audio or video recording capability with microphone add-on.

- Serve as a portable hard drive for data upload and download.

Functionalities

- Enable rich input though podcasts, which can include language lessons prepared by the teacher, as well as broadcasts of authentic speech — either prepared specifically for language learners or through copies of programs intended for native speakers.

- Enable students to download and review classroom materials, such as videos of lectures, for review at home.

- Enable students to record speech samples or homework activities and upload these for teacher or peer review.
Limitations

- Increase instructor workload to develop content.
- Require basic computer literacy to create podcasts.
- With availability of podcasts online, students may be more likely to skip classes.
- May entail copyright issues and poor file searchability (Blaisdell, 2006).
- Limit media with small screen size.

Examples of uses

- Instructors can create podcast lectures in order to free up class time for interactive activities (Rosell-Aguilar, 2007).
- Study support: repeated listening and repetition of commercial and original audio content.
- Classroom recording: capture lectures, class discussion and verbal feedback for review and later discussion.
- Course content dissemination: provide portable access to course content such as lectures, historical speeches and songs. Duke University maintains an iPod content server to distribute foreign language content (Belanger, 2005).
- For out-of-class learning activities or “podquests”: Students download information onto their iPod and then in groups go into the city and complete instructions for “podquest” provided by iPod. This facilitates the use of language in a natural setting. Students practice listening comprehension, reading directions and information, and speaking in the target language. The “podquest” can also stimulate class discussion (Reindeers, 2007).

Cell phone/smart phone

Description

A cell phone is a mobile telephone and a smart phone is a mobile phone with advanced capabilities, and often, PC-like functionality. While no standard definition exists for a smart phone, it will often have a keyboard, internet and e-mail abilities, and the capacity to run an operating system and related software. Both cell phones and smart phones have voice messaging and text messaging abilities for asynchronous communication.

Capabilities

- Enable students to reach other students and tutor/instructor by phone while mobile.
- Provide Internet access with the ability to mobile blog, that is, use a cell phone or PDA to post to a website (Mielo, 2005).
- Enable short Messaging Service (SMS) or text messaging, voice messaging, and picture taking and sharing.
- Represent readily available, portable, less-expensive alternative to personal computers.

Functionalities

- Enable communication between language learner and tutor.
- Enable content sharing, e.g., sharing pictures.

Limitations

- Reduce functionality with small screen size, limited audiovisual quality, virtual keyboarding and one-finger data entry, and limited battery life.
- Complicate language learning with lack of non-verbal communication, shorter message lengths, and lack of cultural context (Colpaert, 2004).

- Increase cost with text-messaging and service plans; some devices are cost prohibitive for schools developing mobile language labs (Colpaert, 2004).

- Can lead to technological isolation, via constant connectivity, with communications breaking into time set aside for other things and intruding on personal life (Cook, Pachler, & Bradley, 2008).

- Frustrate less tech-savvy students (difficulty learning to use new technology).

Examples of uses

- Vocabulary instruction via SMS: Students received mini-lessons three times a day, consisting of new vocabulary, past vocabulary, and contextual vocabulary including episodic stories (Thornton & Houser, 2001, 2002, 2003, 2005). Kennedy and Levy (2008) created a similar program for Italian learners in Australia which sent vocabulary words, idioms and definitions via SMS.

- Portable games and software for language learning including BBC World Service’s Learning English offered via SMS in Francophone West Africa and China, BBC Wales’ Welsh lessons (Andrews, 2003), and an EU-funded initiative known as ‘m-learning’ which provides English lessons to non-English speaking young adults (Godwin-Jones, 2005; Kadyte, 2004; Kukulska-Hulme & Shield, 2008).

- Cultural and linguistic education: AD-HOC project (Malliou, et al., 2002) facilitates ‘learning-on-demand’ for European travelers through multiple media presentations using real-life situations within different thematic fields (e.g. business travel, young travelers, etc.) for varying levels of competency.

- The Speak My Speak project uses SMS as a communication tool between adult English language learners and native English tutors (Markett, 2003).

- Wide variety of mobile learning functions including mobile blogs, dictionary tools, and virtual communities with group chat, comment areas, and a group calendar.

Tablet PC

Description

A tablet PC is a portable computer, with all of the features of other notebook PCs, but using a digital stylus or touch technology for inputting text and interfacing with programs. Tablets typically use a tablet-optimized Windows XP or Vista operating system, with the rare exception of MacBooks that have been converted to tablets by specialists. Tablet PCs have three forms: a slate, with no integrated keyboard; a convertible, similar to a notebook but with the capability to rotate and fold the screen down to slate position; and hybrid, similar to a notebook but with a detachable keyboard.

The potential of tablet PCs has created a great deal of enthusiasm in higher education, reflected in the following blogs and websites:


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25 We maintain here the distinction between portable and mobile devices noted in the IEEE (2002) standards on wireless networks: “mobile devices typically operate on batteries and have a fleeting interconnection with other devices; portable devices are moved less frequently, have longer time periods of connections, and usually run from power supplied by wall sockets” (p. 20). The emergence of mobile Internet-accessible devices (MIADS) in the last five years or so has partially blurred one aspect of this distinction: fleeting connectivity.

Capabilities
One tablet PC proponent (Heiny, 2008) has asserted that tablets have “the most comprehensive set of features of any of the mobile PCs and devices.”

- Enable “Google-like searchability” of handwritten notes (i.e., when converted to text).
- Make notes and materials available at all times.
- Synchronize note-taking with lectures (using OneNote).
- Reorganize notes.
- Capture diagrams and illustrations with digital ink.\(^{27}\)
- Recognize handwriting and convert to text: in Microsoft Windows this is limited to a number of Western European languages using Latin-based fonts, plus three character- or syllabary-based languages: Chinese (simplified and traditional), Japanese, and Korean. However, at least one commercial program (PenReader) claims to offer handwriting recognition for 22 additional languages, including some Cyrillic-based languages (such as Russian) and languages using diacritics (Turkish), for a limited range of tablet devices.

Functionalities
- Provide rich input through e-books.
- Develop and enhance metacognitive skills through searching and reorganizing notes.
- Enhance collaboration through ad hoc peer networks.

Limitations
- Typically more expensive and heavier than notebook PCs.
- Generally lack a built-in optical drive.
- Tend to have limited battery life (although batteries with extra cells are available).
- Do not yet provide handwriting recognition for a number of languages, particularly those with Arabic-based scripts.

Examples of uses
- Oflazer and Donmez (2004) describe a project to develop tablet-based e-readers using natural language processing (NLP) tools to provide “anywhere-anytime ubiquitous access to lexical information such as word meaning, synonyms, antonyms, usage examples in other parts of the text, [and] sentence examples including the inquired word” (p. 754), but fail to make the distinction between language performance and long-term language acquisition.

\(^{27}\) See Scottberg (2007).

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- Collaborative, small-group mind-mapping exercises, for active learning in undergraduate computer science courses, using Colligo (http://www.colligo.com) to form ad-hoc small group networks for collaboration (Willis & Miertschin, 2006).

- Student tablets have been used to supplement the instructors’ use of PowerPoint in electrical engineering classes, by using digitally inking of slides during presentations (Hulls, 2005).

- Tablets and DyKnow (www.dyknowvision.com) have been used to annotate instructor’s notes and Camtasia (http://www.techsmith.com) to record lectures in physics classes (Fisher, Cornwell, & Williams, 2007). The instructor’s tablet is networked with the students’ tablets; the students submit their in-class work via the network and the instructor selects individual student’s work to display, maintaining student anonymity.

- Third-year engineering students used tablets for a year-long group project requiring collaborative work; the software included with the tablets included collaboration (MS OneNote, Mindjet Mind Manager) and knowledge-management (MS SharePoint) tools (Corlett & Sharples, 2004).

- In a graduate level class on intelligent tutor systems, peer tutors used tablet PCs for computer-supported collaborative learning (Ching, Chen, Chou, Deng, & Chan, 2005).

- Computer science and engineering instructors in classes with networked tablets have used Classroom Presenter (http://classroompresenter.cs.washington.edu ) to integrate digital ink with PowerPoint presentations during lectures, allow students also to ink on slides, and display students’ work to the entire class (R. J. Anderson, et al., 2006; R. J. Anderson, et al., 2004; Koile & Shrobe, 2007).

- Allow students to submit handwritten work back to the instructor directly and instantly without a dependence on paper (Anderson et al., 2006).

- Allow teachers to display aggregated or anonymous student response, which encourage students’ active learning and lower the affective barrier to participation thereby promoting collaborative learning in the classroom.

- Incorporate other technological advances: “… it is the mobility, flexibility and robustness of a Tablet PC (over and above other form factors) that makes it possible for these powerful uses of IT to become embedded in every aspect of informal, collaborative learning” (Corlett & Sharples, 2004, p. 61).
2.c. Summary of technology enhanced learning and teaching functionalities

Our review of the relevant literature indicated that technology use has the potential to benefit five primary functionalities of foreign language learning and teaching.\(^{28}\)

1. **Organization**: technology enables learners and teachers to organize learning and instruction outside of the classroom, and enables learners to reflect on and take control of their own learning.

2. **Input**: technology expands access to a broader range of rich target language input than is available in the classroom and/or provided by the curriculum, and creates opportunities to individualize input.

3. **Output and interaction**: technology expands opportunities for learners to create their own output and to interact synchronously or asynchronously with native speakers and more proficient peers outside of the classroom.

4. **Feedback**: technology creates opportunities to give and receive individualized, maximally effective feedback.

5. **Collaboration**: technology creates opportunities to give and receive individualized, maximally effective feedback.

Additionally, we determined that technology use has the potential to enhance four modes of interactivity for language learning and teaching in a blended learning context: users-infrastructure; teacher-student; student-student; student-content (Ariza & Hancock, 2003).\(^{29}\) By users-infrastructure, we mean ways in which users (learners or teachers) can interact with the technological infrastructure of the course or school, such as the Course Management System. By teacher-student, we have in mind ways in which students can interact with teachers (or other native speakers of the target language), synchronously or asynchronously, in or outside of the classroom. Similarly, student-student interactivity entails synchronous or asynchronous collaboration and communication, in or outside of the classroom. Finally, the student-content mode of interactivity means students exploring, modifying, analyzing and synthesizing content, either as part of the curriculum or autonomously.

The matrix on the following pages (Table 1) combines the concepts of functionality and mode of interactivity and illustrates them by giving concrete examples. A matrix overview enables us to explore the full potential of technology use for learning and teaching without focusing on specific pieces of hardware or software that may be obsolete within the near future. For each node in the matrix we describe the intersection of functionality and mode, and give a few concrete, actual or hypothetical, examples of learning or teaching activities and technology uses. Some of these examples are widely practiced in CALL, such as computer-mediated communication (CMC), and have been in use for well over a decade. Other examples are hypothetically possible, but will require research and development to make them effective as learning and teaching tools (for example, automated meta-tagging of non-native CMC transcripts, automated feedback on non-native handwriting, spelling, and grammar). As we noted in the introduction to this technical report, the lack of synergy between CALL and natural language processing (NLP) research has limited the potential impact of technology use on language learning and teaching. Other, as yet unforeseen applications of technology will appear as researchers continue to explore the logical connections and common goals of CALL and NLP.

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\(^{28}\) By “functionality,” we mean a learning or teaching goal that is enabled by a single technological capability or group of related capabilities.

\(^{29}\) Ariza and Hancock (2003), following Moore and Kearsley (1996), identify three modes of interactivity necessary for technology-enhanced learning: teacher-student; student-student; student-content, to which we add the mode of users-infrastructure.
Table 1: Summary of Technology Enhanced Learning and Teaching Functionalities

<table>
<thead>
<tr>
<th>Modes</th>
<th>Users-Infrastructure</th>
<th>Teacher-Student</th>
<th>Student-Student</th>
<th>Student-Content</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Organization</strong></td>
<td>Technology enables teachers to archive, organize, and share content in ways that maximize access, convenience, reuse, and customization across classes/sections. Examples: Course and learning management systems (e.g., Blackboard, ePortfolios); blogging; social bookmarking; RSS feeds.</td>
<td>Technology enables teachers to organize content in ways that maximize access, convenience, and customization for individual students. Examples: Course and learning management systems; RSS feeds.</td>
<td>Technology enables students to share materials for collaborative learning and task-based projects. Examples: SharePoint; social bookmarking; blogging; RSS feeds.</td>
<td>Technology enables students to access, subscribe to, organize and review content, reflect and take control for own learning. Examples: Mobile/portable computing using OneNote; RSS feeds.</td>
</tr>
<tr>
<td><strong>Input</strong></td>
<td>Technology enables access to a wide variety of target language content and learning materials, anytime and anywhere. Examples: Mobile Internet-accessible devices; personal media players.</td>
<td>Technology enables teachers to direct students (and students to direct teachers) to individually appropriate sources of rich input, and to elaborate input (teachers) or request elaboration on input (students) if desired, to maximize effective time-on-task. Examples: Course management systems; social bookmarking; blogging; learning objects; IWB; corpora; glossed texts, electronic dictionaries.</td>
<td>Technology enables students to direct each other to interesting and motivating sources of rich input. Examples: Social bookmarking; collective blogging.</td>
<td>Technology enables individualization of input based on learner’s current state of TL knowledge. Examples: Intelligent tutor systems; electronic flashcards; learning objects; electronic dictionaries; corpora, glossed texts.</td>
</tr>
<tr>
<td><strong>Output &amp; interaction</strong></td>
<td>Technology enables output and interaction to be archived for subsequent trend analysis of student assessment and self-monitoring, and assessing efficacy of course materials and activities.</td>
<td>Technology enables teachers to maximize efficiency of classroom face-to-face time, by assigning self-administered technology-enabled work to students during non-class hours. Technology use also enables greater interactivity to develop hypotheses and discussions.</td>
<td>Technology enables students to communicate with each other in the TL, engaging them in realistic tasks, and encouraging them to push the limits of their current TL knowledge.</td>
<td>Technology enables deep TL processing through creating, tagging, and synthesizing content, and through engaging in TL-based tasks.</td>
</tr>
</tbody>
</table>
### Feedback

Technology enables feedback to be archived for later analysis of effects on subsequent output.

