1. Introduction

The purpose of this article is not to provide a comprehensive survey of the history of CALL (Computer-Assisted Language Learning) for Chinese. A survey of that nature, for work up to 1993, was undertaken by Yao (1996, written in 1993) and Mowry (1997). Nor is the main purpose of the article to critique individual CALL programs. Yao (1996) and Chu (1996, unpublished, parts available on-line at http://philoo.ucdavis.edu/CHINESE/online.html) provide detailed reviews of many such programs. Apart from avoiding duplication, there are two more reasons for not attempting a comprehensive survey and review here. The recent proliferation of CALL programs for Chinese, developed both in and outside of China, has made such a task a very difficult, if not impossible, undertaking. But the more important reason is the noticeable lacuna in the literature, i.e., a general discussion of the issues and practice in the use of computers for teaching Chinese. The present paper aims to fill this gap.

In recent years, with the escalating development in computer technology, a great many CALL programs have been produced. Facing this sudden deluge of CALL titles, students and teachers are likely to wonder: How effective are these programs? How worthwhile is it to spend time and money on them? How do we choose among so many offerings? Having invested much time and effort and come to the sobering realization that their labor of love may not have always worked miracles, CALL developers (including the present author) may also ask themselves: Have the initial promises of CALL been realized? How do we improve? Is there any untapped potential left in CALL?

The time has come for a critical appraisal of the state of CALL for Chinese. In this paper, we would like to address the following general questions:

• What are the strengths and limitations of CALL?
• To what extent has computer technology served language pedagogy?
• What areas have been best served and which areas can be better served?
• What are the strengths and weaknesses with current CALL programs for Chinese?
• Where do we go next?

Although the present article is organized by themes rather than by chronology or product, the general discussion will be accompanied with examples from a number of CALL programs available to the present reviewer at the present time:

1. ABC Interactive Chinese
2. Chinese Character Tutor
3. Chinese Express
4. HyperChina
5. HyperChinese (the pronunciation modules)
6. PinyinMaster
7. Professional Interactive Chinese
8. Step into China
9. The Rosetta Stone
10. Wenlin

Although it may not be possible to form a coherent picture of a particular product from the scattered pieces of commentary on its strengths and weaknesses, the particular format adopted here does allow us to gain a broader perspective, as well as maintaining our thematic focus. At the risk of incompleteness, the ten programs will be briefly described and evaluated in the appendix to the paper.

The organization of the paper is as follows: In section 2, some of the basic pedagogical assumptions will be given. In section 3, strengths and limitations of the current technology, as it applies to language learning, will be identified. Section 4 discusses the relationship between technology and pedagogy by pointing out some observed asymmetries and problems in current CALL applications. Section 5 suggests some uncommon but potentially useful CALL applications. Section 6 delves deeper into some specific issues relevant to the major aspects of language instruction, i.e., material selection and sequencing, presentation, practice and feedback. Section 7 addresses the various aspects of ergonomics, including navigation, help, terminology, integration and personality.

2. Language Pedagogy

The greater importance of language pedagogy in the technology-pedagogy cooperation known as CALL cannot be overemphasized. We therefore start our discussion with pedagogy. Advocating no particular methodology in this paper, we will nonetheless outline some of the most fundamental pedagogical principles for language teaching. While language pedagogy has seen continuous changes over the years as well as a wide range of beliefs and opinions at any particular time, the present paper takes the following to be among the central tenets of today's language teaching methodology.

2.1. The importance of meaning

Meaning must be of the utmost importance in language acquisition as well as language use. The central role of meaning favors a communicative, notional/functional, rather than a structural, approach and focus on expressiveness, as opposed to formal accuracy.
also underscores the importance of comprehensible and contextual presentation.

2.2. The importance of interaction

Interaction is as important in language learning as it is in language use. Just as effective communication requires interaction between the interlocutors, effective language learning too requires feedback, which is a form of interaction.

2.3. The importance of practice

As succinctly pointed out by Robinson (1991), 'once is not enough!' The importance of practice entails not only the central role of the practice phase of the instruction but also the necessary recycling of material.

2.4. Learner-centeredness

In the past few decades, there has been a shift in focus from teaching to learning, from the teacher to the learner. Learner-centeredness requires, first and foremost, respect for and accommodation of individual backgrounds and learning styles. In concrete terms, it gives the learner control in material selection/sequencing and the pace of progress.

2.5. Positive affect

In recent years, more and more attention has been paid to learner's emotional state, which plays an important part in student motivation and receptiveness to learning. The classroom atmosphere should be encouraging and not inhibiting.

3. Technology

In order to realize the full potential of the current technology while not overestimate its capabilities, it is appropriate to identify its strengths and limitations.

3.1. Strengths

Interactivity is a crucial strength of the new technology. The computer is interactive, first of all, by virtue of the fact that the user can gain control over learning and therefore becomes an active participant in the learning process. Interactivity also allows the instant feedback from the computer. The interactivity of the computer makes it especially suited for implementing learner-centered teaching methods.

Multimedia should be considered truly revolutionary for language pedagogy. The new technology really shines in its presentation of form and meaning. The sound and graphic capabilities of the computer not only have improved presentation, they have also made possible what conventional textbooks cannot do. Digitized audio has made possible the modeling of pronunciation. The teaching of characters' stroke order and direction has taken a giant step forward from the cumbersome representation on paper to the animated demonstration formerly achievable only with a human instructor. Still or animated graphics for illustrating meanings and speech production may both educate and entertain.

Random and rapid access allows the instant retrieval of vocabulary and grammar explanations. It also contributes to easy learner control and recycling of materials.

The computer's ability to store and manipulate data also makes it possible to keep scores, log errors and track learner performance.

The consistency and patience of the computer is not only crucial for learning by association and repeated exposure. Paradoxically, without the possible ill-effects of an over-bearing human teacher, the patient and interactive computer can provide a very user-friendly and learner-centered learning environment.

In addition to the above-mentioned general characteristics, digital speech technology in particular has enabled the graphic display of the relevant acoustic properties of speech such as amplitude, pitch level and frequency composition.

