Computer-Assisted Language Learning: From Vision to Reality?

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ABSTRACT

Learning a second language is a challenging endeavor, and, for decades now, proponents of computer-assisted language learning (CALL) have declared that help is on the horizon. As documented not only in the *CALICO Journal* over its 25-year history but also in other scholarly venues, research has demonstrated the value of CALL. Nevertheless, despite the fact that textbook publishers expend significant effort to include computer-based ancillaries with many of their products, many teachers still rely primarily on the textbook alone. This situation is nothing short of astounding, given the advanced hardware and software capabilities of current delivery systems, unimaginable at the outset but now both available and affordable. Is the quest to implement CALL a fool's errand or is success in fact finally just over the horizon? This article provides (a) a brief historical overview of CALL, including a glimpse at both its pedagogical limitations and strengths; (b) a description of current issues that slow the implementation of CALL; and (c) a sketch of research and development efforts that will help teachers, researchers, and developers move CALL to the next level: A carefully crafted combination of teacher and technology with each contributing according to its comparative advantage.

KEYWORDS

CALL, CALL Research and Development, eLearning Specifications, CALL Goals, CALL Implementation, History of CALL

INTRODUCTION

Language learning, perhaps the most complex of all human undertakings, can be characterized by a peculiar paradox. While the attainment of perfection is natural and seemingly effortless for a small child, such an accomplishment is virtually impossible for an adult, even one who is willing and able to put forth a considerable investment of years of learning and decades of practice. Indeed, anyone who learns to speak a second language after puberty will almost certainly be recognized as a nonnative speaker (NNS) a few seconds into even the shortest of conversations, this despite their perhaps having spoken the second language longer than having spoken just their native language alone. While perfection is probably not the goal of the typical language learner, the problem remains: Achieving a functional level of communicative competence in a second language is a significant challenge.

Solutions to addressing this challenge have proven to be hard to come by, despite the claims of miracles promised in expensive airline magazine ads and now even cable news TV spots. Furthermore, numerous teaching-method bandwagons, personality-based instructional approaches, and expensive TV-based courses have come and gone, but none of these have succeeded in changing the language-learning landscape in any major way. Most language textbooks now include perhaps a video component or online materials, but the extent to which instruction has actually changed across the board is debatable.

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For several decades now the promise of computer-assisted language learning (CALL) has been part of this mix, with its proponents promising that help is on the horizon. As proponents have proclaimed imminent relief for all language learners who have access to a computer, they have often puzzled over the best way to use the technology. For example, writing over 40 years ago in an article in *Scientific American* about how computers could be used in education, Stanford mathematician Patrick Suppes saw computer-assisted instruction as a way to implement the individualization of instruction, which had been the dream of educators since the end of the 19th century. In this seminal piece he even wondered in passing how to proceed with CALL: "In the elementary teaching of a foreign language, to what extent should pattern drill precede expansion of vocabulary?" (1966, p. 219). Other researchers contemporary with Suppes were inspired as well by the potential and went to work to answer the ensuing questions that arose. These pioneers were able to demonstrate that "tastefully-designed CAI can be a most profitable and useful tool for the serious student. In fact, bright and motivated students can 'leapfrog' a great deal of tedious classroom work" (Bunderson & Abboud, 1971, p. 68). Whether measured by the impact of individualized instruction or possible reductions in tedious work, a quick visit to the typical language classroom will clearly reveal one outcome of these past decades of work: the vision of CALL has not yet become reality.

What developments in CALL have occurred in the past in attempts to make the vision real? Where is the vision today? What can we expect the future to hold? What has to happen if the future is to be different than the past and the present?

IMPLEMENTING THE VISION: THE CALL OF THE PAST AND THE COMING OF THE *CALICO JOURNAL*

Although the dream was certainly present those decades ago, it was not until the early 1980s that significant momentum began to build toward turning the dream into reality. The action of visionaries like the late Mrs. Minnie Kenny of the National Security Agency and Dr. Frank Otto, founding Executive Director of CALICO, helped the newly developing CALL field move beyond the vision of a few seminal projects to real action. With the publication in June of 1983 of the first issue of the *CALICO Journal,* researchers around the world finally had a dedicated journal to help move the concept of CALL forward at a faster pace than had been theretofore possible.

The history of the *CALICO Journal* is very personal to me as a researcher, developer, and practitioner, given that it parallels very closely my own involvement in the field. Because of these parallels, a brief review of some aspects of my history can reveal a few useful lessons learned and perhaps even breathe new life into a few lessons lost.

At the end of my job interview in 1975 for a position at the US Air Force Academy (USAFA), Colonel William Geffen, Department Head at the time, said something like, "Mike, you need to know that I am very interested in looking at using the computer as a tool in language learning." Acceptance of that position led to a USAFA-sponsored Ph.D. program for me at The Ohio State University in 1978, well before instructional technology was a widely established field, thus resulting in my earning a degree in foreign language education with an emphasis in computer science. The combination was useful in some ways but certainly was not ideal.

Degree programs were unfortunately not the only element lacking at the time. The main approach to CALL that had been considered at USAFA involved PLATO plasma terminals connected via telephone lines to Control Data mainframes that were located hundreds of miles

away. The cost for one terminal, mainframe access, and communications was roughly $1,200 per month in the late 1970s, and the calculator provided by the US Department of Labor, Bureau of Labor Statistics (see http://data.bls.gov/cgi-bin/cpicalc.pl) puts the current cost a little over $4,000 per month! The mind boggles at the realization that this amount is sufficient to make purchases today of four or five microcomputers per month, each significantly more powerful than the typical Control Data Cyber 170 mainframe (dual processors running at 25 or 40 MHz with 256K of main memory) on which the PLATO system might have run at the time. Features such as multimedia capabilities (text+audio+video), web-based connectivity, and worldwide access to over 2 billion pages of information are all possible today. These capabilities were not only impossible at the zenith of the PLATO system, they were all but unimaginable. Despite the limitations of the time, however, the vision was there to incite people to consider ways to find exciting applications for CALL that could enhance the learning experience.

Although some software existed for language learning on the PLATO System (Marty & Myers, 1975; Hart, 1981; Hart, 1995), issues such as requirements from other USAFA departments as well as budget limitations led development away from PLATO. Our effort at USAFA started with Terak graphics terminals, primarily because these could (in theory at least) handle languages like Arabic, Russian, Chinese, as well as handle the graphics-intensive requirements of other departments. The terminals were connected to a Digital Equipment Corporation VAX 11/780 mainframe that had some semblance of an authoring system, but neither the Terak terminals nor the VAX system were capable of bringing to reality the sort of multimedia language-learning experience that was clearly becoming, not only an important, but clearly a necessary objective. This led our investigations in the early 1980s to the TI 99/4A microcomputer from Texas Instruments, which was first connect to 3/4" Sony U-Matic videotape players and later videodisc players from Pioneer, Hitachi, and Sony. A small, computer-controlled switching unit switched the screen display between the computer and the video source.

As those developments unfolded, an impromptu meeting took place one evening in 1983 or 1984 in Baltimore at one of the first two CALICO symposia. People from the federal government, service academies, various higher education institutions, and industry gathered in the hotel suite that had been made available to the Executive Director of CALICO, Frank Otto. The primary subject of discussion in this setting was how to solve problems of non-Roman orthographies required for display by certain languages and necessary to enable the types of materials that were being proposed at the conference.

Discussions quickly turned to the Xerox Star, which was touted by individuals from a couple of the well funded government agencies as the best system available to address the challenge of computers and the challenges of non-Roman writing systems. Unfortunately, as it was quickly pointed out, this system could not integrate video into the materials to be presented. As I reflected on the difficulty being discussed in the meeting, I remember very well contemplating a solution for Chinese characters on the TI 99/4A we were exploring at the time.

Some months after the meeting in Baltimore, we demonstrated the ability to define characters using a crude system to edit a pixel matrix of limited size, and we even used this approach to do a short interactive demo using a video-based dialogue in Chinese that we had included as one of the language samples on the "Seven Language Videodisc" prototype[1] that we had produced. Suffice it to say that, as we contemplated how long it would take to use such a crude approach to create the limited number of Chinese characters required even for beginning learners, we concluded that the resulting approach was never going to yield anything more than a demonstration of concept.