Examples:
- Transcripts of CMC; automated meta-tagging of native and non-native text using NLP tools; archiving notes from IWB

Technology enables teachers to individualize feedback by assessing the student’s global TL knowledge and diagnosing deficits (rather than providing local feedback on error), provide feedback that is retrievable by the student asynchronously, and provide feedback that distinguishes between “acquisition performance” and “learning.”

Examples:
- Intelligent tutor systems incorporating grammar- and spell-checkers appropriate for non-natives; computer-assisted pronunciation training; handwriting recognition; IWB and ad hoc networking.

Technology enables more proficient learners to provide feedback to their less proficient peers.

Examples:
- CMC, blogging; virtual worlds and interactive gaming

Technology enables effective feedback to strengthen TL memory traces through the use of spaced practice and graduated feedback intervals.

Examples:
- Intelligent tutor systems, electronic flashcards; ePortfolios.

### Collaboration

Technology enables users to flexibly create new avenues for collaboration.

Examples:
- SharePoint; OneNote; wikis.

Technology enables active student engagement in classroom activities.

Examples:
- Individual response systems; polling; displaying student work via classroom network.

Technology enables students to deepen understanding by working collaboratively on task-based projects, sharing learning strategies, and sharing one’s own ideas and responding to others’ ideas.

Examples:
- CMC, wikis, blogging.

Technology enables deep TL processing through manipulating, reorganizing and synthesizing content.

Examples:
- Blogging; wikis; corpora.

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30 That is, the distinction between “the momentary strength or accessibility of a response” under training conditions (acquisition performance), and “the underlying habit strength of that response,” especially under real-world conditions (learning) (Schmidt and Bjork 1992, p. 208).

31 For further elaboration on spaced practice and feedback intervals see section 4.a, “How do second language acquisition and cognitive psychology principles inform best practices for technology use in language learning and teaching?”
3. EVIDENCE THAT TECHNOLOGY USE IS EFFECTIVE FOR FOREIGN LANGUAGE LEARNING

In this section, we first discuss the evidence for each technology type we reviewed, focusing on four categories of technologies: (a) schoolhouse or classroom-based tools, (b) individual study tools, (c) network-based social computing, and (d) mobile/portable and network-capable tools. Next, we give a concise summary of the evidence found in literature, starting with an explanation of evidence strength.

3.a. The evidence

We searched for evidence of effectiveness of all the technologies reviewed in section 2. In this section, we focus exclusively on the evidence of effectiveness of the technology use for foreign language learning and teaching.

3.b.i. Schoolhouse or classroom-based technologies: curriculum-driven tools for instruction and assessment

Course/Learning management systems

As far as we can determine, no published research has compared the effectiveness, either in terms of learning outcomes or processes, of different CMSs with each other, or CMS use in general with traditional, paper-based non-technological alternatives. However, Carey (1999), in a case study of WebCT use for a graduate level foreign language seminar, has described CMS as “the most significant innovation that I have experienced to improve the quality and depth of student involvement in a graduate seminar while promoting the students’ improvement in academic reading comprehension and academic writing production” (p. 379). Yet other research casts some doubt on the generalized impact of CMS use on learning processes. Kvavik’s (2004) report on a survey of technology use by students in higher education included questions relating to their perception of the value of CMS. Students in general had positive perceptions of the technology, rating them most highly for their impact on classroom management and convenience. However, Kvavik notes, “[t]he interactive features least used by faculty were the features that students indicated contributed the most to their learning,” including “…sharing materials with students, … faculty feedback on assignments,… and online readings” (p. 7.14).

ePortfolios

We were unable to locate any studies investigating the effectiveness of ePortfolios for foreign language. We assume that because ePortfolios are usually institution-wide projects, they concern whole university communities, and are commonly not single subject-specific. The bulk of literature about ePortfolios concerns conceptual aspects of the portfolios and comes from academic leaders, such as provosts, or from secondary education administrators. These publications often take into consideration insights from cognitive psychology and instructional design and couple them with the capabilities of specific technologies showing how ePortfolios can facilitate learning. In addition, ePortfolios are a relatively new (however, exceptionally fast growing) concept; therefore, well designed research studies investigating the effectiveness of ePortfolios for learning in general and for specific subjects, is still quite limited. The only exception is the field of medicine, where structured qualitative and quantitative studies were conducted to assess the usefulness of ePortfolios for learning specific skills (T. Dornan, et al., 2002; T. Dornan, et al., 2001; T. Dornan, et al., 2005; Lewis & Baker, 2007).

Interactive white board

For FL learning and teaching, we found no evidence that using the IWB yielded higher scores, when compared with classrooms that did not use this technology. While not in the area of FL learning, one study worth mentioning used a more rigorous methodology than other studies and provided quantitative outcomes. This large-scale evaluative study conducted in the UK compared the test scores of elementary schools using IWB with scores of schools that did not have IWBs. The researchers found that the students in the IWB schools performed better than the students in the non-IWB schools on national tests in math and science, but not English, although the language performance of low-achieving students improved in the IWB condition. These results were not maintained in the second year of the study, where no significant difference in test scores was found between students from the IWB and non-IWB schools.

In the field of FL learning and teaching, the evidence on the effectiveness of IWB use comes from studies that analyzed self-reported data and with one exception from qualitative studies. In some cases, self-reported methods were paired with classroom observations. Therefore, the evidence we discuss here can be classified as either moderate or weak. In addition, with the exception of the study described above, no other studies reported learning outcomes. However, there is some evidence regarding the impact of IWBs on learner affect or the process of learning.
What is striking is that in all of the reviewed studies the users, both teachers and students, and both in secondary and post-secondary education, were overwhelmingly positive about the IWB and perceptions that it enhances learning and teaching. Some studies reported that language teachers unanimously felt that use of the IWB had a positive and sometimes dramatic effect on their teaching and that because of the IWB their role in the classroom had changed (C. Gray, et al., 2005). The introduction of the IWB brought the “wow” effect to the classroom (Orr, 2008). In addition, the use of the IWB in a classroom increased enthusiasm and interest of the students (Tozcu, 2008), engaged learners in the learning process (Tozcu, 2008), motivated students (Tozcu, 2008), and attracted attention (Schmid, 2007).

Multiple functions of IWB were discussed in Gray, et al. (2005). The authors applied a grounded method in their study, in which they investigated L2 teachers’ views about using IWBs in their classrooms. The research team used non-structured interviews, focus meetings, teaching logs, and class observations. Disclaiming that their data is anecdotal (because based on self-report), they were able to find some evidence that IWB use may improve memorization, promote independence in learning, and encourage more practice and recycling of already learned material. For example, 7 out of 12 teachers from their study noticed that using an IWB had an effect on their students’ ability to memorize material. They were able to recall more words and after fewer presentations. Some teachers claimed that the use if the IWB helped the teachers to encourage students to be more independent learners. One drawback of this study was that the teachers only referred to using PowerPoint presentations through the IWB, which of course, could be used independently of the IWB.

Tozcu (2008) conducted the only quantitative study examining IWB use for foreign language. Tozcu analyzed a questionnaire on perceived impacts distributed to 75 instructors of Hindi, Pashto, Dari, Farsi, and Hebrew from the DLIFLC and found that the instructors’ responses to the 26 questions were very positive (ranging from 4.3-4.8 on the 5-point Likert scale. As with all of the other studies on the use of the IWB for FL teaching, data here was self-reported. The questionnaire respondents stated that the IWB was an effective tool to teach the four skills, to enhance student learning, to encourage active learning, and to increase time on task.

Another piece of evidence that the use of the IWB is effective comes from a study by Schmid (2007) who conducted a qualitative study using EFL university students in the UK. As mentioned earlier, additional components exist that further enhance the IWB. One example is a wireless response system, in the case of Schmid’s study, ACTIVote. This system allows students to use individual keypads to respond to the teacher’s questions. The compiled answers can be displayed on the screen anonymously in a graph format. Using qualitative research methods (student focus groups, individual interviews, post-course questionnaire, and field notes), the students reported the system was especially useful for self-assessment through immediate feedback and peer comparison, and self-esteem also through peer comparison. Additionally, Schmid found that student reactions towards ACTIVote were very positive.

Studies also report indirect IWB effectiveness. Through a pre-determined definition of success, these studies provide evidence for how this success was achieved with the IWB. In particular, a research team from the British Educational Communications and Technology Agency (BECTA) defined good practices for IWB use as reaching interactivity in teaching/ or a third, enhanced-interactive stage, where the first stage is supported didactic and the second is interactive (Glover, et al., 2007; Miller, et al., 2005). In their qualitative study, they interviewed 33 successful FL and math teachers, identified by their supervisors, and analyzed 50 video-recorded lessons. While there was no comparison group in this study, they found that these earlier identified successful teachers were working at the 2nd or 3rd stage. Therefore, if achieving interactivity is defined as a good practice, reaching it in the IWB condition can be called a success.

3.b.ii. Individual study tools: self-contained programmed applications

Corpus-based materials

Authors of all of the reviewed studies were generally in favor of using corpora and corpus-based materials in FL learning and teaching. The claims about corpora and how they can affect language learning, especially those coming from the corpus linguists, are much stronger than the actual evidence proving that corpus use in FL learning or teaching is more effective than other materials or methods. However, FL teacher and student opinions on the topic are much less enthusiastic and cautionary and corpus linguists often complain about the resistance on the part of the teachers to using corpora in language classrooms. The main theme present in most of the studies that show at least some evidence of the effectiveness of the use of corpora in FL teaching is that corpus consultation can compliment other resources, but not replace them. For example, none of the Chambers’ (2005) 14 college-level students saw corpus and concordance replacing the textbook or grammar book. They rather saw corpus consultation as a complement or an alternative to consultation of a dictionary, textbook, or a grammar.

Another theme in the literature on corpora is the distinction between higher and lower levels of proficiency and the idea that while corpora can be successfully used by linguistics students or students at the advanced level, they might be problematic at the lower levels. Kennedy and Miceli (2001) conducted a study using 17 college-level students of Italian in Australia. They provided workshops for the students and encouraged students to use the CWIC Italian corpus. They found
that the training did not provide students with skills needed to use the corpus data properly. The authors argued that in order to use corpus as learning tool, the students needed other skills, for example, awareness of logical principles. However, it might also be that the students, who were at the intermediate level, were lacking the TL skills needed to maximize the use of corpora. More weak evidence regarding the effective use of corpora at the beginner level comes from St. John’s (2001) case study. St. John asked one college-level beginner student of German in the UK to perform several tasks using only parallel corpus and concordance software (e.g., to find answers to unknown vocabulary). The study produced very weak evidence that the student, who worked in an unsupervised environment, could use the tools. While the author claims that the two tools could be “of great benefit for beginners” (p. 185), she limited the analysis to only lexical items and sentences of the student’s choice. The data did not include any complex sentences, which is problematic given that the corpus data should contain real-world data, and not a limited selection. This study showed that the beginner student was able to figure out the meaning of some basic words or formulate some basic grammar rules, but the study did not provide evidence that the corpus use was more effective than some other method.

Yoon (2008) investigated corpus use in a college-level EFL writing class in the US. In this qualitative study of six learners of English, Yoon used COBUILD—a large English language corpus, and multiple data collection techniques (observations, interviews, recall protocols, corpus search logs, and written recollection of corpus use) to investigate the effect of using a corpus in a FL writing class. The participants’ writing process showed a slight change in that they tended to check their writing more often while composing; however, it is unclear what caused this change. The author also collected some positive comments from the students about corpora. The author advocated the use of corpora, but since no evidence about outcomes was obtained, it seems that this view was based more on the underlying potentials of the use of corpora, not the evidence itself.

Nevertheless, the literature shows that corpus data provides a very good resource for teachers who are not NS of the language they are teaching. They can consult the corpus data for idioms, specific vocabulary uses, collocations, etc. Tsui (2004) describes a situation in Hong Kong, where the majority English teachers are native Cantonese speakers. Teachers use a website called TeleNex, where they can ask language specialists questions regarding English. The language specialists consult the corpora and provide advice to the teachers. At the time of the article publication, the website had served English teachers for over nine years.

**Electronic dictionaries**

Numerous quantitative and qualitative studies have been conducted to measure the effectiveness of using electronic dictionaries (as opposed to traditional paper dictionaries) to read texts in a foreign language, and in particular compare how their use affects the efficiency or rate of reading, reading comprehension, retention of incidentally-learned vocabulary and learner attitude toward reading in a foreign language. Three studies (Aust et al., 1993; Koyama & Takeuchi, 2007; Leffa, 1993) all found that learners using electronic dictionaries were significantly faster at completing reading tasks than users of paper dictionaries. (However, none of the studies investigated whether faster reading using electronic dictionaries transferred to reading without them, due to an effect of incidental word learning.) Additionally, both Aust et al. (1993) and Koyama and Takeuchi (2007) found users of electronic dictionaries looked up significantly more words than those using paper dictionaries. Aust et al. (1993) describes the effect of electronic dictionaries as lowering the “consultation trigger point” which resulted in more look-ups (p. 70). An earlier study by Koyama and Takeuchi (2004) found no significant difference in time needed to complete work between users of the two types of dictionaries. However while the study measured the time and outcomes of using the two types of dictionaries to look up words to answer post-reading vocabulary questions; the reading passage itself was read without using either dictionary.

The convenience of electronic dictionaries results in an increased frequency of look-ups. Whether this increase affects (positively or negatively) overall reading comprehension measured by recall protocols, translating into L1, or answering comprehension questions was another issue investigated in the literature. Aust et al. (1993), Koyama and Takeuchi (2007) and Laufer and Levitsky-Aviad (2006) all found no difference in comprehension scores and concluded that more frequent electronic dictionary consultation did not disrupt the reading process. In fact, Leffa (1993) found that learners using electronic dictionaries understood significantly more (86.10% vs. 62.70%) than users of paper dictionaries and that the use of electronic dictionaries with beginning language students helped close the gap between stronger and weaker learners. (Unfortunately, the study did not include a subsequent condition in which the electronic dictionary was absent; to investigate whether transferred occurred to novel contexts.) The latter finding was corroborated by Knight (1994) who found that weaker learners benefited more in terms of comprehension and vocabulary learning than stronger learners, although her study only investigated electronic dictionary use by learners with different aptitudes and did not contrast this with paper dictionary use.