3.2. Limitations

Although speech recognition is already commercially available, as shown by Apple's recent introduction of the Chinese Dictation Kit, inherent speaker variability in a CALL situation makes speech recognition in CALL programs rather difficult to achieve. Hence the difficulty in providing feedback to learner's speech. On a higher level, due to the complexity of natural language parsing, the learners' creative and open-ended output cannot be easily evaluated.

Due to the difficulty of speech recognition and natural language parsing, the interactivity of the computer does not go far enough. Interactive conversation, which is a most valued pedagogical activity, is very hard to implement on the computer, the attempt to develop conversation simulators like ELIZA notwithstanding.

Given the strengths and limitations of the current technology, the most sensible strategy for CALL programs to adopt is to take full advantage of its strengths while not overstrain it where it is inherently limited.

4. How Well has Technology Served Pedagogy?

CALL is a cooperative enterprise between language pedagogy and computer technology. Unfortunately, advanced technology and innovative pedagogy do not always go together. Some programs fail to exploit the full potential of the new technology. Some impress
with technological razzle-dazzle but do not appear to be serious about language teaching. Some programs are based on outdated beliefs about language learning, while some have no clear pedagogical orientation at all. It is not surprising then that the pedagogical effectiveness of CALL programs can be variable indeed.

How successfully technology serves pedagogy depends on first of all the inherent strengths and limitations of the technology and secondly the way technology is used. In the following, we will examine these two aspects in turn.

4.1. Some asymmetries

Not all aspects of pedagogy are equally served by technology. We now identify a number of asymmetries which result from the inherent strengths and limitations of the current technology.

Of the four skills of speaking, listening, reading and writing, the receptive skills of listening and reading are more commonly addressed by CALL programs than the productive skills of speaking and writing. This asymmetry is rather expected. With receptive skills, the learner is on the receiving end and any response from the learner is restricted to computer-processible choice type comprehension questions. But with productive skills, the computer is on the receiving end; given the state of the technology, it cannot easily process and give feedback to learner-produced language, if the language is open-ended and/or delivered orally or by free-hand writing.

Due to the focus on receptive skills, the phases of the lesson that are best served are the initial ones of presentation and comprehension checks. The presentation of lessons has not only been aided by multimedia, it has also benefited from the easy retrieval feature of the computer in providing on-line explanations and maximal redundancy in such explanations. Comprehension checks are facilitated by the interactive capability of the computer. But practice, the most important phase of the lesson, has to be restricted to the less open-ended exercises. The asymmetry between the receptive and productive skills is thus manifested in the 'big head, small tail' imbalance in the structure of the lesson.

In terms of the level of instruction, the beginning level has attracted the most attention from CALL developers. This is not surprising either, considering the disproportional attention on receptive skills, which are more basic and closely associated with the beginning level.

The most common areas addressed by CALL are pronunciation, vocabulary and characters, for good reasons. These time-consuming but less creative tasks turn out to be what the computer is best suited for. Not only can these tasks take advantage of the consistency and patience of the computer, they can also capitalize on its data-handling and multimedia capabilities. Two programs that have taken good advantage of the computer's data handling capability is Flashware's Chinese Character Tutor (henceforth CCT) and Wenlin (henceforth WL) by Wenlin Institute. Both programs feature large databases of words and characters and extensive sorting, grouping, listing, searching and viewing options. A pronunciation program that has made good use of the multimedia capabilities of the computer is PinyinMaster (henceforth PM) which features voice-over help, movie clips of the speaker's lip movements in addition to digitized sounds for the whole inventory of possible Mandarin syllables.

In contrast, the teaching of grammar is not as common. Although many CALL programs (such as ABC Interactive Chinese, HyperChina, Professional Interactive Chinese, henceforth ABC, HC and PIC respectively) include grammatical explanations similar to those found in conventional textbooks, teaching grammar in a way that goes beyond explanations is a challenge that has not often been met, with perhaps the exception of HyperChinese (the grammar modules). The creativity and abstractness of grammar requires real ingenuity when designing exercises for it.

4.2. Technology, pedagogy and linguistics

The success or failure of CALL programs also depends on the judicious exploitation of technology, informed by knowledge of language structure and language pedagogy.

First of all, it will be unfortunate if we do not take full advantage of the new technology, or worse, if we use the new technology to simulate outdated technology. For example, random access affords the user faster and easier access and control than audio and video tapes. It is thus quite mystifying for a number of programs to simulate the control format of tape recorder. In their Language Lab for Characters, ABC and PIC use the tape recorder control panel quite redundantly, when the characters are already accessible randomly by clicking on them. The only use for the panel, with its REMIND, PLAY, FAST FORWARD and STOP buttons, is to enable someone to sit back and listen to the whole set of characters to be played one after another, exactly the kind of thing we find so objectionable with the traditional language lab! Chinese Express (henceforth CX) even makes it the only form of access in its presentation of dialogs. Random access also makes it easier to relate different items not contiguous to each other. It is thus a pity that a program like CX leaves different parts of its cd-rom (dialogs, words and phrases, talking dictionary) unconnected to each other. PIC can also be improved by linking up its dictionary, flashcards and vocabulary builders.

The use of technology has to be guided by pedagogy. Otherwise, even an acknowledged strength of the technology can be mis-used. As observed by Higgins&Johns (1984) and Last (1989), the computer, with its endemic drills-and-practice thanks to its patience and consistency, seems to have served audio-lingualism particularly well, which emphasizes repetition and imitation for the sake of formal accuracy. In general, CALL programs have not kept up with innovations in language pedagogy. With respect to syllabus design, most CALL courses are structure-driven rather than functional in the sense of Wilkins (1976). Nor do we find many task-based programs like Phiilippe for French, which requires the learner to use language in order to find apartment accommodation in Paris.