These problems with Chinese notwithstanding, we implemented this particular videodisc configuration in a sample lesson in German that was used in one of the earliest interactive video experiments that demonstrated the effectiveness of the technology (Schrupp, Bush, & Mueller, 1983). This research and development effort was followed by other studies at USAFA that corroborated early findings. For example, Crotty (1984) found that students using interactive videodisc technology performed better on a test of writing than students learning in a traditional classroom. In another study Verano (1987) found that students who received a passive videodisc presentation preferred instructor-based learning, while students who used the most highly interactive videodisc-based treatment declared the least preference for learning from an instructor. Furthermore, those who received the most highly interactive instructional experience in this particular study were more interested in learning Spanish than the other students; they felt a stronger desire to visit a Spanish-speaking country, and they achieved better results than students in the other groups that experienced materials that were less interactive (Verano 1987).

That initial research helped lead the way to the successful implementation in 1988 of what was probably the largest videodisc-based language learning center anywhere at the time (Bush, 1997). Each of the 32 Sony View 3000 workstations consisted of a videodisc player, an IBM compatible, 80286-based microcomputer, and a monitor, all of which were networked to a 3Com file server.

Microsoft Windows was not part of the initial design, but, based on research we conducted on authoring approaches, it was becoming apparent that graphical user interfaces could help improve productivity in materials development. The importance of this determination was not initially obvious to all at the time. For example, Sony had designed their system to conform to government requirements for interactive videodisc workstations, specifications which only included the requirement to be compatible with MS-DOS. Although Windows 1.0 had been released in 1985, it was not much of a commercial success, a situation that only slightly improved with the release of Windows 2.0 in 1987. As a result, it was necessary to convince Sony to develop the appropriate hardware display drivers so that the units would be compatible with Microsoft's fledgling graphical user interface. We then created software using a Windows-compatible authoring tool (*IconAuthor* from AimTech) that enabled the production of several hundred hours of video-based activities in French, German, Spanish, and Russian.

In 1989 I was asked to fill in as banquet speaker for Mrs. Kenny who was unable at the last minute to attend the CALICO symposium held that year at the Air Force Academy (Bush, 1989). I focused attention in that talk around several key themes that, as the world turns, are as important today as they were 20 years ago. These themes support the general idea that a paradigm shift was happening at that time and continues today in the way that information is considered and handled. To benefit from the changes brought about by this shift, the pursuit of several significant goals remains of utmost importance.

For example, a sustainable business model for learning materials production and distribution is obviously as essential today as it was then. Moreover, anyone working in this area realizes very quickly that significant progress is not possible without research that can yield pedagogically sound instructional design strategies that not only facilitate language acquisition but that also lead to affordable approaches for materials design. Such research, then as well as today, must deal with the fact that education is moving away from trying to merely attend to the needs of a group as a whole towards instructional and learning strategies that address the needs of the individual.

The point that must be taken from these realizations is that a realistic vision for CALL is possible only through:

1. standards for representing instructional content (elements such as standard character sets and file structures),
2. a broad and inclusive outlook towards multiple disciplines to increase our understanding as to what language is and how it is learned,
3. research that explores how technology can best be implemented in language learning,
4. collaboration in addressing questions of mutual interest despite limited resources, and
5. the application of open systems architectures that will facilitate the necessary collaboration. (Bush, 1989)

The pursuit of those goals had a significant influence on further development of the capabilities of the USAFA language learning center. Subsequent research conducted in that facility concluded that interactivity with the use of video improves learning outcome effectiveness (Moraco, 1996). Such findings, especially when considered alongside research conducted elsewhere (Bunderson & Abboud, 1971; Chun & Plass, 1996), illustrate how technology can have a positive effect on language-learning outcomes. Unfortunately, these positive benefits will remain unrealized unless the specific goals listed above continue to serve as a guide to future development.

THE CALL OF THE PRESENT

Indeed, as is clear from the preceding paragraphs, researchers have pursued quite energetically this compelling vision for CALL for roughly 40 years now, and the field has made a great deal of progress. Considering this progress, however, where are things at present?

Unicode is now available to enable standard personal computers and most software, including web browsers, to easily handle most of the world's writing systems (Bush & Browne, 2005). This representation of non-Roman orthographies can also be easily combined with video that is streamed on the internet or transported on CD or DVD.

The Department of Foreign Languages at the Air Force Academy, having expanded the initial interactive videodisc learning center to 94 PC-compatibles by 1996, has now replaced that facility with a state-of-the art language lab. This new facility can do everything that was possible in the old audio lab and its interactive videodisc-based replacement combined. In fact, students there now have the technological capability to do on their laptops everything that was possible on the huge interactive videodisc workstations, which cost $8,000 at the time and today would cost about $12,000 each.

Publishers are making software available on websites created to support textbook offerings and also often make CDs or DVDs available as ancillaries, and universities are placing course materials online. Meanwhile, popular technology magazines muse about the value of podcasting, blogs, and computer-mediated communication (CMC), while participants in technology-oriented listservs discuss the potential value of *Second Life* for language learning. The *CALICO Journal* has been joined by several other journals dedicated to language learning and technology, and mainstream language learning journals like *Foreign Language Annals* and the *Modern Language Journal* frequently contain articles that discuss issues related to CALL.

With respect to hardware, devices such as the iPod Touch, Apple's new ultraslim notebook computers, laptops, and a multitude of other digital devices from a host of manufacturers can accomplish so much more than was ever envisioned by early pioneers who contem-

plated the effect that computers could have on learning in general and language learning in particular.

Given these developments and the truly astounding set of features offered by today's hardware and software, where are things in the typical language learning classroom? A quick visit to almost any classroom in the country will reveal that the textbook remains the focal point of more activities than one might guess, given the array of possibilities available. If things are disappointing at present, where can we anticipate things going? Such a question becomes even more urgent with the realization that the power of digital devices in general is only now approaching the upswing on the right-hand side of the exponential curve describing the advances over time that are taking place at an ever increasing rate (Kurzweil, 1999). These advances were predicted by Moore's Law and show no sign of slowing. Whether those inevitable advances should be considered for implementation is the key to further discussion.

THE CHALLENGE OF CALL

If CALL is to continue its move from vision to reality, then researchers and developers must determine which particular language learning problems need solutions. Otherwise, just like with other advanced technologies, CALL risks becoming an extraordinary hammer with its users seeing every element of language learning as a nail. In sum, the effort to find the most appropriate application for such a remarkable tool must be guided by pedagogical pull rather than technological push (Bush, 2000).

Considered as a whole, the technology that enables CALL has moved far beyond what was even imaginable those three or four decades ago. Unfortunately, there is a certain irony in this situation since software development has not kept pace with advances in the hardware. The current capabilities of available software and hardware configurations severely limits the level at which CALL can assume a role as a language-learning tool (Clifford & Granoien, 2008). Recognition of this fact, which is that the technology is not where some would like it to be or where technological capabilities indicate it could be, is tantamount to suggesting that work in developing CALL has only begun, despite its four-decade long history.

To better understand current critiques of CALL and how those should be addressed, perhaps an analysis from the perspective of a metaphor will be useful. Not only does a good metaphor have the potential to provide helpful insights into understanding where things are, but reflection based on a different perspective can also provide important guidance as to how to best move toward the future.

In their quest to achieve powered flight, the Wright brothers worked for years on the leading edge of known basic science, pursuing their elusive goal, undaunted even by the deaths of other pioneers. Using an engineering approach, characterized by many experiences filled with trial and error, they refined their designs from experiment to experiment. The apparent foolishness of their endeavor and their approach is illustrated by a declaration by the *New York Times* only 8 days before their success at Kitty Hawk, which stated that in "1 million to 10 million years they might be able to make a plane that would fly."

After their first successful flight, it would have been ludicrous for Orville and Wilbur to declare that they had found the key to fast, affordable air travel, which would revolutionize how people would seek leisure, do business, and wage warfare. Although such a leap might in fact be small in the mind of the visionary, it would be huge in the mind of a critic who might

have observed that historical event, sniffing at the success: "Well, as impressive as some might find this to be, this thing will never fly across the Atlantic!"

In terms of rhetoric, an overly exuberant declaration of the Wright brothers as imagined above would have been seen as excessive, and the disparaging observation would have been considered to be more grounded in reality, both imaginary perhaps, but not at all unthinkable. Such a gap between vision and reality is often as huge as the one between a 12-second flight that covered 120 feet and flights that would carry several hundred people across the Atlantic in about 6 hours.