Several studies also examined the rate of retention of words looked up in electronic dictionaries. Laufer and Hill (2000) found no evidence that more look-ups increased retention but suggested that accessing multiple types of dictionary information (L1, L2, or other information) according to learning style or preference seems to reinforce retention. The Koyama and Takeuchi (2004) study mentioned above found significantly better retention for users of paper dictionaries.
Although Peters (2007) only investigated electronic dictionary use, her study showed a strong correlation between task-relevance and retention of looked-up words and she claims that her results do not support claims that the ease of electronic dictionary use induces shallow processing.


**Glossed and annotated texts**

Because of the almost limitless possibilities of electronic or computer-mediated glossing (text, audio, still image, video), most quantitative and qualitative studies of the effectiveness of electronic glossing or annotations for foreign language reading compared the effects of different types of glossing on incidental vocabulary learning and reading comprehension. Only one study (Hong, 1997) compared the use of computer-assisted reading with the conventional pen-paper-dictionary method, and found that learners using a multimedia program that gave them access to sound files, Chinese glosses and English definitions completed the tasks in half the time and had higher comprehension scores on a multiple-choice test (no descriptive statistics were included, it is unclear whether the differences in performance were statistically significant). Other studies compared the use of electronic text glosses with and without accompanying images, video or audio files. Lomicka (1998) found that learners did not take advantage of multimedia glosses and annotations (images, references, questions and pronunciation) relying mostly on L1 and L2 definitions. Similarly Davis and Lyman-Hager (1997) found that despite the availability of L2 glosses, audio (for pronunciation), grammar explanations and cultural references, 85% of look-ups were for L1 definitions, and no apparent relationship between gloss use and reading comprehension was found.

An advantage of using electronic glosses rather than using electronic dictionaries is the possibility of providing context-specific definitions or translations. In Chun’s (2001) study comparing the use of electronic dictionaries with that of tailored glosses, subjects commented in exit interviews that glosses did not require them to recreate the dictionary form of the word in order to look it up, a capability not possessed by electronic dictionaries. In the same study researchers noted that electronic dictionary users also had to decide among multiple definitions or translations for a word. Grace (2000) found that the availability of L1 dialogue-level translation glosses significantly improved performance on both immediate and delayed vocabulary post-test scores as compared to L2 explanation glosses. In Gettys (2001), which compared dictionary-form definition glosses with sentence-level translation equivalents (reflecting the appropriate tense, number etc.) the only significant finding was that the dictionary-gloss group took more time to read the text; no significant difference in comprehension was found.

The advantage of providing interactive glosses was demonstrated by Nagata (1999), who compared the effectiveness of single L1 translation glosses versus a choice between two L1 translations accompanied by immediate feedback as to the correctness of the learner’s selection. The results showed that multiple-choice type glosses were significantly more effective for learning both vocabulary and grammatical structures as measured by the immediate post-tests but that only grammatical structures maintained a significant difference in performance on the delayed post-test. Nagata (1999) suggests that “closed” (single choice) glosses be used for unguided L2 learning to avoid the possibility of mistaken inferences going uncorrected, unless immediate feedback on correctness is provided.

Two studies (Chun & Plass, 1996; Yoshii, 2006) found significantly better incidental vocabulary learning with text+picture glosses over text-only glosses. Chun and Plass (1996) measured the difference in delayed recall with text, text+picture and text+video and showed a higher rate of recall in delayed testing for text+picture. Yoshii (2006) found a significant difference on a definition-supply test between text-only and text+picture. The same study showed that L2 glosses benefitted more by the addition of a picture than did the L1 glosses. Al-Seghayer (2001) however, found no significant difference in incidental vocabulary learning between text-only and text+picture glosses.

Several studies found that additional glosses beyond L1, L2 and picture did not increase performance; rather such glosses had a negative effect. Chun and Plass (1996) observed reduced recall in a delayed vocabulary test in the text+video condition and Ariew and Ercetin (2004) found significant negative correlations between time spent on video glosses and reading comprehension. In Yeh and Wang’s (2003) study subjects using text+picture glosses significantly outperformed those using text+picture+audio glosses. A significant negative correlation was also found between time spent on pronunciation, audio and video annotations and reading comprehension in Sakar and Ercetin’s (2005) study; their study also included one subject who admitted to completing the comprehension test solely on the basis of the video annotations (he did not even read the text)!
One study (De Ridder, 2002) measured the effect of type of task (general or specific reading) and type of gloss (visible or invisible links) on comprehension, incidental vocabulary learning and frequency of clicking. Results showed that learners clicked significantly more when the availability of glosses was marked, and also significantly more when performing a general reading task. Incidental vocabulary learning was not affected by visible glosses but learners performing a general reading task, both with and without visible glosses, outperformed those doing a specific reading task. Delayed vocabulary tests showed that marked glosses did not lead to more superficial learning. There was no significant difference in the delayed vocabulary post-tests between the group with visible glosses vs. the group with invisible glosses; both groups showed statistically the same degree of loss. Three studies reviewed also included qualitative data on learner attitude toward computerized glosses and annotations. Although quantitatively Ariew and Ercetin’s (2004) study found no evidence of a significant effect of annotation use on reading comprehension, questionnaire and interview data revealed that subjects perceived annotations to be useful and the hypermedia reading environment enjoyable, interesting, and easier to understand. Likewise, learners in Davis and Lyman-Hager’s (1997) study were unanimously favorable toward computerized glosses and felt that they made them more independent, even though the quantitative part of the study found no effect on reading comprehension. Subjects in Chun (2001) all found glossed words helpful and felt they speeded up the reading process.

### Intelligent tutoring systems

Genuine empirical evidence for the effectiveness of Intelligent Tutoring Systems (ITS) in language learning is lacking; however, Dodigovic (2007) represents a quasi-experimental evaluation of an ITS designed to address seven errors common to learners of English as an L2. Dodigovic found that among 266 participants in 3 countries, the ITS treatment resulted in an average 83% reduction in errors. While extraordinarily positive at first glance, interpretation of these results is complicated by a number of confounds, including the use of different formats for pretest and posttest (it is possible that the posttest was simply easier than the pretest, though the author comments that, subjectively, this did not seem to be the case) and the lack of a control group to rule out learning from the tests themselves. In spite of these limitations, the study is illuminating in that it highlights a number of the ITS’s features that are both grounded in SLA theory and seem to function effectively. Among these are the fact that the ITS targets error-types identified as common and problematic through analysis of genuine texts produced by learners, that it implements instruction within a communicatively focused exercise (a dialogue regarding a medical document on malaria) and it provides immediate corrective feedback to learners’ responses.

Additional support for these measures can be found in MacWhinney (1995), who cites communicative context, corrective feedback, and the diagnostic value of learner errors among his recommendations for bringing ITS design more into line with the lessons learned from experimental psychology, psycholinguistics and SLA research in recent decades. In addition, MacWhinney highlights the importance of practice and instruction and advises that ITS designers be mindful of the caveat that learner errors can, in fact, be indicative of learning, and that such errors are often best interpreted in light of the developmental sequences identified for the acquisition of the linguistic phenomena in question.

A final issue regarding the use of ITS in L2 instruction is the criticism that, at the current state of the art, ITS cannot adequately approximate the communicative interaction many SLA researchers regard as vital for L2 acquisition (Chappelle, 1997). On this point, Borin (2002) remarks that there are language learning situations for which communicative interaction may not be the ideal, or else may be impossible; these include the learning of written standard languages, the learning of dead (classical or liturgical) languages, the revival of moribund languages for which there are few native speakers and possibly no trained teachers, and the learning of Linguistics or Computational Linguistics, where grammar is the object of study in its own right.

### Grammar checkers

A general finding in the literature on electronic grammar checkers is that language learners need training in order to make effective use of this technology. Two studies in particular provide empirical evidence supporting this conclusion. Jacobs and Rogers (1999) compared the use of Microsoft Word’s built-in French grammar checker with the use of paper grammar references. Prior to an explicit training session concerning the optimal use of the grammar checker, the group using the paper references outperformed the group using the grammar checker. After the training session, however, the two groups performed with comparable accuracy.

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32 “The general reading task was to answer multiple-choice and open-ended comprehension questions, whereas the specific reading task included four questions where the answers could be found literally in the text or required students to establish a relationship between information contained in two paragraphs” (De Ridder, 2002, p. 130).
Burston (2001) reaches a similar conclusion regarding the French grammar checker Antidote, pointing out one particularly helpful strategy: when the grammar checker remarks that it cannot parse a full sentence, the learner must manually highlight the sentence’s fragments and run the checker over each individually. Learners who had been trained in the use of Antidote, including the manual parsing strategy, outperformed a group who used no grammar checkers across 3 writing assignments. Those who used the program averaged 72 - 82% morphosyntactic accuracy compared with 20 - 54% accuracy in those who had not.

**Automatic speech recognition and computer assisted pronunciation training**

In the field of language learning, automatic speech recognition (ASR) is used as a part of Computer Assisted Pronunciation Training (CAPT) software to improve pronunciation and intelligibility of foreign language learners’ speech. This is a newer technology and improvements are constantly being made to the software, so studies looking at these technologies have produced mixed results. Some studies have looked at the accuracy of the feedback for pronunciation provided by the software as compared to human judgment of pronunciation accuracy. Kim (2006) examined pronunciation scores provided to learners by one piece of software, *FluSpeak*, and compared these to scores provided by human raters. The correlation between the software scores and the human scores was fairly low at 0.56 and consistent with earlier studies comparing human and computer generated scores (Kim, 2006; Machovikov, Stolyarov, Chernov, Sinclair, & Machovikova, 2002; Rypa & Price, 1999). This correlation is also consistent with the level found when comparing scores between human judges (Rypa & Price, 1999). In this study the correlation between interjudge ratings was 0.69 and not significantly different from the correlation between software scores and human scores. *FluSpeak* appeared even less reliable when comparing intonation scores given by the software with judges ratings of intonation. In this area the correlation coefficient was nearly zero indicating that ASR and speech pronunciation still have a long way to go before it can replace human interaction. Students who use this software do express positive experiences and answer positively to questions inquiring if the software improves their pronunciation and language in general. Instructors note that ASR software allows students to focus on low level pronunciation drills outside of class leaving a greater amount of class time for motivating communicative activities (Kim, 2006).

More promising results in pronunciation training have been found with programs that record student speech and acoustically analyze it against a native speaker sample with visual feedback. Often these programs require additional training to interpret the acoustic feedback, but students have been successful at using this feedback to improve prosody and vowel pronunciation (M. Carey, 2004; Hardison, 2004). *Kay Elemetrics Computer Speech Lab* (CSL) has been used with college-level French students and Japanese students to improve prosody, pitch and duration by comparing student production to native speaker productions (Hardison, 2004; Hirata, 2004). Significant improvements on pre- and post-test measures of prosody and segmental accuracy were found in the experimental groups with generalization to novel sentences. Students improved in both production and perception of these distinctive features, while the control group did not experience the same gains (Hirata, 2004). Students reported an increase in their speaking confidence and an increased awareness of the suprasegmental components of pronunciation (Hardison, 2004). Another *Kay* product, *Sona-Match* was used by Carey (2004) to look at the effect of visual feedback on the pronunciation of vowels by ESL learners. Students in the experimental group experienced a significant improvement in their pronunciation after five hours of instruction with visual feedback using formant frequency components (F1-F2) (Carey, 2004).

Another application of ASR has been in Intelligent Tutor Systems which engage the learner in a dialogue and respond based on the accuracy of the student’s speech. The software *CandleTalk* was studied with 49 college-level ESL learners in Taiwan. Students were tested prior to and following completion of the training through an oral production test in the format of the Discourse Completion Test which was scored by two raters. The mean total score for oral performance improved significantly across all participants between pre-test and post-test, but intelligibility did not improve (Chiu, Liou, & Yeh, 2007). This indicates that ASR can be incorporated into programs to teach linguistic and pragmatic components of the TL. Students also significantly improved reading and speaking scores in Arabic assessed through pre-test and post-test face-to-face interviews with DLI raters and mock DLPTs using the Interactive Drama Inc. Virtual Conversations software as part of a 5-day refresher course (Harless, et al., 1999). Students noted an increase in motivation while using the software and improved speaking confidence as a result of participating in this training. Pilot testing of the Military Language Tutor for Arabic also produced positive results with significant pretest-posttest learning gains in vocabulary, grammar, pronunciation and fluency (Holland, et al., 1999). This software uses *Dragon* speech recognition software. While a common complaint in all of these studies is that the ASR accuracy is not 100%, students typically reported positive experiences when using the software, increased motivation to practice the language and an increased confidence in their ability to use the language. These affective variables and the promising empirical results suggest that ASR can be a valuable component of ITS for foreign language learning.
Virtual worlds/serious games

There is no clear evidence that learning in virtual worlds is more effective than traditional forms of classroom learning or other forms of distance learning. The few empirical studies that exist have primarily reported affective reactions to the use of virtual worlds. For example, students’ thought their educational experience was improved, or that they enjoyed learning in a virtual environment (Dickey, 2005; Shih & Yang, 2008).

There is some evidence that the use of animated pedagogical agents or tutors (which are incorporated into some virtual worlds) can improve learning when compared to reading a textbook or learning from an untrained human tutor (Graesser, Jeon, & Duffy, 2008). However, such benefits may be limited to intermediate level students in subjects for which spoken language interaction is not required, and some learners may view such agents as “frivolous” or undesirable (Graesser, et al., 2008).

In terms of serious games, the most relevant literature addresses the use of immersive games for military training, such as America’s Army (de Freitas, 2006). For language learning, the Tactical Language and Culture systems available from Alelo, Inc. (http://www.tacticallanguage.com/) are the most direct application of this technology. Surface, Dierdorff, and Watson (2007) evaluated the effectiveness of the Tactical Iraqi™ program with military personnel. Analyses of pre- and post-program multiple-choice testing indicated that learners demonstrated significant improvement in their declarative knowledge of Iraqi Arabic language and culture after 40 hours of Tactical Iraqi use (plus classroom training for some subjects) (p. 26-27). Only eight learners were tested for oral proficiency (those learners at DLIFLC who used the Tactical Iraqi program exclusively); six of these eight learners receive 0+ OPI scores (p. 21). Due to impending deployments, no users completed the entire recommended 80-hour program of instruction. These results suggest that programs such as Tactical Iraqi™ can be useful for increasing soldiers’ knowledge of language and culture, but the authors recommend that they be part of a “structured language program,” rather than as a stand-alone training solution.