Pedagogy also has to be the raison d'être behind the application of technology. Otherwise, the use of technology may well be gratuitous. As Chu (1996) pointed out quite astutely, some of the games found in ABC and PIC are mostly devoid of pedagogical value (Connect characters, Falling characters, Puzzle). The desirability of multimedia notwithstanding, the quicktime movies used to accompany the
Technological know-how also has to be supported by linguistic informedness. An example of the mis-use of the advanced technology of speech analysis is the visual comparison of speech wave forms, found in Pic. Though voice comparison as found in many programs can be helpful, the visual comparison of speech wave forms, however, is not useful to the same extent. The reason is that the visual representation of speech wave forms only transparently convey amplitude and the timing of the speech signal but not other distinguishing characteristics. Differences in stress and duration will be clearly visible but not segmental characteristics. Therefore, different sounds (such as vowels) will look alike, if they are pronounced with similar loudness; but the same sound can appear different, if it is pronounced with different loudness on different occasions or by different people. Realizing this, PIC is quite candid in admitting the unreliability of such comparisons. Why then include such a feature of dubious value which will certainly undermines confidence in the product?

When linguistically informed, however, the use of speech analysis can be quite helpful, either by increasing awareness of errors and by providing motivational benefit (Stenson, Downing. J. Smith & K. Smith 1992). Pitch tracking, whereby tonal contours are shown visually, can provide useful feedback for students having problem with tones and intonation (Chun 1989). Spectrograms, with which wave forms are sometimes confused, do reflect differences in sounds. Therefore, comparison of spectrograms, while by no means easy, can be pedagogically useful, when a learner can't detect a difference aurally.

5. Further Uses of CALL

Have we fully exhausted the potential of CALL? The answer, happily for the CALL user/developer, appears to be negative. While there are areas that have been served by an over-abundance of programs, there are also areas that can benefit from more uses of CALL. In the following, we identify some such areas:

5.1. Function-based instruction

We noted earlier that CALL programs have typically been structure-based. There is nothing, however, that prevents us from using the computer for functional communicative teaching. Instead of organizing the syllabus around such structural concepts as interrogative and imperative sentences, we may use the functional ones such as request and command. Given the lack of one-to-one correspondence between form and function, organizing the syllabus around notions and functions would mean the impossibility of maintaining a graded structural syllabus. But with the maximal redundancy made possible by on-line help, the need for grading is greatly reduced and hence the argument for the structural syllabus loses much of its force.

5.2. Special-purpose Chinese

Most CALL programs are designed for general linguistic abilities. Fewer have been designed for more specific purposes. Two programs that seem to target the traveler to China, for business or pleasure, are CX and Step into China (henceforth SC). More specific purpose programs for such areas as Business Chinese should be most welcome.

5.3. Students with background

Just as the traditional curriculum has always targeted the true beginner with no language or literacy background, most of the CALL programs have also been designed with such an audience in mind. However, as student demography has changed in many parts of the country, more CALL programs that serve students with background should be developed. The following kinds of programs would be very useful to such students:

Pronunciation programs for dialect speakers.

Programs teaching romanization to Mandarin speakers. They teach not pronunciation but sound-letter correspondence. Similarly, programs teaching the correspondence between Pinyin, Zhuyin and other systems would be very useful for learners and teachers who already know one of the systems.

Programs teaching the correspondence between the simplified and traditional styled characters would be useful for learners and even teachers who already know one style.

Mention should be made of some programs that have taken into consideration the needs of students with background. The aptly named ABC Interactive Chinese, based on a series of textbooks produced in Taiwan for overseas students, is clearly targeted to heritage students. With its use of characters and drills targeted to pronunciation errors of dialectal speakers, HyperChinese (the Pronunciation modules, henceforth HCS) can be used with students with background. PM's use of characters and quadrasyllabic phrases also suggests its potential use for dialectal speakers.

5.4. Facilitative learning environment

CALL programs do not have to be tutors and courses, which teach directly by providing pre-planned lessons, instructional guidance, exercises and tests. They perhaps can, like the modern human teacher, also take on the role of facilitators by providing a learner-friendly and learner-centered environment. Such an environment should provide, within easy reach, all the tools necessary to read or write whatever text the learner chooses. Resources of such a learning environment already exist. What is needed is better integration of the different resources. Two of the most important resources are the text reader/editor and the dictionary.

The computer text-reader/editor (which is more descriptive, albeit more awkward sounding than the common name of word processor)
is far superior for pedagogical purposes to the conventional way of reading and writing. Reading electronically, even without on-line help in vocabulary and grammar, can help pronunciation and listening when digitized or synthesized sounds are available. Writing electronically can allow one to gain facility in romanization, recognition of characters and differentiation of homonyms, all the while when engaged in some more creative tasks.

The dictionary represents one of the best uses of the computer technology. The most important advantage over the conventional printed dictionary is the ease of sorting, retrieval and cross-referencing. The possibility of adding audio and video simply renders it even more superior to the printed medium.

However, when the two resources are not linked together, neither enjoys the full benefit of the new medium. An isolated text reader/editor will not be able to provide instant vocabulary help and hence make reading and writing more arduous. Using a standalone electronic dictionary requires extra effort and hence it may not get as much use as a printed dictionary.

But when a text reader/editor is married to a dictionary, a powerful learning environment is born. An example of such an environment can be found in WL, a text reader/editor (for all possible formats: GB, Big5, HZ, Unicode, ASCII etc.), with instant links to a huge database of words, characters, etymological and frequency of occurrence information. These links allow the user to instantly look up words and characters in reading or writing. Although programs like WL are still uncommon, it is encouraging to find some well-known Chinese word processors becoming more than writing tools. NJstar, for example, has incorporated an on-line dictionary and character to pinyin conversion. Some programs, such as Twinbridge, have added the text-to-speech function.

Although lacking a sense of teacher presence, there are a number of advantages to the learning environment described here. First of all, while tutorials and self-study courses are closed-ended and their usefulness does not last beyond the materials covered, a facilitative learning environment can have longer life-spans. Secondly, these tools can be flexibly integrated with any curriculum. Thirdly, the use of such tools encourage learner initiative, which is necessary for their use. Last but not least, while standalone tutors and courses are severely constrained in their capabilities by the medium, reference and learning tools represent the best applications of it.