As it turns out, the Wright brothers were just as incredulous as our imaginary critic, a fact Wilbur illustrated in 1909 by asserting that no aircraft "will ever fly from New York to Paris" (Hoffman, 2003). This same line of well reasoned thought would lead Maréchal Ferdinand Foch, Professor of Strategy at the Ecole Supérieure de Guerre in Paris, to declare some 8 years later that airplanes "are interesting toys, but of no military value" (Quotations Page, n.d.).

Clifford and Granoien (2008) seem to manifest similar incredulity. Just as the *New York Times*, our imaginary critic at Kitty Hawk, Maréchal Foch, and even Wilbur Wright himself each remained unconvinced of the promise of sustained, powered flight, so do Clifford and Granoien point out the technological challenges of today's CALL. Although they are on target in their assessment of current technology, they perhaps unnecessarily leave readers with little hope for its successful implementation, even for the future.

In particular, Clifford and Granoien suggest that "a CALL program, in order to support language acquisition and proficiency must be capable of interacting with the learner, of recording, analyzing, and interpreting learner output, and of providing feedback for correction, all in a context of meaningful tasks with authentic input" (2008, p. 38). What they propose, however, would only be attainable by software with capabilities to match those of C-3PO, the gold-plated protocol droid of *Star Wars* fame.

Furthermore, Clifford and Granoien (2008) support this bleak picture with several key assertions. They hold that the primary use of today's computer software is based on "assumptions of teaching that are two decades and more old" (p. 26). In addition, they state that the implicit purpose of the software is to prompt the learner to "memorize everything by rote" (p.26), adding that "the prevalent trend in CALL appears to be that learning is by and large an informational construct" (p. 27). They further state that for today's CALL, "learning is the natural result of repeated exposure" (p. 27). Providing their summary of current pedagogical theory, they state that "learners can be brought to noticing and correcting their shortcomings only through stretching linguistic resources while constructing meanings for communication with a native speaker" (p. 29).

One obvious conclusion from these assertions is that CALL is not much closer to making a useful contribution to language acquisition than the world is to being able to engage the services of linguistically gifted, protocol droids. Such an inference, however, is exactly the wrong lesson to draw from Clifford and Granoien's insightful overview of the serious limitations of much of the current generation of CALL. Although they recognize the limitations of today's CALL in general and speech recognition technology in particular, we should not conclude that because CALL cannot do everything, it cannot do anything useful in contributing to the general language acquisition process.

Sadly, the dichotomous nature of such a possible conclusion is not at all unknown to the field of second language acquisition (SLA), with theoretical and methodological pendu-

lums often swinging from one side of various philosophical debates to the other. Larsen-Freeman summarized the fact that the language acquisition field is "beset with dialectics: learning versus use, psychological versus social, acquisition versus participation" (2007, p. 784), a situation very much illustrated by the history of language-teaching methodologies. For example, grammar translation ceded its place in history to audiolingual methodology, which in turn gave way to the communicative approach. Attention turned from linguistic competence to communicative competence and the primacy of input was replaced by an emphasis on output. Now, instructed SLA is on the pedagogical scene, informing us that learning really can lead to acquisition.

Such simplistic, dichotomous relationships belie of course the individuality and complexity of the human mind and its supremely complex creation: language. In his preface to *How the Mind Works*, Pinker states that "we don't understand how the mind works—not nearly as well as we understand how the body works" (1997, p, ix). This is not at all encouraging; especially given the experiences many have had with current medical practices, which too often demonstrate that we do not understand very well how the body works either.

Clearly, with respect to language learning there are no simple solutions, with or without technology, and trying to address any aspect of the complexity of language with CALL is not unlike the situation faced by the Wright brothers. Just as aeronautical science was virtually nonexistent for Orville and Wilbur in the early days of the 20th century, so is scientific knowledge limited today in its ability to explain the nature of language and the fundamentals of how it is learned. This lack of a fully developed science of language acquisition severely restricts practitioners in their efforts to develop an easily achievable and useful implementation of CALL. Moreover, of the various issues raised in the 1989 CALICO banquet speech referenced earlier, this lack of applicable science perhaps restricts more severely our ability to move forward than any of the others.

ALL ON CALL?

Despite the lack of adequate scientific guidance, writers of many of the articles in the *CALICO Journal* over the past 25 years seem to have been working under the supposition that the computer can play a role in language learning. This general attitude seems unaffected by our incomplete knowledge of the nature of language and how it is learned. Are these writers who hail from the field on a fool's errand or are there practical applications for which CALL is indeed suited?

The primacy of the interactionist approach might well contribute to the notion that the CALL venture might be a foolish endeavor. Proponents of this theory assert that acquisition is made possible by the negotiation of meaning between interlocutors, ideally a NNS who is attempting communication with a native speaker (NS). For example, Swain and Lapkin stated that "problems that arise while producing the second language (L2) can trigger cognitive processes that are involved in second language learning" (1995, p. 371). As observed by Clifford and Granoien (2008), CALL is not at the point where these processes can be effectively administered by CALL software.

Although such an issue is a problem for the implementation of CALL, there are also important implications for the typical language-learning classroom. For example, it should be clear that acquisition takes place in ways other then solely through negotiation of meaning with an interlocutor. Even Swain and Lapkin have stated that "It is important to reiterate that output is not the only source of second language learning" (1995, p. 386). Krashen (1993) supported this notion in his book, *The Power of Reading,* which he updated in 2004,

citing ample evidence that something as simple as free, voluntary reading (FVR) is a powerful means of gaining proficiency in a first language, prompting him to also conclude that FVR is "the way to achieve advanced second language proficiency" (1993, p. x).

Borrás and Lafayette (1994) add an interesting perspective to this discussion, having demonstrated that subtitles help in the comprehension of authentic video. Moreover, they determined that the learner's ability to see and control subtitles results in "better productive use of the foreign language" (p. 70).

Finally, the interactionist approach raises two substantial challenges to implementation in the classroom setting. On the one hand, it is easy to understand that language is just too complex to expect that every aspect of language will be uttered and corrected by an NS. On the other hand, even if that were possible, there are just not enough NSs available for each student to have their individual conversation partner.

This realization of the limitations of the one-to-one tutoring approach is similar to findings of researchers who sought to devise the ideal teaching-learning configuration. For example, Bloom (1984) conducted research with his students that demonstrated that learners working one-on-one with a teacher would achieve an average increase in learning outcome that was two standard deviations higher than was achieved by one teacher teaching 30 students in a typical classroom. These findings caused him to wonder whether researchers and teachers can "devise teaching-learning conditions that will enable the majority of students under group instruction to attain levels of achievement that can at present be reached only under good tutoring conditions" (pp. 4-5).

Bloom described the result as the "2 sigma problem" simply because it was clear that the one student-one teacher approach was not economically viable. His findings regarding the differences obtainable with one teacher working with one student illustrate the power of implementing instructional strategies that attend to the needs of the individual. Unfortunately, this brings the current discussion to an interesting crossroads. Due to the limitations of computer-based natural language processing, CALL cannot implement what appears to be the most theoretically sound instructional strategy of one teacher for one student. Nor is it practical to implement this approach in the typical classroom.

The best and most logical place to begin to address this situation is to broaden the perspective of where current language acquisition theory actually finds itself. From such a vantage point, it is possible to state that current theory can, at least for most intents and purposes, be reduced to one simple axiom: In order to learn to communicate in a language, the learner must communicate in the language. On the surface, this statement might seem a bit odd, raising the question as to how one can do something that one does not know how to do.

Such a conclusion illustrates what is becoming increasingly apparent: Speaking a language is very much like riding a bicycle or perhaps even playing chess. It is not likely that someone will become proficient in either of these activities using only a book, the most prevalent instructional technology currently available. Although *Chess for Dummies* is in fact a title in that popular series of "how to" books, the dummies.com website (http://www.dummies.com/WileyCDA) states that the book provides "Proven tactical tips to strengthen your game." This implies of course that the book will be most useful once you already know the basics of how to play. Needless to say, the title "Bike Riding for Dummies" was nowhere to be found.

Applying these observations to language learning, students will learn what they are taught. If we teach them about language, then they will be able to answer questions about

language. If we teach them to use the language for communication, then communicate is what they will be able to do. This notion is supported by various scholars such as Doughty and Long (2003), who provide a comprehensive overview of principles and practices for the implementation of task-based language teaching. They have connected this list to a very specialized, technology-based distance-learning context. Number two on their list of ten methodological principles is "learning by doing" (p. 52).