Interestingly, however, students rated the traditional computer-training element of the program as more useful and more enjoyable than the 3-D videogame element. Students felt that the program was most useful for learning vocabulary, practicing the language, and receiving feedback while instructor-led lessons were ranked higher in terms of learning and practicing cultural knowledge, overall training, and mission-related training.

Chat

Instructors have used chat in foreign language learning since the 1990s. Pedagogical benefits for language learning have been demonstrated in empirical studies looking at chat as a tool for communicating with native speakers, negotiating meaning, collaboration, increasing the complexity of language produced by the learner, and simply increasing the amount of language produced by the learner (Jepson, 2005; Kern, 1995; Lai & Zhao, 2006; Ortega, 1997; Tudini, 2003; Warschauer, 1997). One of the earliest benefits attributed to chat is that foreign language students are more likely to communicate through chat than in the traditional large group, face-to-face classroom. When a class discussion was held online and compared with the same topic discussed orally, students produced 2-3 more conversational turns, with more sentences and total words, using chat (Kern, 1995). Ortega (1997) discusses this effect of chat giving three possible reasons for increased participation in computer mediated discussions: the instructor’s role as an authority figure is diminished and instructor contribution to discussion is reduced; conversely, the students must take more responsibility for the discussion and all speakers share the floor equally. Chun (1994) demonstrated that the ratio of teacher to student messages shifted when comparing classroom discussion using chat with regular oral discussion with students producing more messages in the computer assisted discussions.

These earlier studies have also looked at increased complexity in learner language as a result of using chat for foreign language learning. Students were found to use a greater number of complex sentences and more complex morphosyntactic structures not only in the computer mediated discussions, but also in written assignments produced over the course of the semester (Chun, 1994; Kern, 1995). Additionally, the language used in chat discussions has been shown to be more accurate than in face-to-face discussion (Salaberry, 2000). Despite these findings, instructors need to be aware that due to the speed of interaction in text-based chat, accuracy may be sacrificed in order to produce more discourse and keep pace.

33 See also related sections of this document on Intelligent Tutoring Systems and Automated Speech Recognition and Computer Assisted Pronunciation Training.
34 Unfortunately the authors did not present sufficient details to calculate the effect size of this improvement.
with conversational turns (Lee, 2002). In order to mediate this effect, instructors can monitor chat discussions or require learners to revise or proofread their interactions for accuracy.

Negotiation of meaning is an integral part of foreign language acquisition that can only be accomplished through dialogue with another speaker. Interactionist approaches for L2 learning expect non-native speakers to experience communication breakdowns that require repair and negotiation to settle. Early methods of analyzing chat logs often could not account for the self-initiated self-repair that occurred in the course of a chat session. More recent studies have used a screen-capture method that allows keystroke corrections (excluding spelling errors) to be included in the analysis. This has revealed that the amount of repair moves in text chat has been underestimated when comparing voice and text chat logs (Smith, 2008). Previous research has suggested that learners are more likely to negotiate for meaning in voice chat rooms than the more widely available text chat rooms (Jepson, 2005). While the repair moves involving pronunciation will only be seen in voice chat rooms, negotiation of meaning is occurring at a similar rate in text chat rooms (Smith, 2008). Research has demonstrated that text-based chat increases the saliency of the linguistic errors for the learner leading to a greater number of linguistic repair moves than in face-to-face conversation (Lai & Zhao, 2006). Grammatical errors were more commonly corrected than lexical errors in computer mediated discussion than in face-to-face communication (Smith, 2008). Another study has found that reception strategies used to establish common ground between conversational partners are used at a nearly identical rate in face-to-face communication and text-based chat supporting the use of this medium for development of conversational competency (Vandergriff, 2006).

Chat allows L2 learners to communicate across distance quickly, inexpensively and frequently. Interaction can occur on a regular basis in one-to-one communication. Groups of students from different schools can communicate using chat, providing opportunities for authentic communication with native speakers and collaboration on projects (Warschauer, 1997). Interaction with native speakers of the target language provides the L2 learners realistic models of conversational language to a greater degree than can be provided in the classroom. Tudini (2003) looked at intermediate learners of Italian who interacted as a dyad with native speakers of Italian via chat that was not supervised or moderated by the instructor. Students submitted class logs to be included as part of their assessment. She found that negotiation of meaning occurred, and discussed qualitatively how the native speaker in the public chat room affected this negotiation of meaning. Individual native speaker differences played a role in the learning environment afforded to each individual student. Some native speakers overly praised the student and did not provide correction or negotiate meaning even when the student’s language was incomprehensible, while others showed an intolerance of student errors (Tudini, 2003). While this application of chat in foreign language learning removed the constraints of time and distance related to the classroom, the feedback provided by the native speakers may be counterproductive to the student who is not confident speaking or writing in the target language. When chat with native speakers was used with advanced learners of Japanese with previous in-country experience, negotiation of meaning occurred, leading Toyoda and Harrison to conclude that classroom teaching did not cover all of the language aspects required for competent communication and students would not have noticed these types of errors (particularly inter-cultural differences) without the experience of chatting with native speakers (Toyoda & Harrison, 2002).

Chat’s potential to bridge cultural gaps and create transnational partnerships is discussed in a review of literature from Thorne and Black (Thorne & Black, 2007). An example of this form of partnership is the TRIDEM exchange which united American, British, and French students collaborating synchronously and asynchronously for 10 weeks on projects examining cultural similarities and differences (Hauck & Youngs, 2008). This project reported qualitatively that task-design must be appropriate for the technology employed, and that both synchronous and asynchronous communication can be utilized to form a beneficial partnership.

**Bulletin boards/asynchronous chat**

Bulletin boards can allow users to collaborate in the target language or collaborate on a project related to the target language. They eliminate constraints of time and distance by allowing the users to post messages anytime and anywhere with available network access. Unlike synchronous chat, the users do not need to be online simultaneously, and while this reduces the need for negotiation of meaning, it allows greater time for processing of language input and for editing language output (Levy & Stockwell, 2006). The combination of interaction and reflection is facilitated by bulletin boards (Warschauer, 1997).

As with synchronous computer mediated communication (SCMC), such as chat, asynchronous CMC, such as bulletin board systems, can allow users to interact and provide feedback on language use. Feedback given through a bulletin board in Blackboard was examined when Spanish speaking EFL students were paired with English speaking learners of Spanish. These students collaborated on several projects but also participated in e-tutoring sessions via the bulletin board. While qualitative data indicated that the students valued the feedback they received from their partner on language form, this feedback was only provided in the e-tutoring sessions when it was explicitly required and not during project collaboration (Ware & O’Dowd, 2008). This has pedagogical implications for instructors who wish to use bulletin boards for peer
communication, and implies that instructors will need to design the task so feedback is considered an integral part of the interaction by the students.

Conversely, bulletin boards may be used more effectively as a way for students to discuss cultural issues or react to texts read in class rather than to have dialogue specifically focused on accuracy since immediate feedback is not available to the student. Students participating in a collaborative project using a bulletin board system were found to rely on offline verbal interaction when asking a question about linguistic form while the bulletin board was used for collaboration at the point the student had chosen the linguistic item to post (Kitade, 2008). Additionally, teachers report that the bulletin boards promoted more thoughtful expression because of their asynchronous nature (Kitade, 2008). Students in English for Academic Purposes courses reported positive attitudes to bulletin board participation, and felt that their language improved over the course of the study. An analysis of language complexity showed no measurable improvement in their language, so this may not be the most effective tool for improving TL writing; instead the bulletin board could be used to facilitate supplemental discussion to in-class topics that are of particular interest to the students (Kol & Schcolnik, 2008).

Web 2.0 tools

Social networking

The effects of social networking on language learning and the implications for instruction and curriculum development are still unclear. Our review of the literature did not uncover any studies relating to social networking for language learning with actual data—even descriptive data—concerning actual language use (e.g., number of contributions per user, length of contribution, types and distributions of negotiations and feedback). In contrast to the wealth of CMC studies, no such similar research apparently has been conducted on social networking. Despite their commonalities, important differences in format and context of communication may exist between CMC and social networking. Debski (2002) strikes a sobering note on the lack of studies concerning social computing (including social networking) for language learning:

...social computing... has probably been the single most important factor changing L2 learning and teaching practices in recent time. Second language students are asked to communicate and collaborate in the target language with overseas partners, to search for information on the Internet, create Web projects and share them with online communities... Despite the growing popularity and intuitive appeal, the position of computer-supported collaborative learning is however still far from settled and exactly what and how students learn through such practices is still unclear. (p. 130)

Blogs

Asynchronous CMC allows students to communicate and collaborate via the computer without the constraints of time and distance. Dialogue does not need to be coordinated across time zones or around individual participant’s schedules. This is a feature that has made the addition of this form of communication valuable to foreign language teachers and students, and has been noted in many of the studies looking at the use of asynchronous CMC, including blogs, wikis and bulletin board systems. The TRIDEM project united three groups of students in the United States, United Kingdom, and France through blogging and synchronous CMC. The majority American and British students sought to improve their speaking and listening skills, but as the project progressed the focus shifted to writing skills. This was attributed to the difficulty the Tridem partners experienced in coordinating synchronous meetings leading to an increase in the use of the blogs for communication (Hauck, 2007).

Blogging has also been used to replace traditional writing assignments in the FL classroom. Over the course of a semester, student writing has been measured to improve when blogs were incorporated into the curriculum. Language production changes included: new phrases, improvements in spelling and the use of accent marks, and an increase in the use of conjunctions (Thorne, Webber, & Bensinger, 2005). Students in an intermediate Spanish course who demonstrated a low accuracy in their verb forms in classroom assignments showed an improvement in verb form accuracy across three oral exams which contributed to the student’s grade in a course requiring nine different personal blogging assignments that complemented topics from the text used in class, in addition to twice weekly community blog postings. Average length of T-unit (a main clauses and its subordinate clauses) also increased from 7.2 words to 8.7 words for the class of 16 students (Armstrong & Retterer, 2008). Students were also observed to experiment with the target language in ways not observed in traditional writing assignments (Ducate & Lomicka, 2008).

Qualitative surveys have indicated that students prefer blogging to traditional journals or weekly essays and that publishing their writing online is motivating (Armstrong & Retterer, 2008; Thorne, et al., 2005). 100% of the 16 students in the intermediate Spanish class felt that their writing improved and felt more confidence in manipulating verb forms (Armstrong & Retterer, 2008). When blogs are used collaboratively, students enjoy reading and commenting on their
classmates’ posts. Students also found that reading and commenting on blogs written by native speakers increased their confidence in writing the target language. These students saw blogging as an enjoyable part of their language curriculum but noted that they would have preferred more flexibility in their choice of blog topic, and suggested that creativity be included in the grading rubric to encourage maximal use of blog capabilities (Ducate & Lomicka, 2008).

As blogs are relatively new in the FL classroom, very few studies have quantitatively examined how they can improve FL writing and comprehension. Specific capabilities of blogs have been touted as adding value to traditional writing assignments. For example, the reverse chronological ordering of blogs allows students to create an ePortfolio of their writing through a course and allows for personal evaluation of changes and improvements to their writing (Thorne & Payne, 2005). One student’s blog was examined as a case study, and it was noted that his blog (developed as part of a English composition class) provided insight into the strengths and weaknesses of his writing for the instructors and revealed writing strategies he developed to effectively communicate through the blog (Bloch, 2007).

**Wikis**

Limited empirical evidence exists for the use of wikis in foreign language education, but this is a promising technology for collaboration and knowledge sharing. Wiki activities were incorporated into an Educational Technology introductory course with 24 students. The wiki was used as a means for students to introduce themselves, collaborate on writing, build a database of emerging technologies, exchange ideas and plan the class project. While 90% of the students actively participated in the exchange of ideas by suggesting revisions and commenting on student websites, the authors found that the students primarily used the wiki as a means for cooperative rather than collaborative learning (Ioannou & Artino, 2008).35 This supported the findings of Lund and Smordal (2006), who used a wiki in an English as a foreign language class. Both studies concluded the teachers must be actively involved in student contributions to the wiki to ensure collaboration between students is successful.

Wikis were also used in a Spanish as a foreign language class, where students created individual pages on topics of their interest in Spanish and then cross-linked the pages to create a wiki. Students answered questionnaires regarding their experiences and indicated that wikis assisted in language skill development and cultural knowledge acquisition (Martinez-Carrillo & Pentikousis, 2008). Emigh and Herring (2005) also suggested that instructors should set clear parameters for students regarding the purpose of the writing activity and protocols for peer-editing in order to meet learning objectives and promote collaboration rather than homogenous text types.

**3.b.iv. Mobile/portable networkable devices for anytime, anywhere learning**

**Tablet PCs and PDAs**

So far, the effectiveness of tablet PCs for foreign language learning has not been extensively studied.36 Our search of the literature uncovered only a single study with any data on the impact of tablets; in this case, on language learning processes. In a study of elementary EFL learners in Taiwan, Lan et al. (2007) compared the collaborative, peer-assisted learning practices in small reading groups, with and without tablet PCs. They conducted a quasi-experimental study over a ten-week period, video-recording and coding the collaborative reading behaviors of 52 third-grade learners. They concluded that compared to learner groups without tablets, the learner groups with the tablets attended more to the reading tasks, and exhibited more collaborative behaviors such as giving support and feedback, and avoiding conflict. The authors also cite their “distinct impression that [tablet use] seemed to reduce anxiety in elementary EFL learners, promote motivation to learn, and enhance oral reading confidence” (p. 142).

In the case of PDAs, as of tablet PCs, there appear to be two related questions of effectiveness: the question of the viability of the technology to support foreign language learning, and the question of the effectiveness of the pedagogical approaches implemented through and supported by the technological platform. In both cases, so far the research appears to be directed at the first question rather than the second. Gilgen (2005) and Samuels (2005) report that students considered

35 “Collaborative learning is a method of teaching and learning in which students team together to explore a significant question or create a meaningful project… Cooperative learning… is a specific kind of collaborative learning. In cooperative learning, students work together in small groups on a structured activity. They are individually accountable for their work, and the work of the group as a whole is also assessed. Cooperative groups work face-to-face and learn to work as a team.” (http://www.thirteen.org/edonline/concept2class/coopcollab/index.html, retrieved December 16, 2008)

36 A previous CASL study qualitatively investigated tablet PC and iPod use by Arabic and Chinese learners at DLIFLC, but did not present conclusions concerning their effectiveness.
PDAs useful for reading and writing activities (including written chat) but not for listening or speaking activities, based on a survey of user attitudes. Paredes et al. (2007) claim that their application’s “extensive use has validated it as an effective writing tool for learning how to write by writing” (p. 955) but offer no evidence of language learning effectiveness.