5.5. Templates, authoring systems and textbook development aids

CALL programs have typically been designed for students. However, teachers and material developers can equally benefit from the new technology.

One kind of program for the teacher and material developer, still quite uncommon for Chinese, are authoring systems and open-ended templates that allow teachers to develop and customize CALL programs easily and quickly. Templates and authoring systems enjoy certain advantages over both finished commercial products and those that result from in-house development. Commercial products may not be exactly what the teacher wants but in-house development can be time-consuming and technologically daunting. Templates and authoring systems however do not require programming skills and they can be designed to fit local needs. Although none of the programs mentioned in this paper are authoring systems and templates, it is encouraging that some programs have incorporated the feature of user customization. ABC and PIC, for example, both have a teacher's edition, which allows the addition of lessons. WL and CCT also allow the addition of user terms.

CALL programs can even help the development of teaching materials. Wouldn't it be tremendously useful for the textbook writer to have a text editor linked to the following resources/information that can be easily retrieved and incorporated?

- multi-media resources:
  - complete digitized syllable inventory
  - still and animated graphics, movie clips
  - a database of words and structures with:
    - definitions and explanations
    - example sentences
    - frequency and collocation
    - level of difficulty
    - usage tracking within current text

How much more systematic and yet less labor-intensive would the textbook writing process become! Yet this is not altogether a pipe dream. With its flexible grouping feature that can list dictionary entries according to frequency, number of strokes, pinyin, English gloss, WL can be used as a useful resource for teachers.

5.6. Research

With its local and global search and frequency count feature, WL can also be used as a research tool by linguists and stylisticians alike in various linguistic and literary endeavors. CALL programs for student use can also be augmented with data collection and analysis capabilities, both for diagnostic and research purposes. For example, pronunciation programs with testing and record keeping capabilities can be used to study the acquisition of phonology. When equipped with different romanization systems, they may even be used to compare the relative efficacy of the different schemes.

6. The CALL Classroom: Some Specific Issues

We now turn to some specific issues in CALL. We will do this by going through the most common components in any instructional
6.1. Selection, sequencing and learner control

One of the differences between CALL programs and conventional language classes is that in the latter the selection of material is pre-determined and lessons are sequentially ordered and proceed at a fixed pace, the selection, sequence and pace being all determined by the teacher. The computer, thanks to random-access, allows the learner to control selection, sequencing and the pace of learning. Learner control allows accommodation of individual differences in background and ability and therefore may increase the efficiency of the learning process. To allow learner control, however, we must provide maximum redundancy, with on-line help for all vocabulary and grammatical items.

The desirability of learner control has often been taken for granted. But a critical reexamination is necessary, as pointed out by Dunkel (1991). Some learners, especially those at the beginning level, may feel overwhelmed when confronted with many choices. They may feel more comfortable following a teacher-suggested sequence of activities. The guidance of a teacher can be comforting and provides a sense of security. How to take advantage of both teacher planning and user-control indeed is a tricky balancing act.

Most of the programs mentioned in this paper allow the user some choices. PM, for example, allows the user to choose the range of sounds to practice and be tested on. Some programs, however, also retain some degree of teacher control, with different amount of success. In the drill section of HCS, the learner has to follow long and tedious teacher-led listen-and-repeat sequences. Giving learner the choice here as to what to listen and repeat would be more appropriate. SC decides for the learner what the new words and expressions should be for each lesson (the underlined items) and offers explanations for only these items. This again seems hard to justify other than that it is following most conventional textbooks. More judicious is The Rosetta Stone (henceforth TRS)’s decision to offer a choice between learner control and teacher control. Therefore, in addition to learner-chosen combinations, tutorial sessions are also provided that follow a fixed sequence of activities such as listening alone followed by a combination of listening and reading.

6.2. Presentation

6.2.1. The use of technology

The three features of the computer technology that are relevant to the presentation phase of the instructional cycle are multimedia, easy access and timing control. We will now examine the application of these three features in turn.

Multimedia presentation, which render CALL programs far superior to conventional textbooks, have been used to various extent in all CALL programs. All programs mentioned in this paper feature digital audio. Half of the programs (ABC, HC, PIC, SC, WL) feature animated demonstration of character writing. ABC, PIC use animation and PM uses movie clips to demonstrate the production of speech sounds. WL uses still graphics to show character shapes at various historical time periods. TRS depends solely on graphics to convey meanings. But despite the potential presentational advantages of CALL programs, the basic format of presentation remains similar to conventional textbooks. In most of the programs referred to in this paper, the initial presentation is still done mostly with the written form, either in romanization or in Chinese script. Meanings are also mostly conveyed with English glosses.

Why is it a problem to present with the written form? Most importantly, speech is primary while writing is secondary. The question is not whether written representation should be used but when to introduce the written form relative to the spoken form. With a human teacher, the spoken form can be introduced before the written form; in a conventional textbook, the spoken form cannot be presented without the written form. But there is no need for CALL programs to put up with the limitations of the print medium. As programs already provide audio along with the written form, it is then just as easy to present the spoken form without the written form. One program that does allow audio-first presentation is TRS, which clearly separates text and voice and offers all the possible combinations, such as text with voice, text without voice and voice without text. The second problem with pure written presentation is the assumption of literacy, which cannot always be made. So if someone does not know romanization or characters, it does not mean that s/he does not know how to speak, and vice versa. This realization can be especially important in a testing situation, where the validity of the test can be compromised by a mixing of skills.

The problem with the exclusive use of English glosses to convey meaning is that it is indirect as well as possibly misleading. Admittedly, CALL programs are not particularly worse than conventional textbooks, which do the same thing. But CALL programs can have many more resources than a conventional textbook. A more direct mode of presentation, especially for concrete vocabulary, is eminently possible. An early program developed by Yao and Mowry, modestly named Miss Li and Mr. Wang, uses simple animation to teach the action verbs for dressing and undressing. Of the programs mentioned in this paper, TRS’s conveying of meanings is exclusively with pictures. PIC uses pictures to convey meanings in both the flashcard stack and the interactive vocabulary builder.