While such a statement amounts to a simplistic view of a very complex process, even the most casual of observers will find it difficult to conclude anything other than learning will take place by doing. This conclusion aligns with the views of cognitive psychologists who make the distinction between knowing versus being able to do. Just like reading about riding a bicycle or playing chess, neither reading *about* how to communicate in a language nor listening to a teacher talking *about* language is going to lead to the development of any practical skill. While this conclusion differs slightly from the tenets of instructed second language acquisition, the difference is more in degree rather than substance. Even if instruction can play a role in acquisition, the development of a skill is possible only by engaging in the activity itself.

What does this realization mean for CALL? Given that learners are unable to interact with computers by negotiating meaning as they would with another human being, it might be tempting to assume that CALL can have little impact on language acquisition. Such a conclusion, however, is based on the premise that language interaction can only happen through speech acts that take place in the context of a conversation between an NNS and an NS, or perhaps between teachers and their students, or even online in a CMC setting. Each of these three techniques for language learning has its own challenges.

First, simple reflection reveals that there are not enough NSs to individually attend to the language-learning needs of the number of NNSs that fill our classrooms. Furthermore, the complexity of language is such that there is no way to expect learners to make every single, possible error and subsequently be corrected by formulating output for which they then receive corrective feedback. Language teachers address this problem by providing opportunities in the classroom for students to interact with each other. Unfortunately, recent research in one study abroad setting has shown that the proficiency of students who speak the target language with classmates improves less than that of students who avoid this activity (Magnan & Back, 2007).

Second, perhaps the best form of dialogue that can exist in the classroom between a teacher and students is labeled by some scholars as instructed SLA. Although this approach has been shown to be of value by connecting learning to acquisition (Doughty & Williams, 1998), it presents significant challenges in its implementation. How is the construct of "instructed second language acquisition" to be defined consistently? How will such instruction be delivered consistently by various teachers in various settings and received by various students, each characterized by a wide variety of individual differences? Crossing individual differences of teachers with individual differences of students with all possible instructional techniques yields an incredibly large number of possible combinations. Although it would certainly be interesting to determine learning outcomes for each unique case, the complexity of such an endeavor is beyond the reach of prevalent methods of educational research.

Finally, CMC presents its own particular challenges, the most prevalent one having to do with the fact that learners in a CMC setting communicate with each other without the formative feedback of a teacher (Clifford & Granoien, 2008). Whether students are sitting in class or in computer-mediated situations with other students, interlanguage theory suggests that all will most likely be at a similar level in their development and thus likely to be subject to making similar errors. Although the collective wisdom of a group in a CMC setting might

counter this tendency, the absence of teacher feedback to address this particular challenge could well cause learners to reinforce each other's errors.

Researchers and developers can no doubt establish and apply general and valuable principles in each of these three areas, it is impossible to determine that one particular learning tool or technique will be useful under any and all circumstances. With respect to the value of learner output, for example, techniques that work in one situation might well not necessarily work in all others. Techniques to elicit output from students in Canada with an average age of 13 who had participated in an early French immersion program since kindergarten (Swain & Lapkin, 1995) might not work for university students learning Arabic at a large private university in the United States. Experienced practitioners will not doubt that language-learning activities that promote output are a very useful mechanism for promoting language acquisition in general, perhaps even in some ways the most powerful. Furthermore, output could well be essential for the development of the speaking skill itself. For example, Nagata (1998) demonstrated that "output-focused practice is more effective than input-focused practice for the development of skill in producing Japanese honorifics and is equally effective for the comprehension of these structures" (p. 34). As illustrated in the previous section, however, there is no reason to believe that output is the only mechanism that can promote acquisition. To be sure, there is evidence to the contrary, as has been shown.

Recognition of these various issues confirms the notion that language acquisition is a complex process that cannot be explained by just a few hypotheses that have been suggested by the findings of a limited number of research studies. Nor can the problems encountered during the difficult process of acquiring a second language be solved by the application of a few simple principles and associated instructional techniques.

At this point in the development of instructional approaches and methodologies, many techniques and tools can be brought to bear to facilitate the acquisition process. The key issue is to determine where and when during the SLA process each technique and tool can be applied to achieve maximum benefit.

This same rationale applies to the consideration of whether CALL can play a useful role. According to the "big hammer and everything looking like a nail" principle elicited earlier, perhaps we frame the question inappropriately when we ask, "What role can CALL play in language acquisition?" It is probable that a more suitable approach would be to ask, "Which subprocesses of language acquisition are amenable to being consigned to CALL?" As demonstrated above, human intervention for certain instructional tasks will be superior for the foreseeable future to what is possible with technology, at least until C-3P0 moves from the realm of science fiction to science fact. In addition, previously cited research demonstrates that technology can play a successful role in the SLA process (Bunderson & Aboud, 1971; Schrupp et al., 1983; Crotty, 1984; Verano, 1987; Moraco, 1996; Chun & Plass, 1996).

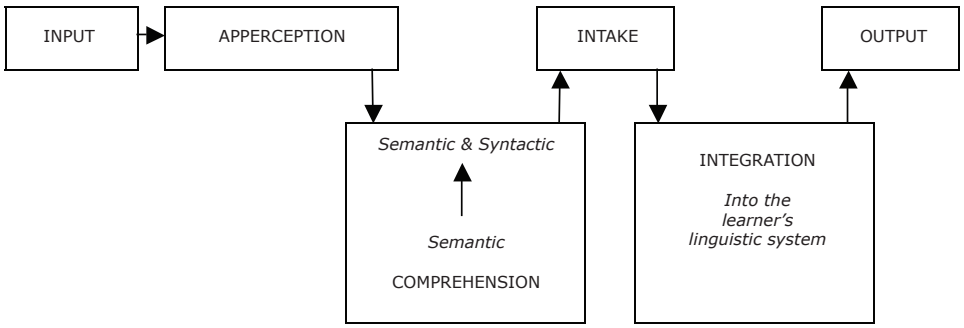
Unclear at this point is the role to assign to each medium of communication and interaction: teacher or technology. One key issue that governs the usefulness of the technology is the extent to which it is "interactive," a term for which the value is questioned by Clifford and Granoien (2008). They seem to assert that because "there is no true communicative interaction between human and computer" (p. 37), there is no true interactivity. Although this assertion is true as stated, there is obvious value in the ability for a learner to replay an audio or video segment or to get clarification of the definition of a word or to receive previously unknown information that had been assumed by the creator of the content to be present in the mind of the reader, listener, or viewer. Joiner (1997), for example, maintains that the ability to control playback, pausing, rewinding and relistening to audio is such that "the *immediacy* skill of listening can be made to resemble the *recursive* skill of reading" (p. 82). The ways the

learner can use this capability, whether or not it is termed to be interactivity, is key to at least one role that the technology can play in acquisition and, by definition, the role that should be retained by the teacher.

To determine these roles and the most appropriate elements of language acquisition to which either teacher or technology is best suited, it is useful to consider the SLA process as adapted by Chapelle (1998) from Gass (1997) and discussed by Clifford and Granoien (2008). As shown in Figure 1, the main elements or components in play are

1. input,
2. apperception,
3. comprehension,
4. intake,
5. integration, and
6. output.

Figure 1
Basic Components in the SLA Process in Interactionist Research (Chapelle, 1998)



Chapelle (1998) summarizes a consensus view among interactionist SLA researchers that explains how language learners process input and integrates new language elements into their linguistic system. From this model she posits seven hypotheses that are relevant to the development of multimedia CALL, some involve reception activities and some production, but all involve using language for communication.

Simple reflection leads to the conclusion that steps one through five are possible when the learner is using interactive technology as medium for receiving language input through activities such as reading, listening to spoken language, or watching a video. This realization is not disputed by Clifford and Granoien (2008), and, in fact, these steps are not unlike an important process described by the cognitive psychologist and psycholinguist Frank Smith (1975). He described comprehension and learning as "making sense of the world" (p. 1), basically the normal mode of operation of the human organism. New information or experiences are constantly assessed in terms of what is already known and then integrated into the learner's cognitive structure as needed to improve the learner's understanding of the world through the various channels of sensory input. Where SLA considers the negotiation of meaning to be the process that normally transpires between two interlocutors, it is possible to consider the components of input, apperception, comprehension, intake, and integration to be steps similar to those involved with Smith's "making sense of the world."