In a small-scale study of PDA use with a learning outcome measure, Chen and Hsu (2008) found significant gains of large effect size in target language reading comprehension in an analysis of 15 learners’ scores on ten-item pre- and post-tests. Using the same subjects and research design, Chen and Chung (2008) evaluated a PDA-based vocabulary learning system to tailor English vocabulary learning materials to individual learners, and found that target language vocabulary recall on a cloze exercise improved significantly. Neither study included a control group. Again, the question remains whether the results validate the PDA as an EFL learning device, or whether they are due to the particular learning activities involved, or indeed whether the learners would have improved on the ten-item reading comprehension measure after five weeks, independent of the technological platform.

iPod

While we found no empirical evidence of the effectiveness of iPod use in the language classroom, Sathe and Waltije (2008) investigated whether use of iPods would increase motivation and/ or time on task among 121 language students. They purchased 24 iPods with iTalk microphones for their project “The Mobile Mini-Lab”. Statistically they found no correlations among attitude towards technology, language studied and/or grade average. 90% of the students reported that they liked the convenience of the iPods, and 91% of students said that “overall” they benefitted from working with an iPod. 80% of students reported no trouble with technological glitches. However, textbooks were still the most commonly used source for studying. 51% thought that “access to the iPod increased knowledge of target language.” 67% reported that “having the iPod motivated me to spend more time” on listening/speaking activities for language class, and 56.7% thought that “using the iPod helped me learn the language better.”

Outside the language classroom, Kurtz, Fenwick, and Ellsworth (2007) converted an entire lecture course into 65 podcasts, allowing class time to be dedicated to problem-solving and project sessions. They found that students who received podcast lectures had higher overall grades than those from a previous cohort who received conventional lectures.

Doolittle and Mariano (2008) investigated whether studying with an iPod while mobile would have an impact on its effectiveness (relative to using the iPod for study while stationary), and whether such an effect depended on the user’s working memory capacity (WMC). 84 undergraduate students in a health education class completed a multimedia “historical inquiry” tutorial, which they viewed as a video on an iPod with headphones. The stationary group viewed it while sitting in a chair, while mobile participants had to walk around in a hallway while viewing the tutorial and responding to navigational cues. After completing the tutorial participants’ recall was tested with an open-ended comprehension question; and ability to transfer knowledge was tested with four short-answer questions. Doolittle and Mariano found that stationary participants learned more than mobile participants, both for recall and transfer. High WMC students did better on both tasks as well. The mobile condition was most detrimental for participants with low working memory spans.

Cell phone/Smart phone

Empirical support for the effectiveness of using mobile technology to teach languages comes from Thornton and Houser (2002, 2003, 2005) who developed several innovative projects using mobile phones to teach English at a Japanese university. One focused on providing vocabulary instruction by SMS, and compared learning gains made by students instructed in this format with those made by students who accessed vocabulary instruction via the Web and those who used paper references. The results indicated that the SMS students learned over twice the number of vocabulary words as the Web students, and that SMS students improved their scores by nearly twice as much as students who had received their lessons on paper. Students’ attitudes were also measured. The vast majority preferred the SMS instruction, wished to continue such lessons, and believed it to be a valuable teaching method. The authors theorized that their lessons had been effective due to their having been delivered as push media, which promote frequent rehearsal and spaced study, and utilized recycled vocabulary”.

Kiernan and Aizawa (2004) investigated the impact of using mobile phones in task-based language instruction. They argued that second language acquisition is best promoted through the utilization of tasks, which require learners to close some sort of gap, thereby focusing the learner on meaning. In the traditional classroom, however, such activities are easily defeated by the close proximity of students. The use of mobile technologies would be one way to separate learners.

In their study, upper and lower level Japanese university students were placed into three groups: PC email users, mobile phone email users, and mobile phone speaking users (due to cost, this latter group became face-to-face speaking users). Then they were given a pre-test, three narrative tasks, three invitation tasks, and a repeated post-test. While all the face-to-face speaking users completed these tasks in the time provided, only two pairs of PC email users and one pair of mobile phone email users completed the tasks.
The face-to-face speaking users had significantly faster performances, and the mobile phone email users had the slowest; however, the latter were not significantly slower than the PC email users. These differences were attributed to relative speed of typing versus speaking, and the relative speed of typing on mobile thumb pads versus keyboards. An interesting side-note was that the fastest mobile phone email user had conveyed the entire story in only a single text-message. In general, fewer words were used by mobile phone email users, yet they were able to communicate effectively. While the upper-level students' performance improved significantly on the post-test, this was likely due to a change in the post-test format for this group (since the pre-test required written translations, but the post-test consisted of multiple choice questions).

3.b. Evidence summary

In spite of the abundance of publications available on the topic of technology use in FL learning and teaching, the evidence that the technology made a measurable impact upon FL learning or teaching is quite limited. The existing studies span a wide range in terms validity and reliability and many do not include measures of outcome data. In this report, we make a distinction between strong, moderate, and weak evidence for the effectiveness of technology use in FL learning and teaching. Table 2 presents the three levels of evidence and their characteristics.

Table 2: Strength of Evidence

<table>
<thead>
<tr>
<th>Strength of evidence</th>
<th>Description</th>
</tr>
</thead>
</table>
| Strong                | • A number of well-designed experiments, quasi-experiments, correlational studies, or qualitative studies; OR  
                         • A large number of well-designed experiments or quasi-experiments, correlational studies, or qualitative studies with contradictory evidence available. |
| Moderate              | • A single well-designed experiment, quasi-experiment, correlational study, or qualitative study; OR  
                         • A number of well-designed experiments, quasi-experiments, correlational studies, or qualitative studies with contradictory evidence available; OR  
                         • A number of experiments, quasi-experiments, correlational studies, or qualitative studies with design limitations. |
| Weak                  | • A single well-designed study of any kind with contradictory evidence available or with design limitations; OR  
                         • Expert opinions based on theory or own practice but not empirical data; OR  
                         • Studies with flaws in methodology or methodology not discussed in detail. |

In our search for evidence of effectiveness of technology for FL learning and teaching, we uncovered three types of studies: (a) those that compare the use of technology with more traditional non-technological methods or materials; (b) those that compare different variants of one technology; and (c) a very small number of studies that investigate the viability of technology for FL learning. Within the first group (technology vs. non-technology comparisons), we differentiated publications about input, output and interaction, feedback, affect, and metacognition. The only strong evidence for the impact of technology on FL learning and teaching we found was for the ASR programs and chat. Research shows that the ASR technology can facilitate improvement in pronunciation to a larger extent than human teachers can and, because of constant improvements of this technology, ASR programs have great potential in FL learning. More strong evidence came from a number of studies investigating the use of chat in FL learning. These studies proved that with chat, both the amount of learners’ language production and its complexity significantly increased. We also found moderate evidence that technology use changed the process of learning; for example, it caused more frequent dictionary look-ups or faster completion of tasks. However, further investigations determined that increased frequency of look-ups did not make a significant difference in learning outcomes.

A large number of studies confirmed that learners enjoy using technology in FL learning and that they prefer using technology over more traditional methods and materials. Because of technology, learners tend to be more engaged in the process of learning, and have more positive attitude towards learning. We classify this evidence as moderate, by and large because it is often based on qualitative self-reported and observational data, and because we found the theme of affect and motivation spread across several technologies, such as IWB, electronic dictionary, blogs, and virtual worlds. One other study presented moderate evidence that while using chat, learners are more likely to correct their errors than in face-to-face conversation.
Among the studies that compared different variants of technologies, we found some weak evidence that L1 glosses are more efficient than L2 glosses; text plus picture glosses are more efficient for incidental vocabulary learning than text only glosses; and that in voice chat rooms learners are more likely to engage in negotiation of meaning than in text chat rooms.

We uncovered a very small number of studies investigating the viability of certain technologies for FL learning and teaching rather than their impact on learning. We found weak evidence that PDAs can be adapted to FL learning and teaching, and that corpus materials can be used at the beginner and intermediate levels.

Table 3 summarizes the evidence for effectiveness of technology use in FL learning and teaching.

**Table 3: Summary of Evidence**

<table>
<thead>
<tr>
<th>Claim</th>
<th>Study</th>
<th>Technology type</th>
<th>Strength of evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Technology vs. non-technology comparisons</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enhanced input</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technology enables rich input from native speakers that would normally not be covered in class.</td>
<td>Toyoda &amp; Harrison, 2002</td>
<td>Chat</td>
<td>Weak</td>
</tr>
<tr>
<td>Technology enhances learners’ comprehensibility of input.</td>
<td>Leffa, 1993</td>
<td>Electronic dictionary</td>
<td>Weak</td>
</tr>
<tr>
<td><strong>Enhanced output and interaction</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>With technology, learners improve pronunciation more efficiently than with human teachers.</td>
<td>Hardison, 2004; Carey, 2004; Hirata, 2004; Harless et al., 1999</td>
<td>ASR</td>
<td>Strong</td>
</tr>
<tr>
<td>With technology, learners’ language production increases, both in terms of amount and complexity.</td>
<td>Kern, 1995; Ortega, 1997; Chun, 1994</td>
<td>Chat</td>
<td>Strong</td>
</tr>
<tr>
<td>With technology, learners complete tasks faster than without technology.</td>
<td>Aust et al., 2993; Leffa, 1993; Koyama &amp; Takeuchi, 2007</td>
<td>Electronic dictionary</td>
<td>Moderate</td>
</tr>
<tr>
<td></td>
<td>Hong, 1997</td>
<td>Glossed and annotated text</td>
<td>Weak</td>
</tr>
<tr>
<td>With technology, frequency of dictionary look-ups increases.</td>
<td>Aust et al., 1993; Koyama &amp; Takeuchi, 2007</td>
<td>Electronic dictionary</td>
<td>Moderate</td>
</tr>
<tr>
<td>Technology enables enhanced teacher-learner, learner-learner, and learner-content interaction.</td>
<td>Miller, 2005; Glover, 2007</td>
<td>IWB</td>
<td>Weak</td>
</tr>
<tr>
<td>With technology, learners attend more to reading tasks.</td>
<td>Lan et al., 2007</td>
<td>Tablet PC</td>
<td>Weak</td>
</tr>
<tr>
<td>Technology facilitates collaboration.</td>
<td>Lan et al., 2007</td>
<td>Tablet PC</td>
<td>Weak</td>
</tr>
<tr>
<td>With technology, frequency of edits of own writing increases.</td>
<td>Yoon, 2008</td>
<td>Corpus</td>
<td>Weak</td>
</tr>
<tr>
<td>With technology, learners tend to experiment with TL in ways not observed in traditional writing assignments.</td>
<td>Ducate &amp; Lomicka, 2008</td>
<td>Blog</td>
<td>Weak</td>
</tr>
<tr>
<td>Technology enables language gain in reading comprehension.</td>
<td>Chan &amp; Hsu, 2008</td>
<td>PDA</td>
<td>Weak</td>
</tr>
<tr>
<td>With technology, learners can increase their knowledge of TL language and culture</td>
<td>Dierdorff, and Watson 2007</td>
<td>Serious games</td>
<td>Weak</td>
</tr>
<tr>
<td><strong>Enhanced feedback</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>With technology, learners can obtain immediate corrective and targeted feedback.</td>
<td>Schmid, 2007</td>
<td>IWB</td>
<td>Weak</td>
</tr>
<tr>
<td></td>
<td>Dodigovic, 2007</td>
<td>ITS</td>
<td>Weak</td>
</tr>
</tbody>
</table>
### Enhanced affect and motivation

<table>
<thead>
<tr>
<th>Activity</th>
<th>Source(s)</th>
<th>Technology</th>
<th>Effect Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>With technology, learners are more motivated and engaged in the process of learning.</td>
<td>Orr, 2008; Gray, 2005; Tozcu, 2008; Miller, 2005; Glover, 2007</td>
<td>IWB</td>
<td>Moderate</td>
</tr>
<tr>
<td>With technology, learners have a positive attitude toward learning FL.</td>
<td>Aust et al., 1993; Liou, 2000; Laufer and Levitsky-Aviad, 2006; Loucky, 2005; Thorne, et al., 2005; Armstrong, &amp; Retterer, 2008</td>
<td>Electronic dictionary</td>
<td>Moderate</td>
</tr>
<tr>
<td>Learners prefer blogging to traditional journals.</td>
<td>Thorne, et al., 2005; Armstrong, &amp; Retterer, 2008</td>
<td>Blog</td>
<td>Moderate</td>
</tr>
<tr>
<td>With technology, students enjoy the process of learning.</td>
<td>Ducate &amp; Lomicka, 2008</td>
<td>Blog</td>
<td>Weak</td>
</tr>
<tr>
<td>Students enjoy learning with technology</td>
<td>Dickey, 2005; Shih &amp; Yang, 2008</td>
<td>Virtual worlds</td>
<td>Weak</td>
</tr>
<tr>
<td>Technology facilitates confidence in producing in TL.</td>
<td>Ducate &amp; Lomicka, 2008</td>
<td>Blog</td>
<td>Weak</td>
</tr>
<tr>
<td>With technology, students are motivated to spend more time on learning activities.</td>
<td>Sathe &amp; Waltje (2008)</td>
<td>iPod</td>
<td>Weak</td>
</tr>
</tbody>
</table>

### Enhanced metacognition

<table>
<thead>
<tr>
<th>Activity</th>
<th>Source(s)</th>
<th>Technology</th>
<th>Effect Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>With technology, learners are more likely to correct their errors than in face-to-face conversation.</td>
<td>Lai &amp; Zhao, 2006</td>
<td>Chat</td>
<td>Moderate</td>
</tr>
<tr>
<td>(Asynchronous) technology enables more time for reflection, at the same time for processing of input and editing.</td>
<td>Levy &amp; Stockwell, 2006</td>
<td>Bulletin boards/asynchronous chat</td>
<td>Weak</td>
</tr>
</tbody>
</table>

### Comparisons of variants of technologies

<table>
<thead>
<tr>
<th>Activity</th>
<th>Source(s)</th>
<th>Technology</th>
<th>Effect Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1 glosses are more efficient than L2 glosses.</td>
<td>Grace, 2000</td>
<td>Glossed and annotated text</td>
<td>Weak</td>
</tr>
<tr>
<td>Incidental vocabulary learning is more efficient with text+picture glosses than text-only glosses.</td>
<td>Chun &amp; Plass, 1996; Yoshii, 2006</td>
<td>Glossed and annotated text</td>
<td>Weak</td>
</tr>
<tr>
<td>With technology, learners are more likely to engage in negotiation of meaning in voice chat rooms than in text chat rooms.</td>
<td>Jepson, 2005</td>
<td>Chat</td>
<td>Weak</td>
</tr>
</tbody>
</table>

### Viability of technology for FL learning and teaching

<table>
<thead>
<tr>
<th>Activity</th>
<th>Source(s)</th>
<th>Technology</th>
<th>Effect Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Although not originally designed to facilitate learning, certain technologies can be used in FL learning and teaching.</td>
<td>Gilgen, 2005; Samuels, 2005; Paredes et al., 2007</td>
<td>PDA</td>
<td>Weak</td>
</tr>
<tr>
<td></td>
<td>Kennedy &amp; Miceli, 2001; St.John, 2001</td>
<td>Corpus</td>
<td>Weak</td>
</tr>
</tbody>
</table>
4. BEST PRACTICES IN TECHNOLOGY USE FOR FOREIGN LANGUAGE LEARNING AND TEACHING

There are a variety of capabilities represented by the technologies reviewed in this report. Are these capabilities actually useful for supporting learning? It is clear that additional, solid, empirical research is needed before this question can be answered with confidence. However, it is also possible to approach this question theoretically. That is, one may lay-out accepted cognitive-linguistic principles of language learning and learning in general, and attempt to map them onto the functionalities provided by technology. Two fields of inquiry that provide relevant principles of learning are Second Language Acquisition (SLA) and cognitive psychology. In section 4.a, we describe three key SLA principles and four key cognitive psychology principles. In section 4.b, we apply these principles to the potential uses of technology described in section 2.c, weigh the supporting empirical evidence from the reviewed literature (section 3.c), and propose best (and putatively good) practices.