The easy access allowed by the computer has a number of desirable consequences for presentation. It allows instant retrieval of help for pronunciation and comprehension, with the simple ‘when in doubt, click’ format. We can thus avoid the pre-teaching of vocabulary, which is out of context and can miss the target altogether due to individual differences in learner backgrounds. The easy availability of help also enables, paradoxically, the option of hiding the help initially, hence making it possible for the learner to challenge themselves. Furthermore, since every grammatical and vocabulary item in a lesson can be linked to a shared pool of glosses and explanations, an extreme form of redundancy and recycling is possible. This redundancy and recycling further encourages learner-choice in lesson selection and sequencing.

The programs reviewed here make use of the easy access feature to various extents. For example, while ABC, HC, PIC and SC opt to present part or whole of a dialog on the screen, CX presents it one sentence at a time, in a sequential fashion. Obviously, it is harder for a CX user to locate a particular word or sentence. While most programs do not pre-teach vocabulary, HC presents the vocabulary
separately, before the dialogs, thus taking the vocabulary out of context and making it hard to provide help for every linguistic item in the dialogs. While SC, ABC and PIC provide on-line vocabulary and grammar explanation only when requested, HC uses such optional on-line help for grammar only and opts to provide glosses to words and sentences obligatorily, thus missing an opportunity to challenge the learner. Programs also differ in exploiting the maximum redundancy the easy access feature makes possible. With no graded lessons of its own, WL has to provide instant lookup to every word and character. Though their vocabulary help is a bit hard to use ABC and PIC also provide glosses for every character and word in the text. SC, however, provides vocabulary help for only pre-determined new words and expressions. By having pre-determined vocabulary for every lesson, HC also does not provide maximum redundancy.

Timing, impossible to do in a printed textbook, has been used in some CALL programs. Users of CCT can opt to incorporate delay of different amount in the presentation of audio, text or characters. It too uses user-selectable time limit in its tests. In its vocabulary drills, HC uses delay in presenting the audio or the written form. The use of delay introduces the element of challenge without actually turning it into a test.

6.2.2. Comprehensibility

Comprehensibility should be the most important consideration in presentation. Help in this regard can also be inadequate. In its presentation of dialogues, CX gives glosses only to the whole sentence, having no explanation for the meanings of words and phrases. While this may be justifiable for ABC, whose audience is Chinese speaking children with no problem in comprehension, it would not be for CX. As Chu (1996) noticed, HC provides English translation of only whole passages in the extra readings. In their presentation of dialogues, HC and SC provide glosses for only the vocabulary items that the programs consider new for the current lesson. No redundancy is provided. This will be justified only in the unlikely scenario that the course is followed sequentially, the student backgrounds are uniform and students can learn new material with just one exposure.

However, it should be pointed out in this connection that although most CALL programs assume, as most textbooks do, the explicit presentation of grammar and vocabulary, it is by no means the only option. A program that teaches grammar and vocabulary implicitly by induction is TRS. In the whole course, no grammar and vocabulary is identified and explained. To enable induction, TRS relies heavily on minimally contrasting sentence groups and still pictures, which are designed to show the patterns of grammar, as well as the meanings of vocabulary items. Certainly viable as an option, the implicit and inductive approach to presentation requires careful planning of the text, which otherwise can become unnatural as well as incomprehensible.

Another problem leading to incomprehensibility is to take zi, unit of the written script, rather than ci, unit of the spoken language, as the basic unit to construe the sentence meaning from. As Chu (1996) observed repeatedly in a number of programs she reviewed, characters, rather than words, are often assumed to be lexical units in that only characters are given meaning glosses. Computerized flashcards, which are quite popular, are often character-based as well. Of course, conventional textbooks are often no better. The problem with this practice is that the meanings of characters, if existent at all, are often not related to the meanings of larger combinations in a compositional manner. A more linguistically informed practice would be to take ci as the units of vocabulary and character meanings would be mentioned, if at all, only for the purpose of etymology and relating groups of words for better retention. The programs mentioned in this paper vary greatly in this regard. Even though word meanings can be obtained ABC and PIC seem to accord more importance to the character. While CCT does not teach all aspects of characters (leaving out such a crucial feature as the animated demonstration of character writing), it gives as much weight to words as to characters. While correct in practice, SC is often mistaken in its terminology. WL should be commended for its two tiered solution. Its database includes information on bothzi and ci. But for its default instant lookup mode, the meanings of compounds are given first and the user can further click on individual characters to find out their meanings.

6.3. Practice

The most important pedagogical activity is undoubtedly the exercises, including drills, games and quizzes. While many conventional textbooks are rather weak in this area, leaving it largely to the device of the teachers, most CALL programs have rightly taken advantage of the interactive capability of the computer and have provided various exercises. In this section, we survey the main types of exercises, both for receptive and productive skills, critically appraising their strengths as well as limitations and suggesting ways to overcome the limitations.

6.3.1. Receptive skills

The current state of technology asymmetrically favors the teaching of the receptive skills of listening and reading. There are many more exercises for receptive skills than productive skills. Although various names are given to them, they are basically all objective tests that simply match learner responses with pre-determined answers stored in the computer. There are two most common subtypes:

a. Find/identify: In such exercises, the computer presents a linguistic token aurally and then a number of choices visually, one of which is the correct answer. The user finds/identifies and clicks on it. The choices can be non-linguistic, such as pictures, or linguistic, such as sounds, syllables, words or sentences. Hence the exercises practice either listening alone or a combination of listening and reading. Some examples are:

• find the character/pinyin you just heard
• find the picture corresponding to the word you just heard
• find the translation that correspond to what you just heard

b. matching: In such exercises, the computer presents multiple tokens visually, two of which match in one of the following ways:
Matching practices recognition and/or comprehension.

While all the receptive exercises invariably are interactive by providing immediate feedback, the quality of feedback is often quite problematic, as we will discuss in more detail in section 6.4.