Considered in this light, therefore, the receptive steps of the interactionist model appear be accomplishable by learners working to comprehend language in written or auditory form, perhaps aided by visual information as well. This process of facilitating input and help-

ing it to become comprehensible has been shown to be within the capabilities of multimedia CALL (Verano, 1987; Moraco, 1996; Chun & Plass, 1996; Meskill, 1996). In a related vein, recent research demonstrates that the technology can help focus the attention of learners to better attend to the meaning of the input (Bachelder, 2007), addressing to some extent the issues of apperception and comprehension.

Afterwards, the additional steps outlined, such as output during which learners produce language and negotiate meaning, can proceed under the guidance of the teacher. Furthermore, the shared context that is gained by the learners in the initial steps of the process creates a rich setting in which a great deal of useful communicative activities can take place.

The conclusion to be drawn is that numerous activities can contribute to acquisition as a process that is made up of several subprocesses, each conceived and executed by various means. Working from this perspective enables the teacher and the technology to contribute in interesting ways to the benefit of the overall process and has shown to be effective in a language instruction setting (Scida & Saury, 2006). As reported by Scida and Saury, with such an approach students come to class better prepared and enjoy the course more, potentially rendering classes more enjoyable for the teacher. Ideally in such a hybrid setting the teacher is able to consign to the technology those tasks of which it is capable, saving for the classroom those that are best carried out by learners interacting with each other and with the teacher. In other words, CALL does what is doable in a setting where students work independently, and the teacher does the rest.

THE CALL OF THE FUTURE

Given this guidance as to how CALL can be implemented in a structured language-learning environment, researchers and developers must recognize the situation for what it is, one that requires that the field move forward with caution. The associated challenges result not only from the complexities of language and language learning but also from the increasing pace of technological change. The good news with respect to this change is that capabilities are increasing dramatically and at an accelerating pace. The bad news is that these increases bring complexity that is not always adequately addressed.

Although preliminary guidance is available to deal with these issues in implementation, additional research and development will be necessary into the foreseeable future if we are to address the inevitable difficulties that will arise. For example, finding the ideal mix of teacher and technology is crucial. Furthermore, given such a mix, how are the various instructional tasks best accomplished? As answers to these questions are developed, how can researchers and developers share what they learn?

To begin to address such questions, a close examination of the CALL of the past and the present is essential in determining how to proceed. For example, one only has to review the pages of the *CALICO Journal* to recognize that many questions exist as to the ideal tasks that could be consigned to CALL. Unfortunately, many of those articles explain only the "why" of using CALL and its effects in limited circumstances. Not so prevalent are articles that describe full programmatic changes that result from its implementation.

Specifically, no clear picture yet exists of exactly how language instruction should proceed in a systematic, systemically oriented fashion in situations where technology plays a significant role. Although most publishers include a technology component (e.g., video and/or online exercises), some publishers will confide privately that the percentage of teachers who actually make use of the resources is quite low.

This low level of implementation notwithstanding, pendulums continue to swing and bandwagons continue to roll. It is therefore paramount that CALL not be assigned a particular direction of movement, either by principle or by practice, without adequate forethought and consideration. The urgency of the situation is accentuated by the fact that accelerating change promises to render obsolete in the future various aspects of what is done today.

In any case, finding CALL's appropriate role is crucial, one that can only be determined by careful study. For instance, the theoretical underpinnings of popular models of language acquisition rely significantly on the special role attributed to the negotiation of meaning in the process (Chapelle, 1998; Doughty & Long, 2003; Clifford & Granoien, 2008). Although CALL is obviously more limited in this regard than a human tutor, it can facilitate the conveyance of meaning in the target language (Chun & Plass, 1996; Meskill, 1996). Furthermore, theorists and practitioners alike must recognize that good instruction is good instruction, regardless of delivery system, and that each channel of communication (e.g., teacher, text book, or technology) has certain advantages over the others.

To illustrate, we know without a doubt that the teacher in the classroom is able to do things that the technology cannot do, suggesting the teacher's time will be better spent with instructional tasks that cannot be assumed by the other channels. An orderly process of research and development will help make the necessary distinctions between various possible tasks. Furthermore, the ensuing research will not only help determine the exact role that CALL should play, but it will also assist in "theory-building SLA research" (Kramsch, 2000, p. 316) that explores not only SLA but also foreign language teaching methodology.

THE CALL OF RESEARCH

Language Acquisition Research

To envision and implement a system that takes into account the combined capabilities of the teacher and the technology, as well as facilitate important SLA research, research methodologies must address questions that are related to each system element, separately and in conjunction with all the others. This multilevel approach implies studies that take place at the activity or exercise level (microlevel), independent of delivery system, and at the overall system level (macrolevel) which considers all channels of communication and loci of activity in the typical educational setting.

For research to take place at the microlevel, system components must be identifiable and separable from the whole. For example, a recent report on multimodal learning concludes that it is important to separate media from the instructional approach (Metiri Group, 2008). Such decomposition enables a process for learning about language learning at a fine level of granularity in which activities become the target of interest rather than the delivery system. Illustrating this notion and peripherally addressing the unknowns as to how technology might have application in language acquisition research, Kramsch speaks of language as social semiotic practice. She states that "applied linguistic research can focus language study on the universe of signs in which it is embedded—signs that are only partially verbal, and increasingly visual, acoustic, gestural, or electronic." She continues, saying that "In particular, computer technology offers new ways of representing and mediating language and its associated cultural capital" (2000, p. 322).

Chapelle (2005) illustrates the lessons learned from previous CALL research, summarizing these in six hints. Specifically, she suggests that the multimodal capabilities of CALL should be implemented and that to provide help for comprehension is beneficial, adding that teachers should teach their students how to best use capabilities of CALL. In addition, she

concludes that explicit methods for teaching grammar are superior to those that are implicit and that CMC experiences can be beneficial, particularly with respect to the development of pragmatic competence. She also states that implementation poses significant challenges with respect to pedagogically appropriate design of the experience: "Much remains to be learned about how to shape CMC into a language learning tool" (p. 4). Essentially confirming the assertion by Kramsch cited above, she calls specifically for more research with extended international exchanges.

As a concrete example of the benefit of CALL at the microlevel of research in language acquisition, Bachelder (2007) conducted a study at Brigham Young University (BYU) that investigated the value of remediation during an online language-learning experience. Using analysis of variance, as well as a repeated measures analysis of variance, she compared the achievement over time of two groups of learners. Each group completed a short assessment at the end of each unit of online instruction, and the control group continued to the next unit, regardless of their scores. Learners in the experimental group who did not achieve the minimum required score had to repeat certain activities in the unit until they achieved the minimum passing score. By the end of several units of instruction, the learners in the experimental group were receiving higher scores on the first attempt of successive assessments. It is unclear whether the outcome was due to the cumulative effect of mastery of the language presented in the activities or simply due to the fact that the learners paid closer attention to what they were doing. In either case, the study demonstrated that the use of CALL can have an impact on learning outcome. This effect can come into play, either with respect to facilitate the process of turning input into intake or perhaps by ensuring the positive effects of mastery as learning proceeds.

Where Bachelder (2007) investigated the effects of various types of uses of custom-developed materials, Rimmasch (2007) investigated how students use publisher-supplied materials that accompany a college language textbook. In order to determine student usage patterns of the online materials, the research team at BYU reverse-engineered the software to collect data associated with activity type (e.g., means of response, media, meaningfulness, and feedback) and program use (e.g., time spent, buttons clicked, etc.). In addition, the researcher videotaped sessions with students going through a guided, think-aloud protocol as they used the materials. This study revealed that using CALL in this way not only is a viable form of research, but also that "CALL materials can be the basis for a more than adequate environment for language acquisition" (p. 112). Furthermore, the study revealed that the greater the manipulation of the target language by the learner the deeper will be the processing of the input. Depth of processing was determined according to Gass' (1988) model that includes the need for input to be apperceived and comprehended in order for it to become intake. These three elements of the learner's mental process constitute the three initial steps of acquisition as discussed by Chapelle (1998) and Clifford and Granoien (2008) referenced above. The results of this study also demonstrated that all the activities that are possible with CALL are not created equal with respect to the variables of interest, confirming the need for further research in this important area.