4.a. How do Second Language Acquisition and Cognitive Psychology principles inform best practices for technology use in language learning and teaching?

Principles of Second Language Acquisition

Three main principles of language learning from SLA empirical research contribute best practices for instructed language learning using technology:

- **Provide rich target language input to learners**
- **Engage learners in interactive tasks using the target language**
- **Provide feedback to learners so that they notice and correct their own target language errors**

These principles originate in the Interaction Framework (see section 1): the widely accepted position in SLA that the interrelated processes of input, interaction and output, and feedback are necessary (although may not be sufficient) for psycholinguistic gains; i.e., changes in the learner’s interlanguage toward a target language norm (Gass & Mackey, 2006). Gass (2003) succinctly summarizes the role of these processes: “conversational interaction in a second language forms the basis for the development of language rather than being only a forum for practice of specific language features” (p. 234). Although interaction integrates target language comprehension and production, we acknowledge that practice focused solely at comprehending target language input may have specific goals (with regard to listening skills, goals such as finding word or intonation boundaries, identifying changes in topic or speakers, etc). The relationship between target language comprehension and production may not yet be totally clear; however, inadequate target language knowledge inarguably limits, or “short circuits,” target language comprehension (Vandergrift, 2006).

The general interactionist framework has been robustly supported by over 25 years of research, shedding light on the “black box” of processes that spur second language development (Ellis, 1994; Gass, 2003; Long, 1980; Seedhouse, 2004). However, these principles can be implemented in better or worse ways for acquisition, as Chapelle (1998) p. 23) notes: just as input “…can be either uncomprehended noise or valuable for acquisition, output can be produced mindlessly or it can be created by the learner under conditions that facilitate acquisition.”

The first SLA-based principle is to **provide learners with rich target language input**. This principle is embodied in Chapelle’s (1998) first two guidelines for the development of useful CALL programs (p. 23-24):

- Linguistic characteristics of the target language input need to be made salient through some type of enhancement, in order for the learner to notice unknown forms;
• Learners need help comprehending semantic and syntactic aspects of linguistic input through some type of modification, such as simplification or elaboration.

Doughty and Long (2003) propose complementary methodological guidelines concerning target language input (p. 3):

• Provide rich input from a range of sources;
• The input must be accessible at the learner’s level of TL development.

On the topic of input modification, Doughty and Long emphasize that authentic input should be elaborated, rather than simplified, as simplification removes potentially important cues to novel forms and makes the input less useful for acquisition.

The second, related SLA principle is to engage learners in interactive tasks using the target language. Chapelle’s guidelines state that:

• Learners need to produce comprehensible target language output, not just responses in their native language, in order to “stretch their linguistic resources”;
• Tasks should maximize interaction that modifies target language structures through negotiation of meaning.

Doughty and Long (2003) similarly assert that interactive tasks draw learners’ attention to important linguistic features through negotiation and elaboration, again reinforcing the importance of noticing for learners to incorporate target forms.

The third, and once again, related SLA principle is to provide feedback to learners so that they notice and correct their own target language errors (Chapelle, 1998 p. 23-24). Feedback on error (i.e., negative feedback) draws learners’ attention to differences between their own existing interlanguage representations and native norms. Several types of negative feedback exist, ranging from explicit (on-the-record corrections) to implicit suggestions that the learner output contains non-native-like forms (Gass & Mackey, 2006; Long, 1983). Implicit negative feedback enables learners to notice the errors, and may either prompt the learner to correct their output or provide the necessary input for the learner to correct their output, by recasting the learner’s utterance with the correct form. Some controversy remains in the SLA field concerning the effectiveness of negative feedback (Long 2007, p. 75). Nonetheless, interaction in which negative feedback is absent, or in which interlocutors explicitly point out and correct the learner error, generally limits opportunities for target language development by depriving the learner of the opportunity either to notice errors or to produce the correct form. In a review of the recent SLA literature on negative feedback, Long (2007, pp. 77-78) concludes that recasts best facilitate learners’ acquisition, while providing additional input. Psycholinguistic factors also play a role in the efficacy of negative feedback. As Doughty and Long (2003) point out, feedback, similarly to input and interaction, needs to take into account the learner’s developmental readiness to make use of the feedback (p. 65-66).

Cognitive Principles of learning

What principles of learning are supported by solid, empirical work in the area of cognitive psychology? Which of these general principles might be particularly important for adult foreign language learning and might enhance the use of the technologies discussed in this report?

As a starting point towards addressing these questions, the research team summarized and condensed important principles of learning derived from empirical research. Three principles, which the team judged to be particularly relevant

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39 For example, by “providing learners with more detailed semantic information…”, such as replacing a pronoun with a full noun phrase (Gass & Mackey, 2006, p. 6).
40 Negotiation of meaning is the process of communication during which the interlocutors make “adjustments to linguistic form, conversational structure, message content, or all three, until an acceptable level of understanding is achieved” (Long, 1996, p. 418; cited in Gass & Mackey, 2006, p. 4).
41 Feedback “… is generally considered to be a form of negative evidence, or information that a particular utterance is deviant vis-à-vis target language norms.” (Gass & Mackey, p. 7)
42 As defined by Gass and Mackey (2006), a recast is “some modification of the original erroneous utterance without a concomitant change in meaning” (p. 8).
to foreign language learning, were selected from those presented in two recent key projects concerning the science of learning, 43 and one additional principle was selected from the larger literature.

Before discussing the four selected principles and the ways in which they might be enhanced by technology, a caveat is in order. These principles were derived from experiments primarily with students learning information in their native language, and have been only partially explored in SLA research. Nonetheless, we hypothesize that these are universal cognitive principles that apply to all aspects of learning, including adult foreign language learning, and that the principles can enhance the effectiveness of technology use for language learning and teaching.

Testing/retrieval effect

The testing/retrieval effect refers to the finding that frequent testing promotes learning. When tests are given frequently, students are encouraged to maintain a study schedule, teachers (and students) receive important feedback on students’ progress, and students are less likely to forget material (Halpern, 2008). Whereas the first two benefits of frequent testing may be self-evident, the relationship between memory for information and testing may be less clear. In fact, research shows that “the single most important variable in promoting long-term retention and transfer is practice at retrieval” (Halpern & Hakel, 2003). Recent research using memory for pairs of English-foreign language words supports this finding. Karpicke and Roediger (Karpicke & Roediger, 2008) found the attempt to retrieve learned information through testing, rather than passive study, is the critical variable in memory for that information after a delay (see also (Karpicke & Roediger, 2007)). It is important to note that such tests should be those that provide the learner with minimal cues and require the learner to generate the answer (e.g., tests of recall, not of recognition) (Halpern, 2008). This principle is supported by technologies such as flashcards (electronic or analog) because a student is required to attempt recall of a word’s meaning, and then receives immediate feedback on his or her accuracy, or is prompted with additional cues to try again.

Spaced practice effect

Spaced practice, also known as distributed practice, refers to the finding that students show higher learning performance and greater long-term retention for material when practice is distributed across several smaller sessions, rather than completed in a large block (Cepeda, Pashler, Vul, Wixted, & Rohrer, 2006; Donovan & Radvosevich, 1999). The advantages of spaced practice have been demonstrated for a variety of learning tasks, ranging from retention of foreign language vocabulary (H. P. Bahrick, Bahrick, Bahrick, & Bahrick, 1993; H.P. Bahrick & Phelps, 1987) to acquisition of perceptual-motor skills and the learning and memory of declarative knowledge (Donovan & Radvosevich, 1999) and over a large range of time scales (e.g., retention intervals ranging from seconds to nine years) (Bahrick et al., 1993; Cepeda et al., 2006). The advantage of spaced practice may arise because it naturally provides variable contexts for learning (see next section). This principle might be implemented, for example, through the use of mobile technologies to encourage practice of material at intervals throughout the day.

Variable contexts effect

The variable contexts effect refers to the finding that information is learned more thoroughly, and transferred more usefully to new situations when learning takes place in a variety of different contexts. These contexts can differ in physical location, mode of presentation, type of media or type of learning activity (J. R. Anderson, 1990; Halpern, 2008; Halpern & Hakel, 2003). The more variable the conditions of initial learning are, the more memory traces are available for later recall (Halpern & Hakel, 2003). Also, because learners need to be able to transfer their learning to a variety of different real-world contexts, training should not be limited to only a few, standard contexts (Druckman & Bjork, 1994). Technology can support this principle by providing a variety of media for presentation of class materials, and by providing different learning contexts through the use of mobile devices or virtual worlds.

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43 The first, a list of 25 Learning Principles to Guide Pedagogy and the Design of Learning Environments, was developed by the Life Long Learning at Work and at Home taskforce of the American Psychological Society (Halpern, 2008) The second document, Applying the Science of Learning to the University and Beyond (Halpern & Hakel, 2003), understandably, shares significant overlap with the first. Both of these source documents were generated from projects designed to bring together groups of established research scientists active in the areas of psychology and learning. In some cases we merged two or more principles into one overarching principle.
Desirable difficulties effect

The desirable difficulties effect refers to the finding that some activities that make learning initially more difficult actually can lead to better long-term retention of information (Halpern, 2008; Healy, et al., 2002; Schmidt & Bjork, 1992). Such difficulties may be in the way the information is presented, such as learning vocabulary words from a number of different semantic categories, rather than grouped into categories such as “food” or “clothes”. (Schneider, Healy, & Bourne, 1998). Alternatively, difficulty may result from the learner having to search out and organize information, rather than simply passively “receiving” information organized by the teacher (Halpern, 2008). Such difficulties may enhance retention because they require the student to process the studied information more deeply, better encode meaning into existing semantic networks, and create stronger representations in long-term memory. Technology can support this principle by modifying input to make it more challenging; for example, by overlaying noise onto listening clips, omitting key information that the learner must supply, or otherwise distorting texts.

The intersection of SLA and Cognitive Psychology principles

The SLA and cognitive psychology principles discussed above intersect in several ways that may increase the effectiveness of language learning and teaching generally. The following lists are examples of how the principles overlap and mutually support each other. We believe that these integrated principles create powerful recommendations for the use of technology for language learning and teaching, although most of them await rigorous exploration and investigation, as we discuss in the next section.

Input

- Practice at retrieval: Especially in receptive modes, learners should be actively engaged in connecting, comparing or contrasting meaning of new input with already acquired forms; learners should practice retrieving the new target forms frequently and with minimal retrieval cues. Elaborated cues should be provided only after initial attempts at retrieval have failed.

- Spaced practice: The input, and practice at retrieval, of target forms should be temporally distributed, with increasing intervals.

- Variable contexts: The input of target forms should be varied by linguistic context (spoken or written mode, single or multi-media; genre, topic, discourse type, planned/unplanned discourse, number of speakers, complete/incomplete/defective texts, authentic/elaborated texts) and extra-linguistic contexts (situation, time of day, location, physiological/emotional state, physical activity).

- Desirable difficulties: Activities that aid task performance during training (for example, repeated word look-up to assist target form comprehension or production) may degrade acquisition, long-term retention and transfer to real-world contexts.

Interaction/output:

- Practice at retrieval: Strengthen learners’ TL acquisition through repeated practice at retrieval by engaging in meaningful tasks that require TL output, and especially, negotiation of meaning, (that is, not multiple choice activities).

- Spaced practice: Distribute the practice that requires interaction and output of target forms.

- Variable contexts: Vary the linguistic and extra-linguistic factors under which learners engage in interaction and produce target forms.

- Desirable difficulties: Introduce task difficulty factors that may degrade performance in the short term (e.g., listening in noise, using the target language when fatigued or in emotionally charged situations) but enhance long-term retention.
Feedback on learner error:

- Practice at retrieval: Provide negative feedback on failed retrieval efforts and require the learner to produce the correct target form; teach learners to recognize implicit feedback and to notice differences between their output and the target, and encourage them to self-correct.

- Spaced practice: Test at spaced intervals to assess and facilitate long-term retention (good testing involves practice at retrieval with minimal cues).

- Variable contexts: Vary the provision of feedback on error by feedback type; the feedback could be explicit or implicit (clarification requests, prompts, or recasts); graduated feedback intervals may be more effective than constant feedback.

- Desirable difficulties: The use of implicit negative feedback, compared to explicit negative feedback, creates a desirable difficulty effect by requiring the learner to incorporate (in the case of recasts) or produce (in the case of prompts) the correct target form.