6.3.2. Productive skills: going beyond imitation

Due to technical reasons, the exercises for practicing productive skills are more limited in format and effectiveness. The most common format is imitation without feedback. A model of a sound, syllable, word, phrase, sentence or a character is given and then learners are expected to imitate the model. Neither interactive nor creative, this kind of exercises smack of behaviorism and audiolingualism. The lack of creativity renders the format suitable only for the initial stage of learning; the lack of feedback makes the learner unable even to ensure the quality of imitation. Is there any way to incorporate feedback and creativity in productive exercises?

To be sure, there has been an attempt to remedy the lack of feedback. One common practice, found in all programs except CCT and WL, is to compare the model pronunciation with that of the learner. While such comparison may serve some pedagogical purposes, for judging the quality of learner's speech, it is neither as direct or valid as speech recognition. Such comparison assumes that the learner can detect the difference between their own production and the model's in the first place.

The problem of feedback stems from two sources, one being the difficulty with speech and hand writing recognition, the other the involvedness of processing open-ended language. One strategy adopted in some CALL programs is to dodge these two difficulties. Text in machine-understandable codes is used instead of speech and free-hand writing. Matching with pre-stored answers, instead of parsing, is used to judge the learner's response. A good example, found in ABC and PIC, is dictation requiring the use of typing. There is no parsing of open-ended language, since the learner is only expected to produce what the computer dictates; there is no recognition, since only the keyboard is used. Another kind of exercise, found in ABC, HC, PIC and SC, is rearranging scrambled sentences. A similar kind of exercise, which deals with only one part of a sentence, is fill-in-the-blank or substitution drills. The learner either chooses from a list of given words or types in any word from the keyboard. The descrambling and fill-in-the-blanks exercises can easily provide feedback, when pre-determined answers are stored in the computer and only the keyboard and/or the mouse is used to respond.

The next, more difficult, step with respect to feedback is to address the problem of speech and hand-writing recognition. Although speech recognition is commercially available, but due to the consistent speech characteristics required by speech recognition, the technology may not be ready yet for language pedagogy, where inter-speaker variation is to be expected. It is unfortunate that PIC claims to feature speech recognition, when in reality it does not work well at all. Hand-writing recognition fares better. A number of commercial products are currently available. A CALL program that goes beyond the copy-the-model mode of practicing character-writing is WL. The program not only checks the visual configuration of the written character, it also is sensitive to stroke order, thereby giving feedback not only to the final product, but also to the process of character-writing. In the teacher's edition of ABC and PIC, hand-writing recognition is available as one input method. This advanced feature can well be extended, a la WL, to these programs' character-writing component to provide feedback to student's hand-writing.

The problem with the lack of student creativity is more difficult to overcome. Of course, in a trivial sense, we can require the learner to do as many creative productive exercises in a computer program as we can in a conventional textbook and the result would not be any less effective. In HC, for example, there is a 'how to say' section, which attempts to coax the learner to produce creative speech. But without feedback from the computer, these exercises are about as helpful as a conventional textbook without the feedback from the human teacher.

In the following, I suggest, by way of a sentence making exercise, that creativity, albeit of a very limited kind, can be achieved without going beyond pattern matching.

The sentence making exercise can be used for teaching vocabulary as well as teaching grammar. The exercise requires the user to make sentences patterning on an existing model. All the sentence slots will be given. The words used will also be provided, for example, in a word list. All the user has to do is to put in the right word, one by one, in the right slot. Since students have a range of choices in what words they use instead of using the exact words given beforehand, they enjoy some degree of creativity and may come up with unexpected combinations of words. Feedback is still possible by using pattern matching. Instead of matching individual words and sentences, as required respectively in fill-in-the-blank and descrambling, the feedback can be based on a more abstract matching algorithm such as the matching of parts-of-speech or sentence slots. Unlike descrambling, this exercise focuses not on individual sentences but on sentence patterns; unlike fill-in-the-blanks, which focuses on one sentence slot, this exercise requires the global ability of sentence construction; unlike both de-scrambling and fill-in-the-blanks, this format is more like the real-world use of language in producing the whole sentence in the natural word order.

6.4. Feedback

A major reason for the usefulness of CALL programs as tutors lies in their ability to provide feedback. Just as different human tutors can choose to give feedback differently, there are also a number of options for providing feedback in CALL programs. Feedback can merely inform the learner of error. It can also provide hints for the benefit of further trials. It can also go further and provide the correct answer. Feedback can also be explicit or implicit. It can directly tell the learner the error or the correct response or it can rephrase the learner's response or asking a clarification question containing the correct response. Feedback can also be immediate or delayed.
Despite all the possible feedback options, possibly due to the ease in implementation, immediate and explicit feedback seems to be the mostly commonly used. While any feedback is an improvement over a printed textbook, it should be pointed out that doubts have been expressed, for example, by Dunkel (1991) and Robinson (1991), concerning the desirability of immediate and explicit feedback. Robinson (1991) suggests that it may be better to for learners to arrive at the correct answer by discovery strategies rather than by direct program disclosure.

Although most CALL programs employ feedback, there remains much room for improvement in the quality of the feedback. The common problems with feedback are:

- categorical judgment
- lack of explanation
- negativity

They all contribute to reduce the usefulness of feedback. They also run counter to the spirit of modern language teaching philosophy. Categorical judgment emphasizes absolute accuracy rather than the more realistic goal of fluency; lack of explanation reduces language learning to simple trial and error, rather than a cognitive process; the negativity of feedback is detrimental to student affect. But feedback does not have to be this way. We will now suggest some ways to make feedback more helpful and less negative.