Design-Based Research

In consideration of the implementation of technology for research at the macrolevel, the Wright brothers story serves not only as a metaphor (Bannan-Ritland, 2008), but also as a model for what needs to happen with respect to implementation of CALL. Proceeding with an engineering approach, similar to the one that enabled powered flight at Kitty Hawk, will enable the implementation of instructional techniques that not only reveal their level of effectiveness in practice, but the lessons learned will also contribute to the development of language acquisition theory. Returning once again to work that took place four decades in the

past, we see where Suppes also maintained that data from the use of the computer would enable us to think about its use "in a more scientific fashion and thereby learn to develop a more adequate fundamental theory than we now possess" (1966, p, 219).

A new approach to educational research has evolved over the past 15 or so years to accomplish what he proposed, not only with respect to how technology is used for learning but also with respect to educational research in general. Known as design-based research, this process operates in accordance with engineering principles, that is, experimentation guided by the best available theory. The resulting trial-and-error process would enable CALL researchers to find ways to move forward with a less than perfect science of language acquisition, all the while helping to perfect that science as they go forward. Enabling research in situ, such an approach attempts to address the difficulty of much of educational research, which lacks "an adequate methodological reconciliation that attends to issues of both experimental control and ecological validity" (Sandoval & Bell, 2004, p. 199).

As an example of the type of design-based research that is possible, McFarlin (2008) conducted a study in physiology education that compared the results from teaching a course in exercise physiology using a hybrid (online plus classroom) versus a traditional approach. Although not described by the researcher as an example of design-based research, this study involved an experimental approach that substituted online learning for part of the class time, with the addition of innovations such as an in-class response system that was used to track both student comprehension and attendance. McFarlin compared the results obtained with 312 students taught over three academic terms using the experimental approach with the results of 346 students taught using the traditional approach. Analyzing the results from each instructional approach using final course scores, he found that the experimental group scored a little over one standard deviation better than the traditional group. Although this is not the same level of effect observed by Bloom (1984), these results illustrate the methodology for implementing design-research as well as the gains that are possible with combining the capabilities of online learning with classroom based instruction.

The challenge of designing, developing, and delivering instruction, while taking into account the individual differences of those by whom and for whom it will be delivered makes research of any sort difficult. This is especially true for studies that seek to experimentally compare one instructional method with another. The integration of online instruction into the instructional delivery paradigm can address this challenge by facilitating more extensive research into the effectiveness of various instructional techniques. An approach that combines data collection for this sort of interaction (microlevel) with the benefits of design-based research will enable researchers to study the effects of each important element of the entire process (macrolevel). Not only will such an approach potentially lend understanding to the nature of language and how it is learned, it will also provide insights into instructional techniques and the materials that such techniques require.

MATERIALS DEVELOPMENT

The fact that the CALL field has at times focused more on the various technologies that can deliver instruction rather than on the best ways to use these technologies is somewhat disheartening. In the mid to late 1990s, presentations at the annual CALICO symposia at times amounted to demonstrations of ways to deliver multiple-choice questions via the web rather than providing insights as to the best methodological principles that can be used to guide the development of new technologies. At the recent 2008 CALICO Symposium, attendees at the annual banquet were treated to demonstrations of graphics-based, animated, 3-D talking heads that seemed so real it was spooky. Nevertheless, the obvious question went unan-

swered, "Now that we can do this, what should we have the animated talking heads say?" In addition, many speakers seemed to focus once again more on technologies such as web 2.0 and podcasting rather than on the instructional benefits of the materials that can be made available to students by each technology. Podcasting, like any other educational technology, is only as good as the ways in which we use it (McCloskey, 2007). The same can be said for web 2.0 technologies, iPhones, or whatever new gadget will become available as the capabilities of various technologies advance up the right-hand side of the exponential curve that illustrates Moore's Law.

Indeed, we increasingly have so many technological options that it is not always clear which ones should be implemented. When text-based, multiple-choice interactions were all that were available, developers found ways to build materials around those limited capabilities. Today, we have Unicode, color graphics, computer-generated talking heads, DVD video, streaming video, Flash animation, MP3 audio, streaming audio, intelligent string processing, web 2.0, and podcasting. Some universities are modifying websites or even announcing the issuance of iPhone and iTouch devices to students (Branigan, 2008). Given the pace of these developments, it is perhaps easy to find ourselves like a deer in the headlights, contemplating all that is possible and becoming immobilized, not knowing which way to turn.

None of this is to say that the delivery system is not important. Early leaders in the cell phone revolution often extolled universal information availability with a catch phrase something like "anything, anywhere, anytime." Nicolas Negroponte, digital pioneer and former director of MIT's Media Lab, took issue with that notion, drawing a line in the sand for the personalized content revolution: "Nothing, nowhere, never unless it is timely, important, amusing, relevant, or capable of engaging my imagination" (Negroponte, 1994). This is another way of declaring that the content to be delivered will meet the requirements for quality established by the requesting individual. Once the requirement for quality is met, then the delivery system must of course be capable of doing its job.

With respect to language learning, although digital delivery systems are extremely flexible and powerful and open up fundamentally new ways for teachers to communicate with their students, the materials delivered by those systems warrant significant attention by researchers and developers. This means that the value of each technology contributing to language acquisition is dependent more on what is communicated than the system by which it is communicated. While it is certainly handy to watch video on an iPod, the actual viewing experience itself is not going to be qualitatively better than if the student had go to the language learning center to access the material. Although ease of access cannot be discounted, researchers and content developers must work to ensure that the content selected, edited, created, or even "mashed up" is well designed such that it will best meet the needs of the language acquisition process.

Not only must the content itself (e.g., audio, video, text, etc.) be well designed, but developers must also pay particular attention to the pedagogical treatment that will govern how the content will be employed with learners. As stated by Chapelle (2001), "teachers, classroom researchers, and software developers need to be concerned about what kinds of CALL tasks may be beneficial" (p. 51).

Taking the use of video as an example, it is important to use an appropriate instructional design approach, rather than to do things such as simply show a video clip and then ask some questions, demonstrated to be inferior in an instructional treatment involving simple interaction with the video (Schrupp et al., 1983; Verano, 1987). Unfortunately, articles in the literature that focus on these issues of instructional design and implementation are virtually nonexistent, as illustrated by a recent "advanced" ERIC search using the specific terms "in-

structional design," "language acquisition," "materials development," and "CALL." Although searching on each of these terms individually yielded hits of 8,886, 15,037, 965, and 11,096, respectively, searching with all of the terms did not yield a single article. The same was true even with the elimination of the "materials development" term.

As an example of the sort of issue to be addressed in materials development efforts as well as in research for CALL, consider the deep prejudice that exists among many language teaching experts against making subtitles available for video for language learning. Despite the potential for using technologies such as DVD where subtitles can be turned on and off, my experience has been that some language teaching experts do not want to have any part of making L1 subtitles available to students at any point in the learning process. While there is little doubt that the institution of an appropriate pedagogy is crucial to their use, there is an increasing body of evidence that the availability of subtitles significantly increases the opportunity for the development of language proficiency (Danan, 2004; Fallahkhair, Pemberton, & Griffiths, 2005). In her excellent overview of research in this area, Danan provides a detailed discussion of principles and practices that are supported by empirical studies, taking issue with several of the prejudices relative to the use of subtitles and providing evidence supporting their use.

In one such study researchers actually documented the positive effect that the availability of subtitles can have on the development of oral proficiency (Borrás & Lafayette 1994). To illustrate this phenomenon anecdotally, consider my neighbor in Paris some years ago who was from Holland and who spoke excellent English. We would often ride the commuter train together, and one day I asked him how it was that he spoke English so well. He responded that I would only laugh if he told me but went on to say that it was from watching American movies during his youth. He explained further that the market for Dutch was so small that movie distributers would provide subtitles rather than dub the soundtracks, due to the significant difference in costs. He was convinced that being able to see subtitles in Dutch while listening to John Wayne and other American actors speaking English accounted in a major way for the development of his language skill.