4.b. Best practices in the use of technology for language learning and teaching, as supported by empirical research and theoretically grounded principles

In this section we propose several best practices, and some prospective good practices, in the use of technology for language learning and teaching. By “best practices,” we mean those uses of technology:

- whose effectiveness (in terms of benefiting learning processes has strong or moderate empirical support, as summarized in section 3;
- and which are supported by cognitive-psycholinguistic principles of learning.

Two proposed best practices have strong empirical support, and also exemplify key principles of learning:

1. **Use technology, such as written chat, to maximize target language practice outside of the classroom.**

   Learners using computer-mediated communication (CMC) increased their target language production, both in terms of amount and complexity; they were also more likely to correct their target language errors than in face-to-face conversation. This use of CMC highlights the importance of target language interaction and output, and the importance for learners of noticing and correcting errors in their target language output. Additionally, cognitive learning principles may strengthen this use of technology; for example, by emphasizing and prompting practice at retrieval and varying the contexts for language production in diverse ways (communication goals; interlocutor; time of day; etc).

2. **Use technology, such as computer-assisted pronunciation training, outside of the classroom to maximize the efficiency of classroom contact time with the teacher.**

   Learners using automatic speech recognition (ASR) and computer-assisted pronunciation training (CAPT) technologies improved their target language pronunciation more efficiently than learners working with human teachers. These technology uses help teachers to maximize the efficiency of classroom teacher-learner interaction by assigning effective self-administered work to students during out-of-class hours. They also highlight the importance of learner target language output with specific feedback (although, in this example, non-human feedback). However, this use of technology may be further strengthened by the application of cognitive learning principles, such as spaced practice and introducing desirable difficulties.

Next, we propose several of the uses of technology discussed in this report (and some combinations of technologies that we did not discuss) as potential best practices incorporating one or more SLA or cognitive psychology principles of

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44 To the best of our knowledge, no rigorous empirical study has demonstrated definitively the effectiveness of technology use on language learning outcomes, either in terms of immediate post-training proficiency, or in terms of long-term retention and transfer to novel, real-world contexts.

45 None of the reviewed research studies, however, attempted to validate these principles empirically.
learning. However, these potential best practices lack empirical support, and as yet are only hypothetically possible uses that will require:

- Extensive collaboration among disciplines with currently insufficient linkages (for example, SLA and natural language processing); and
- Rigorous and systematic investigation of their effectiveness for long-term retention of learning and transfer to real-world contexts.

3. Use technology, such as course management systems, natural language processing tools and mobile devices, to enable customization, shareability, reusability, and anytime/anywhere access to target language content and instructional materials.

The essential characteristic of course management systems is their capability to archive, organize, and repurpose content. Effective target language content and instructional materials should be shared and reused to the greatest extent possible in order to maximize teachers’ efforts where they most count: in interaction with learners. Additionally, target language content could be meta-tagged by natural language processing tools and stored in course management systems in ways that emphasize retrievability and reusability.

Mobile and portable technologies in particular enable access to target language input, and possibly interaction, in different physical contexts using a variety of media. These devices, used in conjunction with course management systems, have the capability to encourage the spaced practice of material as a natural result of their functional use for short periods of study, distributed across the student’s day.

4. Use technology, such as intelligent tutoring systems, ePortfolios, and natural language processing tools, to archive and analyze interaction, learner output, and incorporation of feedback, and to individualize subsequent input and feedback.

An as-yet unexplored synergy of technological capabilities for language learning and teaching is the combined use of course management systems, ePortfolios, and intelligent tutor systems to archive computer-mediated communication into corpora that can be analyzed using natural language processing tools. The results may be used to monitor learner progress, assess the efficacy of instructional activities and materials, and to individualize subsequent input, tasks, and feedback. The effectiveness of this potential practice may be maximized by optimally spacing practice and feedback, varying the linguistic and extra-linguistic task contexts, and introducing desirable difficulties that entail practice at retrieval. Additionally, learners’ creation of ePortfolios and exploration of corpora to gather information about the target language lexicon are both challenging tasks. The desirable difficulties of these tasks encourage learners to create organizational schemas and explicitly process the complex links among elements of the target language.

An additional capability of natural language processing requiring investigation is meta-tagging of target language content for the purposes of instructional manipulation and individualization. That is, content could be meta-tagged by natural language processing tools and delivered by intelligent tutor systems incorporating the cognitive principles of spaced practice, variable contexts, and desirable difficulties. This content could be manipulated in order to elaborate input or make target forms more salient to learners, based on their current level of target language development. As an example of technology use incorporating practice at retrieval and desirable difficulties, annotated or glossed texts could be modified so that the reader must generate a hypothesis about a word’s meaning before receiving the glossed meaning as feedback.

5. Use technology, such as ad hoc networks and serious games, to motivate students and engage them in meaningful target language use.

Although this review focuses mainly on cognitive and psycholinguistic factors in language learning, the summary of evidence in section 3 indicated that some uses of technology (interactive whiteboard, electronic dictionaries) may be positively correlated with improved learner motivation, affect, and attitude toward learning the target language. In SLA research, motivation is commonly accepted as a key moderating factor in the language learning process (Crookes & Schmidt, 1991; Ellis, 1994; Gardner & Lambert, 1972), by increasing a learner’s interest in accessing rich sources of input,
willingness to engage in meaningful interactions, and other goal-oriented behaviors. Although motivation (whether instrumental or integrative) has not been demonstrated to be either a necessary or sufficient factor for language gain, as a moderating factor it still plays a very useful role.

The summary of evidence in section 3 indicated that, under certain circumstances, technology use (for example, interactive whiteboards (IWB) and electronic learning aids) may increase learner motivation and improve their attitude toward learning the foreign language. We hypothesize that those circumstances are those that provide rich input, promote meaningful interaction and output, and induce learners to notice and correct their target language errors. Certain classroom practices, such as networking the IWB with learners’ PCs, may engage learners in active learning and promote interaction between the teacher and students, and among students. The application of cognitive principles may further strengthen the effectiveness of these technologies for learning; for example, applying the desirable difficulty principle and making electronic dictionaries unavailable at certain times or only after the learner first generates a hypothesis on meaning.

Virtual worlds and serious games share the characteristic of intelligent tutor systems of being customizable to learners’ current developmental level and learning needs. Additionally, they share the characteristic of computer-mediated communication of generating digital target language output that can be archived and analyzed. But more importantly, virtual worlds and serious games offer the capability for learners to interact freely, whether synchronously or asynchronously; to negotiate meaning with other individuals (who may be real persons or virtual agents); and to receive input that may bear real-world implications (such as appropriateness of a given word, intonation, or cultural strategy).

In addition to these five proposed best practices, a number of the technology uses reviewed in this technical report offer exciting possibilities for accessing diverse and rich input, engaging in meaningful interaction and negotiation of meaning, and receiving feedback that leads learners to correct target language errors. The Web 2.0 applications of blogs, wikis, and social networking offer these possibilities, as well as the potentially motivating capability of collaboration with other learners. However, these uses have not yet been rigorously investigated for their contribution to effective language learning and teaching, and so at this time we must consider them to be only prospective good practices.

4.c. Conclusions

Our review of literature revealed that while the use of technology to enhance FL learning and teaching has been rapidly growing in the past three decades, not much empirical support is available to form definitive conclusions regarding its effectiveness in this field. Our review also indicated that the domain of CALL has not been systematically investigated, and that some potential uses of technology for learning have not been explored at all. The available publications represent a rather diverse spectrum of expert and practitioner opinions, qualitative research and case studies based on self-reported data, and a fairly small number of well-designed empirical studies. Clearly, empirically-derived evidence is required to quantify, characterize, and document the impact technology can make on adult FL learning. In this review, we identified key principles for learning based on insights from cognitive psychology and SLA. From cognitive psychology, we identified four widely accepted principles – practice at retrieval, spaced practice, variable contexts, and desirable difficulties. From the field of SLA, we chose to focus on, again, a widely accepted interactionist position that the processes of input, interaction and output, and feedback are necessary for language acquisition. We also identified a number of recommendations for enhancing FL learning and teaching that correspond with these principles. While we believe these principles are soundly grounded in empirical cognitive psychology research, their implementation in CALL remains to be investigated.

Furthermore, we believe that where technology is used to enhance learning, pedagogical goals, not technological means, should come first (L. Gray, 2008). Using technology in delivering a lesson or instructional unit will not make bad pedagogy good. Nor is the converse true – that a lack of technological tools or applications necessarily prevents effective teaching. Higgins et al. (2007) concisely summarizes this viewpoint: “Good teaching remains good teaching with or without the technology.” (p. 215). Instruction for effective language learning must be developed based on sound principles of learning, independent of the superficial glamour of the latest technological wizardry; technology should be used to enhance the delivery of instruction, not to determine its fundamental design.

A related caveat is that technology users need appropriate training. We cannot assume that users, even young ones, will use technology to its fullest potential. What may be overlooked is that young users may lack adequate skills in using technology to support learning, despite the fact their generation has grown up with technology. The same caveat applies equally, or even more so, to more mature users, even those with extensive pedagogical experience. The availability of a

46 Masgoret and Gardner’s (2003) meta-analysis of 55 independent samples from language learning motivation studies involving over 8,000 individuals found a moderate correlation between motivation and objective measures of second language achievement (95% confidence interval: .25-.32; p. 187).
multitude of computer-based or web-based tools and programs does not improve learning or teaching unless users receive appropriate training on how to incorporate and exploit technological tools to facilitate the attainment of learning goals. Users need to be trained in how to harness the advantages of technology for specific objectives, and to not expect technology to be a panacea or substitute for solid principles of learning.
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Kukulska-Hulme, A., & Shield, L. (2008). An overview of mobile assisted language learning: From content delivery to supported collaboration and interaction. ReCALL, 20, 271-298.


Livingston, A. (2004). Web-enabled mobile devices help users become more effective, providing a variety of tools for different purposes. EDUCAUSE Quarterly, 47-52.


APPENDIX A: METHODOLOGY

Literature search process and strategies

For this review, the task of searching the literature was divided among the six authors. Each author was assigned a number of technologies to review with the goal of locating evidence to bear on each of the five research questions with respect to that technology. Priority was given to research question 3; that is, the review was focused on finding evidence for each technology type’s effectiveness when used for language learning or instruction.

Each author then searched the major electronic databases available through the University of Maryland Research Port using a set of relevant key words. Resources located in this manner were categorized in terms of a) which research questions (if any) they pertained to, and b) the strength of the evidence presented (see section 3.b. for a summary of criteria for evidence).

The process of this literature review, which included early preparations and planning, locating the relevant literature, reading, and report writing, took three months to complete. Weekly meetings were held to discuss the process of searching and categorizing resources. Ultimately over 200 publications, including books, journal articles, and websites, were reviewed.

List of databases employed

<table>
<thead>
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<tbody>
<tr>
<td>CogNet</td>
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</tr>
<tr>
<td><strong>Education Resources Information Center (ERIC)</strong></td>
<td>education and related fields</td>
</tr>
<tr>
<td>Google Scholar</td>
<td>academic publishers, repositories, professional societies in various disciplines</td>
</tr>
<tr>
<td>JSTOR</td>
<td>humanities, social sciences, sciences</td>
</tr>
<tr>
<td>Linguistics and Language Behavior Abstracts (LLBA)</td>
<td>linguistics and related fields</td>
</tr>
<tr>
<td>MLA International Bibliography Database</td>
<td>language, linguistics, literature and related fields</td>
</tr>
<tr>
<td>PsycINFO</td>
<td>psychology and related fields</td>
</tr>
<tr>
<td>Web of Science</td>
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<td>WorldCat</td>
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<td>Arabic handwriting recognition</td>
<td>foreign language</td>
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<tr>
<td>asynchronous CMC</td>
<td>foreign language learning</td>
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<td>automatic speech recognition</td>
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<td>empirical evaluation</td>
<td>ITS</td>
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<td>electronic annotations</td>
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<td>electronic dictionary</td>
<td>language learning</td>
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<td>electronic glosses</td>
<td>learning object</td>
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<td>electronic flashcard</td>
<td>MMPORG</td>
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<td>electronic portfolio</td>
<td>mobile phone</td>
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<td>ePortfolio</td>
<td>mp3</td>
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<td>Farsi handwriting recognition</td>
<td>nonroman scripts</td>
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<td>flashcard program</td>
<td>online handwriting recognition</td>
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<td>PDA</td>
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<td>synchronous CMC</td>
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<td>virtual world</td>
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<td>wikis</td>
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APPENDIX B: INVENTORY OF TECHNOLOGY ISSUED TO DLIFLC STUDENTS IN THE MULTI-LANGUAGE SCHOOL\textsuperscript{47}

## HARDWARE

### CLASSROOM-BASED TECHNOLOGY

The SMART Board and desktop computer can be used as platforms for running a variety of software applications that facilitate language learning by providing access to rich input, practice opportunities, and a medium for collaboration. With Internet connectivity this hardware can provide students and instructors with a multitude of opportunities for language learning.

| SMART Board | The SMART Board, or Interactive White Board (IWB), comprises three pieces of equipment: a computer, a projector, and a display panel, which is a large free-standing or wall-mounted touch-sensitive screen. The projector displays the image of the computer screen on the large touch-sensitive screen, which is easily viewable to all the students in the classroom. SMART Boards help with content and course organization; enable access to rich, authentic input; promote interactive activities; engage students and teachers in collaborative work; and draw students’ attention to the course material. |
| Desktop Computer | Desktop computers are stationary machines, operated by using a mouse and keyboard that is connected to the PC and is displayed on the monitor. Computers run a variety of programs that allow students and faculty to write reports/assignments, exchange email, search the internet and can also host a number of software programs to aid in language learning. |

\textsuperscript{47} Data provided by Lt Col Jorge Serafin, Chief Information Officer, DLIFLC, on November 25, 2008.
MOBILE / PORTABLE TECHNOLOGY

The Tablet PC and iPod are devices that learners and instructors can use from home or the classroom; and, in the case of iPod – anywhere, for example, on a bus, in a gym, while walking, exercising, or doing chores around the house. The mobile/portable features of this hardware coupled with Internet connectivity can provide the students with access to target language and course content anytime and anywhere.