The categorical judgment typical of feedback is due to the mere matching of the student's response with the key. This can still be helpful if the range of possible responses is limited, such as in yes/no, same/different or multiple-choice type questions. But such feedback would not be very helpful when the range of possible answers is large. Take the examples of the dictation of a longer string or a sentence descrambling exercise. Simple matching will consider correct only the response that matches the key in every way and regards all other responses as wrong. This is very unlike the typical feedback from a human teacher. If a student has most of the sentence right but one word or letter wrong, a human teacher would count it as mostly correct. But the simplistic feedback scheme will treat it as wrong as if nothing in the sentence is correct. This would be very unfortunate. The student would not know how far the response is from the truth and how to improve. One way out would be to avoid questions that can have a wide range of possible responses. Instead of rearranging whole sentences, the drill can be limited to phrasal level units, which have fewer chances of errors.

But the more interesting strategy is to confront the problem head-on. Instead of using simple categorical feedback, we can try to indicate degrees of correctness. One simple way is to use percentage based on simple error counting.

The second problem with feedback is the lack of explanation. Again, the lack of explanation is very unlike a good human teacher, who most likely would be helpful enough to impart to the student not just that a response is wrong, how much of it is wrong but also what is wrong with it. How can we make feedback more explanatory? Two strategies, still based on simple matching, can be used. One way is to identify not just the number of errors but also the location of errors. Such information should be easy to obtain from simple matching. Such feedback indeed is given in ABC and PIC in their sentence descrambling game. The second strategy is to identify the type of errors by matching a structural template with elements of the learners' response. In a dictation of syllables, for example, learner errors can be analyzed according to type, i.e., whether the error(s) are with tones, initials or finals. The feedback messages can then incorporate the results of these analyses.

The last problem is the negativity of feedback, which tends to be more seriously registered (Robinson, 1991) than positive feedback. One way to temper negativity is of course simply to reduce the amount of negative feedback. In doing this, one does not have to compromise the distinction between right and wrong either. For its flashcards, WL has adopted an interesting practice: when an answer is correct, a reward will be given; but when an answer is wrong, no penalty will be dealt out. The second way to reduce negativity is to improve the quality of negative feedback. Negativity is not just an inherent feature of negative feedback itself; it can also arise from the way negative feedback is given. To be repeatedly told that an answer is wrong is surely discouraging; but when no explanation is given as to how wrong the answer is and how to correct it, it becomes frustrating. Less categorical and more explanatory feedback will therefore lessen the impact of negativity. Instead of focusing on what is wrong, we can focus on what is right; instead of simply negating a response, we can build on and improve on it.

7. Ergonomics

No matter how technologically sophisticated and pedagogically effective, a program will not get used if it is not user-friendly. In this section, we highlight a number of areas contributing to the overall ergonomics.

7.1. Menu, toolbar and navigation

To facilitate usage, menu items should be descriptive; toolbar icons should be intuitive and navigation should be fast, simple or familiar to the user already.

The difference in menu clarity can be seen in the two pronunciation programs. While HCS has rather descriptive menu items, the rather distinctive exercises in PM are opaque named Drill 1, 2 and Exercise 1, 2, 3.

The integrated courses can be used to illustrate the difference in toolbars. HC has very suggestive toolbar icons, while some of ABC, PIC and SC's icons are rather opaque and hard to remember.

The two hypercard derived programs can be used to show the difference in navigation facility. To get around HC is fast and easy, as its two navigation patterns, hierarchical and sequential, are familiar conventions for hypercard stacks. Its near namesake, HCS, however, suffers from redundant steps and ad hoc navigation quirks (Zhang 1997).
7.2. Help
In most CALL programs, on-line help is presented in pop-up text windows or dialog boxes. Such a format has the advantage of requiring less harddisk space, but reading the text can be tedious, especially when the text is long.

But on-line help does not have to be delivered this way. For example, PM uses a combination of voice-over and visual pointers. PIC also provides voice explanations. This kind of non-text help, although taking more storage space, requires less reading and better simulates interaction with a human teacher.

It seems that despite on-line help, the hard copy manual still has a number of advantages. The hard copy manual will certainly cater to some users’ preference. While on-line help is hidden, a hard copy manual's content is plainly visible and its bulk can indicate the extent and depth of help. Among the programs reviewed here, CCT, PIC, TRS and WL all have rather detailed user manuals while the other programs have done away with the hard copy manual altogether. TRS not only has hard copy manual, it also has hard-copy script for all the lessons and a teacher's manual for using the program.

7.3. Terminology
With developers from diverse backgrounds, it is not surprising to find the terminological laxity and confusion in CALL programs. To wit: pronunciation is phonics in ABC and PIC, a character is called a word in SC. Even though the correct reference may be identifiable in context, the terminological blunder may distract from the credibility of the program.

On the other hand, some programs, such as HCS, do not hesitate to use highly specialized linguistic terminology. While technical terms have definite meanings among linguists, they may not be the most descriptive and the most memorable for the user. Many of the terms only add to the burden of memorization and their pedagogical values are rather dubious. Therefore, Teng (1997)'s point was rather well-taken: 'the use of highly technical and specialized terms used in linguistic writings should be avoided and modified'.

7.4. Integration
The ability to have everything within easy reach should be an important ergonomic consideration. The best way to reach everything is, of course, to integrate all of them in the same program. Instead of having a separate dictionary, a separate pronunciation tutor and a character tutor, we can incorporate these different components into one program with close links between the components. The argument for integration also goes beyond ergonomics. Integration also provides the larger context and justification for the separate components. For example, pronunciation and vocabulary can both be better learned in connection with the lesson.

It will be unfortunate if components within a single program are not related to each other. Interestingly, the five integrated programs referred to in this paper are not integrated to the same extent. One extreme example of compartmentalization is CX, whose different components such as the word list, dictionary, dialogs, China-related informational texts are not related to each other at all. ABC and PIC are much better in this regard.

7.5. Personality
CALL programs can have personalities as well. Some are charismatic and inspiring; some are quiet but helpful; some are pedantic and overbearing. Some are more fun than others. However, tastes do differ. What is charismatic to one may be overbearing to another; what is cute to one may be too cute to another. Though very hard to please everybody, the personality of a program should nonetheless be considered, if only to avoid jarring audience’s sensibilities.