Although the many similarities between Dutch and English were surely also a part of my friend's success, this phenomenon of the effect of subtitle use has been discussed by other researchers. For example, de Bot (2004) attributes the differing levels of the presence of English in countries across Europe as accounting in large part for the varying levels of English proficiency that is observed. He specifically cited the fact that television and movies are most often subtitled rather than dubbed in the Netherlands and the Nordic countries and stated that citizens attribute their proficiency to the presence of media rather than to instruction, much more so than in countries such as Spain. After acknowledging that Dutch pupils "do acquire a fairly high level of proficiency in English" (p. 10), de Bot summarizes that the proficiency level is not due to the "the good qualities of the educational system or the methodology used in language teaching," adding that the "main reason why those pupils acquire high levels of proficiency is that English is very present in their lives, in particular in the media" (p. 10). To illustrate his point, he states that anyone who watched TV or listened to music on the radio for one day in any Dutch home "would find that more than 60% of the language used on any so called Dutch channel is actually English" (p.10).

What is it about subtitles that might cause such an effect? Clearly, something is taking place at the input, apperception, and the comprehension steps of the SLA interaction model discussed earlier (Chapelle, 1998). This realization of the value of the presence of subtitles during these steps illustrates the point made earlier that the acquisition process can indeed be facilitated through the use of technology.

Finally, the development of knowledge and experience necessary for the creation of quality language-learning materials has proven to provide important insights into the nature of language and how it is learned. Over the past 7 years, student teams at BYU have participated in the creation of materials in various languages, developing in the process a significant level of understanding of language acquisition issues among graduate students and undergraduates alike that has been observed by project evaluators (Otto & Lyman-Hager, 2004). Whether working in the development of sample materials in various less commonly taught languages, an online course in Swahili, a DVD for learning Romanian, a DVD for learning Business French, or video and online exercises for the award-winning *Arabic without Walls* materials, students have developed an in-depth awareness of important theoretical and pedagogical issues that will serve them in any language acquisition environment. Indeed, students who work on the development of materials in CALL and related areas not only benefit personally, but they also make important contributions to future students of the languages for which the materials were created.

A FEW CHALLENGES FOR CALL

Challenges for moving forward can be divided into two categories: (a) political and (b) technical and logistical. With respect to the political area, most conventional materials development efforts begin with university professors who work under contract with textbook publishers. Whether having to do with this area or in the newer area of CALL, there is little to no reward for being involved in materials development efforts (Bush, 2007). Exacerbating this problem, professional advancement policies at many universities discourage junior faculty at many institutions from getting involved, due to the need to write articles in accepted areas of scholarship. The *Report of the MLA Task Force on Evaluating Scholarship for Tenure and Promotion* states that although attitudes are changing, "work presented in electronic formats is still in the process of gaining the recognition necessary for it to fulfill expectations and requirements for tenure and promotion" (MLA Task Force, 2007, p. 45).

The technical and logistical issues for CALL are in a constant state of flux, as witnessed by the incredible and rapid advances discussed earlier. Speech technology is seen by many as the Holy Grail of CALL, but it is not yet where it needs to be (Clifford & Granoien, 2008). There is every reason to believe that things could well change in this regard, but in the meantime, other important technical and logistical issues can occupy the attention of researchers and developers. For example, Colpaert stated that the future of CALL depended upon "the eventual breakthrough of dedicated CALL" (2006, p. 480). He continued, "The main problem in this respect is the gap between technology and language pedagogy. Attempts to bridge this gap have been rather unsuccessful" (p. 480).

The cost of materials development continues to be one of the thorniest of all the issues holding back such a breakthrough and is exacerbated by changing technologies and the need to develop materials for delivery on multiple platforms (Dorwick, 2002). Although the advent of the web has mitigated these issues to some extent, there are still challenges that arise as browsers move from generation to generation and as developers create materials for delivery on Macs and PCs. In addition to the benefit from the near universal appeal of the web, new tools such as Adobe's *Flex* and *Flash* add to the potential for progress. In addition, video playback with *Flash* video is now universally available due to the popularity of video services such as *YouTube*.

In order to obtain maximum benefit from these capabilities, researchers and developers must implement them in the best way, guided by effective instructional design principles implemented in a research-friendly environment (Colpaert, 2006). Such an implementation

can facilitate the development not only of interesting interactive capabilities but also of powerful research infrastructures. Implementation will enable extensive study of techniques of learning as well as language learning itself.

SHARING THE RESULTS OF CALL IMPLEMENTATION

Given the ubiquity of the web, the widespread availability of video playback, the increased functionality of development tools, and increasingly powerful and affordable delivery systems, CALL appears to be poised on a threshold of fascinating developments. Yet the fundamental problem has remained unchanged over the past four decades: What is to be done to best implement presently available technology? How might CALL be integrated into a language program along with the unique skills of the trained teacher?

Given the level of interest in technology use that has been brought on by an increasingly connected and online student population, these questions are perhaps more urgent today than in the past. Yet the discovery of answers might in some ways be more difficult than ever before. To be sure, today's technologically sophisticated context seems to call out for a different way of doing business, rendering almost anachronistic the sharing of ideas and research results through *PowerPoint* bullets in conference presentations or words in journal articles. Consider, for example, the statement that a picture is worth a thousand words and then reflect on how to describe a current, multimedia CALL application. How many words would it take to adequately describe software that enables learners to access a multitude of video clips, images, and text passages, separately, sequentially, at the same time, or randomly, all according to the individual needs of each learner? Although the classic approaches of conferences and journals will remain useful for sharing research results, they do not address the issue of how to best share the essence of complex (and correspondingly expensive) online multimedia work. Moreover, although sharing research results is important in any scholarly endeavor, the extensive investment required for CALL development demands wide use in order to provide a large number of user-learners over which costs can be amortized.

One approach over the years to the informational aspect of the dissemination problem has been the *CALICO Journal* "Software Reviews" section, which provides an excellent service to the profession. Review editors work hard to find individuals to review CALL applications, who in turn contribute significantly to the discussion of software capabilities and quality. All the same, the applicability of CALL software is very much dependent on the nature and goals of particular language-learning contexts, making it close to impossible to fully address in one software review the needs of all those who might use particular software packages.

Although such a review-based approach facilitates an initial evaluation, it does not remove the challenge of actually testing the software in the context where it would be used. Further, even if the software appears to be appropriate for use in a particular program, full integration for testing purposes can be difficult or even impossible. Reading about an interesting CALL application or even seeing it demonstrated at a conference might be sufficient to develop an understanding of the value of the ideas presented but is insufficient for colleagues who would want to embrace and/or extend through implementation the ideas instantiated in the software. Because such ideas are best expressed through software, then the software itself is most likely the best medium through which such an evaluation will be possible. Regrettably, cross-platform compatibility (or interoperability) is a serious obstacle to this type of evaluative implementation, not to mention the fact that exploration of how the software would actually be used by students can itself be a complex and even expensive process.

The challenge of interoperability has been reduced to some extent with the advent of

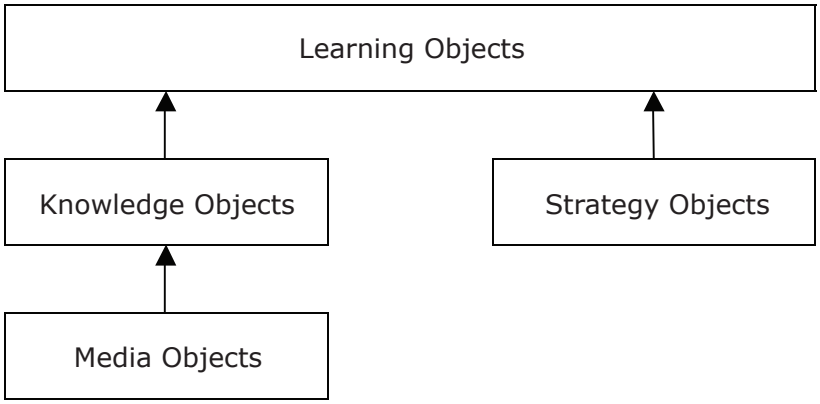
the Shareable Content Reference Model (SCORM), which seeks to foster commonality across various online learning contexts (Bush, 2002). By developing learning objects that implement the content-packaging specifications that are part of SCORM, it is theoretically possible for researchers and developers to create CALL applications that can be implemented on any SCORM-conformant learning management system (LMS). To facilitate such a process, developers of open source systems such as *Moodle* and *Sakai* have promised SCORM-conformance, and commercial producers of systems such as *Blackboard* and *Desire2Learn* claim to be compatible with SCORM as well.