<table>
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<tr>
<th>Tablet PC</th>
<th>A tablet PC is a portable computer, with all of the features of other notebook PCs, but using a digital stylus or touch technology for inputting text and interfacing with programs. Tablets typically use a tablet-optimized Windows XP or Vista operating system, with the rare exception of MacBooks that have been converted to tablets by specialists. Tablet PCs have three forms: a slate, with no integrated keyboard; a convertible, similar to a notebook but with the capability to rotate and fold the screen down to slate position; and hybrid, similar to a notebook but with a detachable keyboard. Tablet PCs enable “Google-like searchability” of handwritten notes; make notes and materials available at all times; synchronize note-taking with lectures (using OneNote); reorganize notes; capture diagrams and illustrations with digital ink; and recognize handwriting and convert to text.</th>
</tr>
</thead>
<tbody>
<tr>
<td>iPod</td>
<td>An iPod is a portable media player produced by Apple, Inc. While Apple markets iPods primarily as digital music players, these devices can also serve as external data storage devices with a wide range of memory capacities. iPods can be used to play downloaded television shows and movies and have a small screen for viewing this media. iPods enable rich input though podcasts, which can include language lessons prepared by the teacher, as well as broadcasts of authentic speech; enable students to download and review classroom materials, such as videos of lectures, for review at home; and also allow students to record speech samples or homework activities and upload these for teacher or peer review.</td>
</tr>
</tbody>
</table>
SOFTWARE

SOFTWARE FOR WEB BROWSING

The growth of Internet connectivity in the 1990s vastly widened opportunities for foreign language learners and teachers to access target language content. Internet Explorer (IE) is the most commonly used web browser for computers with open-source, world-wide access.

| Internet Explorer | Internet Explorer is used to obtain information through a large network of browsers developed by Microsoft. This application allows students and faculty to search for an endless amount of topics and to access a multitude of applications relevant for language learning including: cultural information sites, language translations, chat platforms, bulletin boards, blogs, wikis, and web-based email services. |

AUDIO AND VIDEO PLAYERS

Software within this category is generally provided for free, although content may need to be purchased. These software systems allow a user to play audio or video files on personal computing devices. The usefulness of these software packages for language learning depends largely on the content of the audio or video files that are accessed. Functionalities range from downloadable quizzes to listening to audio files or watching movies in the target language to creating original audio and video in the target language.

| iTunes | Apple’s iTunes system is a method for distributing audio and video files to user’s personal computers or compatible mobile devices such as the iPod. Students can download commercially available songs, audiobooks, television shows, movies and video games. They can also subscribe to podcasts, listen to radio broadcasts, and rent movies. Any of these functionalities could be useful for foreign language learning, depending on the specific content included. In addition, teachers can create their own, customized podcasts or quizzes that students can then download. |

| RealPlayer | RealPlayer is a free software package that allows a user to play video or audio files on his or her personal computer. Students can download and watch movies or television shows, or watch streaming video files. They can also download and listen to songs or other audio files, and access radio programs or other streaming audio. Finally, they can also save files to CD or DVD. RealPlayer Plus allows students to record audio/voice input. |

<p>| Windows Media Player | Windows Media Player is a free software package that allows a user to play video or audio files on his or her PC. Students can play movies, television shows or songs related to the target language on their personal computer or sync them to a mobile device. They can also display still pictures. |</p>
<table>
<thead>
<tr>
<th>Software</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>QuickTime</strong></td>
<td>QuickTime is a software platform that works with both Mac and PC computers. It allows the user to play or display files encoded in a variety of formats and also allows the user to create multimedia files for distribution to others. Students can play movies, television shows or songs on their personal computer and display still pictures. Teachers or students can create customized multimedia files in the target language to share with others.</td>
</tr>
<tr>
<td><strong>Windows Movie Maker</strong></td>
<td>Windows Movie Maker is a software package that allows the user to create and edit movies from digital video files. Movies can also be burned to DVD. Students can create their own target language movies. Teachers can create and edit movies for distribution to students.</td>
</tr>
<tr>
<td><strong>InterVideo DVD</strong></td>
<td>InterVideo DVD has been replaced by WinDVD. The software allows users to watch DVDs on their computers. Students can watch target language movies using this software.</td>
</tr>
<tr>
<td><strong>DivX</strong></td>
<td>DivX is a software package that allows the user to play videos on the computer, embed videos into websites, convert existing videos to a compatible format, and compress video files. Students can watch videos in the target language. Teachers can convert videos and put them on websites for students to access.</td>
</tr>
</tbody>
</table>
PRESENTATION AND PUBLISHING SOFTWARE

Microsoft PowerPoint and Publisher can be very useful for in-class teacher presentation of material and for showcasing student work. In the language learning environment, both tools have potential to engage students, enhance collaboration, and student-student, student-teacher, and student-content interaction.

**Microsoft PowerPoint**

Microsoft PowerPoint is a presentation application with animation and multimedia abilities. It allows users to create and edit presentations for slide shows. Slides may contain text, tables, graphics, pictures, movies, and animations. PowerPoint has become very popular among teachers at all levels of education, because they can store, organize, modify, and present learning material during the class directly from their computer. Ultimately, in the classroom environment, PowerPoint has nearly entirely replaced the less versatile overhead projector. Students can also work individually or in groups to create their own presentations and show them in class.

**Microsoft Publisher**

Microsoft Publisher allows users to create, edit, and share documents such as brochures, flyers, newsletters, and greeting cards. Users can choose from multiple available templates or design their own materials using blank documents. Similarly as with PowerPoint, this tool can be used for individual assignments as well as group projects.

DATA MANAGEMENT SOFTWARE

Both Microsoft Access and Excel allow users to store and manage data. In a learning situation, they can be used to archive and organize content and Microsoft Excel in particular can assist language learners and teachers in creating graphs and tables for their presentations.

**Microsoft Access**

Microsoft Access is a database management system that allows users to create databases and store, track, sort, and manage large amount of data. While very useful for researchers and administrators, its features might not be very practical for language learners.

**Microsoft Excel**

Microsoft Excel is a spreadsheet application designed to create and format spreadsheets, analyze information, perform calculations, and visualize data. For language learners and teachers, the rich data visualization feature can be very useful to create a variety of graphs and tables that could be used in presentations.
**DOCUMENT MANAGEMENT SOFTWARE**

This category of software enables instructors and learners to create and view documents allows for creation of text in the target language or reading of materials in the target language. Electronic documents are easily shared with other users and feedback can be provided more efficiently than with printed materials. These applications allow users to easily revise text, organize information and share documents with other users in a common format. Microsoft Keyboard Layout complements editing software by enabling users to type in non-roman writing systems.

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<tr>
<th>Software</th>
<th>Description</th>
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<tr>
<td><strong>Microsoft Word</strong></td>
<td>Microsoft Word is the most widely used document authoring and word processing software that enables users to create, edit, and share documents. Together with language-specific software, such as Microsoft Office Language Settings, it has endless applications for foreign language learning and teaching (from note taking to professional-looking reports).</td>
</tr>
<tr>
<td><strong>Adobe Reader 8</strong></td>
<td>Adobe Acrobat is a family of computer programs developed by Adobe Systems to view, create, manipulate and manage files in Adobe’s Portable Document Format (PDF). Adobe Reader is available as a no-charge download from Adobe’s website, and only allows for viewing and printing PDF files. Reader is generally used as a way to present information in print with a fixed layout, similar to paper publication. Adobe Reader can also provide written input in the same way that printed materials can, with the notable advantage that electronic PDFs are more shareable and reusable. Adobe has features dedicated specifically to accommodating non-roman languages, supporting the text encoding for scripts like Sanskrit and Hindi, and right-to-left formatting for Arabic, Farsi and Hebrew.</td>
</tr>
<tr>
<td><strong>Bluebeam PDF Revu</strong></td>
<td>Bluebeam PDF Revu is an alternative to Adobe Acrobat. It allows the user to create, edit and share PDF files in the same way as Acrobat, but includes added functionalities to increase ease of use. For instance, there is a tool chest for saving frequently used tools, and document-comparing function that summarizes changes made between different versions of a PDF.</td>
</tr>
<tr>
<td><strong>Microsoft Keyboard Layout</strong></td>
<td>The Microsoft Keyboard Layout Creator (MSKLC) allows users to customize their keyboard’s layout from scratch, or base a new layout on an existing one. Users can also package the resulting keyboard layouts for subsequent delivery and installation. MSKLC could be very beneficial for language learners who need to type in non-roman alphabets, enabling them to adjust the keyboard for the target language, (e.g., making special characters and diacritics more accessible).</td>
</tr>
</tbody>
</table>
INFORMATION MANAGEMENT AND COLLABORATION SOFTWARE

Microsoft OneNote, Journal, and Sticky Notes can be very useful software for learning in general and language learning in particular, by providing the students with means to organize ideas, notes, set reminders for themselves, and by creating opportunities for the students to collaborate on projects.

Microsoft OneNote

OneNote is a digital notebook that allows users to gather, organize, find, and share their notes. Sometimes referred to as an “idea processor”, the software can help to capture ideas and thoughts during brainstorming sessions as well as taking and organizing own notes. With a possibility of other users to have access to the same notebook and edit at the same time, it creates an extremely useful tool for collaboration, cooperation, and interaction.

Microsoft Windows Journal

Microsoft Windows Journal is a note-taking application, created by Microsoft and included in certain editions of Windows XP and Windows Vista. It allows the user to create and organize handwritten notes and drawings. The user can compose handwritten notes with the use of a mouse; however, the use of a graphics tablet or Tablet PC is recommended. The program is designed to imitate a paper notebook, while being more flexible, that is, users can change writing tools, move items on the page, insert additional space, insert calendar information, and share notes electronically with other users.

Microsoft Sticky Notes

Microsoft Sticky Notes allows users to create, organize and manage short handwritten or voice notes on their desktop. The application to language learning is not obvious, but learners could use notes to remind themselves about, for instance, vocabulary.

COMMUNICATION, TIME- AND PERSONAL INFORMATION MANAGEMENT SOFTWARE

This group of software can assist learners of any discipline in setting goals, checking their progress towards achieving these goals, day-to-day time management, planning, and keeping track of activities. For language learners in particular, the possibility to communicate in the target language with other learners and native speakers of the target language can be extremely valuable.

Microsoft Outlook

The most commonly used feature of Microsoft Outlook is an e-mail application that allows users to send, receive, store electronic correspondence. Microsoft Outlook also allows users to manage schedule, contacts, and tasks through its calendar compatibility, ability to create to-do-lists, journal entries, and to subscribe to RSS Feeds. Outlook can be applicable for foreign language learning as means for communicating with teachers, other learners, and native speakers of the target language. Time- and personal information management features of Outlook can enhance learning in general.
**Microsoft Project**

Microsoft Project is a project management tool that allows users to set schedules, control project work and finances, and communicate with team members. While it has potential to be used as a tool to assist students working on team projects, this tool could be especially useful at times when schedule is tight and when work control is needed. For collaboration and idea sharing, the OneNote software seems to be much more promising.

**SOFTWARE TO FACILITATE LANGUAGE LEARNING**

The Transparent Language family of software applications allows learners to enhance classroom based language instruction with self-paced learning. These programs provide the means to review written and spoken vocabulary words and phrases through customizable lists. These applications are compatible with each other and can be used together to meet the individual needs of the learner. Additionally, the lists can be downloaded to portable media devices for on-the-go language practice.

**Rapid Rote 3.7**

Rapid Rote is a flash card presentation program aimed at assisting learners to gain “perfect recall” of the target vocabulary in the “shortest possible time.” Available alone or in conjunction with CL-150’s LanguagePro platforms, Rapid Rote’s content is completely customizable; learners can click on words in LanguagePro to create word lists, select word lists saved by other learners and instructors and archived on the CL-150 download center, or create their own word lists. Learners are able to customize their flash cards, with photos, graphics, audio, transliterations and notes. They can also adjust color and font to make specific words/items more salient. The word lists can be exported to iPods or PDAs for independent practice.

**LanguageProTalker**

LanguageProTalker is included as part of the CL-150 suite of software applications used by the United States Government to support language learning. A list of mission-specific terms and phrases is included in the software, but learners can also create lists of utterances relevant for their job or language course. The utterances are translated into the target language and displayed visually while an audio pronunciation is played for the learner. The instructor or learner can add recordings and translations expand the available utterances. This software is designed to work with Rapid Rote and lists can be imported and exported between the two software applications. As with Rapid Rote, Talker is designed to work with PDA and pocket PCs for portable reference and study.
SECURITY APPLICATIONS

This category of software provides the user with the confidence that their hardware is protected from viruses, spyware and other malware that could compromise the safety of the user’s personal information and the functionality of the hardware being used. These applications perform a variety of functions including: virus scanning, digital signing of e-documents, email filtering, and restricting network access to authorized users. While there is no specific link to language learning, this software ensures that technology can be utilized safely and securely by all instructors and students.

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<tr>
<th>Software Name</th>
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<tr>
<td>Symantec AntiVirus</td>
<td>Symantec AntiVirus software provides security for consumers to protect and manage information stored on their computers. This risk management software and service provides protection against viruses, along with anti-piracy security. Viruses are designed to alter typical computer functions by specifically damaging the computer, or slowing the operation of the computer. With the Symantec AntiVirus software installed on all computers (students and faculty), it will assist in detecting and eliminating all types of viruses.</td>
</tr>
<tr>
<td>Tumbleweed Communications Corp.</td>
<td>Tumbleweed Communications Corp. provides enterprise and government customers with protection services for secure messaging and file transfer. Three product types include MailGate which filters emails/messages for spam and viruses; SecureTransport which allows customers to send large files safely; and Validation Authority which verifies digital certificates.</td>
</tr>
<tr>
<td>ActivClient</td>
<td>ActivClient is security software used by business and government customers. It is smart card-based by allowing only members of that network access to specific applications through password protections and USB tokens. Students and faculty can log into the network by using their Common Access Card (CAC).</td>
</tr>
<tr>
<td>PureEdge Viewer</td>
<td>PureEdge Viewer, also known as IBM Workplace Forms, enables users to securely digitally sign and submit forms online (e-forms).</td>
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<tr>
<td>DBSign and Approve It</td>
<td>DBSign and Approve It are both third party signing software applications used for adding digital signatures to e-forms.</td>
</tr>
<tr>
<td>Odyssey</td>
<td>Odyssey is mobile device management software used to remotely manage, monitor and support Windows devices. Odyssey could be used to sync a PDA with a desktop computer which could aid in the organization and archival of foreign language learning material.</td>
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