With the use of SCORM-based CALL activities, the results obtained by learners are available for transfer into the grade book of a SCORM-conformant LMS. Although the recording of student performance for the most recent attempt at an activity might help a teacher assign a grade to the student, it does not facilitate the sort of deep analysis that would help evaluate the quality of the materials. How many attempts were necessary to master a particular activity? Of the various forms of help available during the completion of an activity, which ones were used most often by the learners? How does performance on various online activities correlate with the quality and level of classroom participation? These are the sorts of questions that should be answerable by the systems that administer CALL software. Answers to these questions constitute elements of what should be a rich student performance data model that would enable the sort of research discussed earlier.

The sharing of research results and finished CALL products that conform to SCORM content-packaging specifications that enable interoperability across learning management systems is interesting, but it suffers from a key drawback in terms of the relationship between applicability to a particular learning context and reusability: As applicability is designed into a learning object, reusability will decrease. It is possible to address this drawback to a certain extent, however, with the design of objects at optimal levels of granularity, that is, objects that are neither too big nor too small. It is also possible to envision sharing across other levels of design and development.

Just as it is possible to design homes that can be built by following architectural plans and using standard building products, so is it possible to imagine parallels in the development of CALL. Merrill (2008) proposed that it is possible to imagine an approach for the creation of learning objects that would entail design and development processes that implement media objects, knowledge objects, and strategy objects, integrated as shown in Figure 2. Sharing would be possible at the level of each component, with SCORM available for sharing at the learning object level.

Figure 2
Basic Components of Learning Objects (Merrill, 2008)



Media objects (MOs) could consist of a graphic, a video clip, or a reading passage. Each of these would be maintained in standard file formats such as JPG for graphics, *Flash* video, AVI, or QuickTime for video and RTF files for text. *YouTube* has created an incredibly large repository of video files using the *Flash* video format, but unfortunately sharing is not straightforward beyond providing the URL of the clip. As a result, incorporating files such as these into any sort of interactive video activity is limited at the present time.

Knowledge objects (KOs) basically contain information about media objects (metadata) that enable them to be used in online learning activities. KOs contain content but not the information that controls specific interactions with the content. For example, it is easy to imagine a still image in JPG format (an MO) that would contain examples of everyday objects in a culturally authentic setting. The knowledge object associated with this particular MO would contain names, definitions, and locations within the image where each object is located. In fact, one could easily imagine various KOs for a single media object, demonstrating how sharing can take place at each of these levels.

With respect to KOs that would describe time-based media, work at BYU has helped define the means for using a standard XML schema to describe media assets such as video (Bush, Melby, Anderson, Browne, Hansen, & Corradini, 2004). This work was necessary because existing metadata specifications were either too limited or too expansive. Too complex was the MPEG-7 standard (ISO 15938), formally named the "Multimedia Content Description Interface" which "is a standard for describing the multimedia content data that supports some degree of interpretation of the information meaning, which can be passed onto, or accessed by, a device or a computer code" (MPEG, 2004). At the other end of the spectrum was the IEEE Learning Object Metadata (LOM) that was incorporated into SCORM but was not rich enough to describe MOs at a level of granularity necessary to be useful for learning (Bush & Melby, 2006). The team at BYU worked with individuals from Japanese National Television and Motorola to develop a subset of the MPEG-7 standard known as MPEG-7 Part 9, Core Description Profile. As an example of its use, this standard can be easily transformed into other data structures that make video easily implementable in CALL applications.

Strategy objects, the remaining component of learning objects in this model, are defined by Merrill (2008) as "instructional algorithms for the presentation, demonstration, practice or application of content" (p. 13). Merrill's work over the years has described this particular class of components as transaction shells (Merrill, Li, & Jones, 1992). More recently, a research group at BYU has been investigating the application of software design patterns to the problem of representing strategy objects (Bush, Anderson, & Dunster, 2005). Essential to this discussion is the realization that any approach that disaggregates content, presentation, and instructional design strategies from each other increases the chances for sharing.

Although the technical challenges of developing mechanisms for sharing work and developments in CALL at various levels are daunting, they perhaps pale when compared with the legal hurdles that loom quite large as well. At numerous times over the years, efforts to work with colleagues at other institutions in various aspects of CALL development have been stymied more by intellectual property protection offices than by the technical challenges. All too often, efforts have been thwarted by officials who seem to have their attention focused more on dollar signs rather than on encouraging collaborative work that could help move our science and practice forward. Although the technical challenges will no doubt yield to technological advances, the legal issues promise to remain a thorn in the profession's collective side for years to come. Perhaps developments associated with the Open Courseware Consortium (see http://www.ocwconsortium.org) will mitigate this challenge over time. To date, however, this particular effort has focused more on sharing course syllabi, worksheets, and handouts, than it has on interactive applications. It would be no surprise if this work were slowed as soon as really interesting online activities begin to appear.

CONCLUSION

The implementation of CALL is not going to happen in one giant leap forward. Not only is the problem addressed here extremely complex, but technology, despite its incredible advances over the past 40 years, is just not where our imaginations would like it to be. As a result, the rapid technological advance required for a tremendous leap ahead is no more likely than would have been the creation of a modern jet liner in a 5-year crash program undertaken after the Wright brothers' success at Kitty Hawk. Even with unlimited funding, there would have been no way for them to avoid the necessary trial and error, the twists and turns of technology and the development of the necessary science that only comes with concerted research over time. Things are not different today with CALL.

With respect to instructional technology, problems arise from its misuse or from implementers not having a clear rationale of how it should be used. Unfortunately, when a new technology comes along, advocates wonder how the technology can be used for learning rather than asking which instructional problem exists that could benefit from the application of the technology. Apple had no sooner brought about the ubiquity of extremely small, portable digital audio players with its iPod than the technology's early adopters began to wonder how podcasting could be useful in an educational setting. The need for the development of effective uses seemingly penetrates our consciousness much more slowly than exciting new technologies penetrate society.

In a recent discussion with a student on the potential value of CALL and the fact that research does not absolutely confirm that technology is better than the teacher, I asked, "Which is more useful for learning, the teacher or the blackboard?" "Point well taken!" she responded. Pondering on this later, I concluded that perhaps my metaphor might not be appropriate, given that the blackboard is an inanimate object that lacks the ability to function on its own. Upon further reflection, however, it occurred to me that because the blackboard in fact provides access to what a teacher places there, it becomes a means of communication between the teacher and the student. In essence, this is the role of the computer, given that it only communicates to the student what the teacher—or a team of subject matter expert(s), instructional designer(s), graphics artist(s), and programmer(s)—have made available.

There is evidence, however, that the computer has an added advantage in that it can facilitate the student's learning, primarily due to its ability to respond to the needs of the student at the appropriate time. General learning theory informs us that learning in its ideal form takes place when learners sense a real need. One interesting aspect of CALL is that theoretically it can create a need to which it then responds, should the learner request assistance. Although this type of interaction is impossible for the computer in the context of a real conversation because of the limitations noted above, technology can assist in the input/apperception/comprehension/intake process. This ability, for the computer to create a need for certain elements of language and then to facilitate the learner's response to that need if required, is not to be discounted, despite the fact that this functionality is not at the level of real, open-ended human communication.

Finally, it is important to recognize that the study of language acquisition is an imperfect science, made difficult not only by the complexity and nature of language itself, but also by the complexity of the human mind of which language is a product. Because the transformation from hypotheses, to theories, to laws is not proving to be a simple enterprise, it is essential to implement a process that can yield information about practice as well as theory. Such a process is one that involves research which can investigate the many prejudices held by individual researchers and by the language teaching profession as a whole. Good research will support the intuitively obvious beliefs and practices of some practitioners, but all beliefs

and practices that are supposedly intuitively obvious will not be supported by good research.

By determining what sort of activities work better than others, it is possible for us to increase our understanding of the underlying mental activities that constitute language acquisition. We are then able to improve not only techniques and materials but also further our understanding of the nature of language and how it is acquired.

The end result will be to devise profiles for instruction such that the teacher and the technology work together, making contributions according to the comparative advantage each holds over the other. This will not be possible until researchers and developers find ways to share their work beyond journal articles and completed materials, enabling subsequent iterations of work to build on what has gone before.

NOTE

[1] The "Seven Language Videodisc" was the result of a project created to give the language sections at USAFA the opportunity to explore how interactive video could be used in each language. In some cases we wrote and recorded dialogues, in others we conducted interviews in the target language, and in still others we repurposed video from various sources.

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