Appendix

Brief Descriptions/Evaluation of Software and Contact Information:

1. ABC Interactive Chinese (ABC), 1 Windows CD-ROM
Amtrade Products Inc.
675 Brea Canyon Rd. Suite11
Walnut, CA 91789
Phone: (909) 595-1669
Fax: (909) 595-1971
$25 (basic); $99 (deluxe, including teacher's edition)

An self-study course meant for children of overseas Chinese. Lessons are based on Huayu Keben published by the Overseas Education Bureau of Taiwan (book 1 through book 9), but with pinyin and simplified characters added. Features include games, karaoke read along, animated display of speech production and character demonstration, recording, printing and English-Chinese dictionary. Notable for its voice-over explanation, innovative pronunciation and dictation exercises and student performance monitoring. Similar in format to Professional Interactive Chinese.

Some games do not provide pedagogical benefit. On-line vocabulary glosses hard to use. Somewhat character-based. Some uses of tape recorder control panel redundant. Menu icons and terminology confusing. (Reviewed by Chu 1996)

2. Chinese Character Tutor (CCT, version 5), Windows program on 8 high-density disks
Flashware International
E-mail: 71045.3475@compuserve.com
A feature-rich learning tool based on a large database of Chinese words and characters with extensive sorting, grouping, searching, viewing, printing and testing options. Includes main, user-defined dictionaries and vocabulary from two commonly used textbooks (Elementary Chinese Readers and Practical Chinese Reader). Option to find words, characters, phrases or word groups by sound, meaning, radical, subjects, index, lesson, frequency and shared characters. Notable for wild card search, parts of speech information, highlighted correspondence between simplified and traditional characters, auto-display, delayed presentation for self-testing, time limit in tests, performance tracking, user folders and user-addition of entries/sounds and annotations. Potentially useful for teachers and researchers. With detailed and clear documentation.

Animated demonstration of character not available. Grouping the features into basic and advanced categories and more guidance in the use of the wealth of features may enhance its use potential. (Reviewed by Chu 1996)

3. **Chinese Express (CX)**, 1 Windows CD-ROM
   Perfect Media Inc.
   Distributors:
   SUP Bookstore- 818-293-3366 Monterey Park, CA
   V&W Bookstore- 562-865-8882 Cerritos, CA
   I.Q. Star Bookstore- 562-860-7827 Cerritos, CA
   Great Wall Bookstore- 213-617-2817 Los Angeles, CA
   ProSoft Training Center- 818-282-6280 Monterey Park, CA
   $29.95

   An inexpensive program for the casual browser. Components include bi-lingual cultural and business information about China, a list of words and phrases, dialogs on travel-related topics, and a mini English-Chinese Talking Dictionary. With recording option, digitized images and quicktime movie clips.

   Different components are not related. Sequential presentation of dialogs sentence by sentence makes locating a sentence cumbersome. Translation provided for only whole sentences or passages. No vocabulary help for dialogs and texts on China. Movie clips not very useful.

4. **HyperChina (HC)** Mac program on 19 high-density disks
   Sinologic Software
   Phone: 800-869-9654 OR 510-420-0634
   www.sinologic.com
   $195

   A self-study course notable for its keenly felt friendly and enthusiastic teacher presence, detailed explanations on grammar and usage, high quality of production, simple and elegant layout, user-friendly ergonomics and imaginative packaging. Features include recording, animated characters, and a dictionary. Other notable features include delayed presentation for self-testing, musical clips, innovative presentation of map, calendar, date and time, currency conversion and restaurant menus.

   Pre-teaching of vocabulary questionable pedagogically. Graded vocabulary and no on-line vocabulary help contributes to lack of redundancy and therefore does not permit sufficient user control of sequencing. No vocabulary help on extra reading passages. Dictionary not related to the lessons. (Reviewed by Chu 1996)

5. **HyperChinese** (HCS, the pronunciation modules, version1.1.) 1 Mac CD-ROM
   Jing-heng Ma & Robert H. Smitheram
   Cheng&Tsui Company
   25 West Street, Boston, MA 02111
   Phone: (617) 426-6074
   Fax: (617) 426-3669
   $79.95

   A comprehensive course on all aspects of Mandarin pronunciation and pinyin romanization for beginners as well as dialectal speakers. Complete and detailed. Good selection and sequencing of materials. High quality sounds. Innovative tests. With recording, scoring and error-logging functions.

   Long 'listen and repeat ' sessions uninteresting. Ergonomics leaves something to be desired. (Reviewed by Chu 1996, Zhang 1997)

6. **PinyinMaster (PM)** 1 Mac CD-ROM
   San Pao Li & Jeff Winters
   Ambassador Educational Services
   7011 Coventry Circle, La Palma, CA 90623
   Phone: (714) 523-2043
   Fax: (714) 522-7410
   $59.95
A pinyin and pronunciation tutor with recording, testing, score-keeping and error-logging functions, for beginners as well as dialectal speakers. Noteworthy features include complete syllable chart, movie clips of lip movements, on-line audio/visual help, inclusion of characters and user-selection of sounds for practice.

Menu items not descriptive. Practice items not varied enough. (Reviewed by Chu 1996)

7. **Professional Interactive Chinese (PIC, full version)**
   Venture Tech. Inc.
   2 East Lancaster Ave., Ardmore, PA 19003
   Phone: (610) 896-9150
   E-mail: pic@venturetech.com
   http://www.venturetech.com
   $199, $58 (teacher's edition)

A self-study course. Features include karaoke read along, animated display of speech production and character demonstration, recording, printing, games, English-Chinese dictionary, comparison of wave forms of the model and the learner and choices between Pinyin and Zhuyin, simplified and traditional characters. Notable for its voice-over explanation, innovative pronunciation and dictation exercises, student performance monitoring, capability for adding lessons, picture-based flashcards and interactive vocabulary builder. Similar in format to **ABC Interactive Chinese**. With detailed documentation.

Some games and sound waves comparison do not provide pedagogical benefit. On-line vocabulary glosses hard to use. Somewhat character-based. Some uses of tape recorder control panel redundant. Menu icons and terminology confusing. (Reviewed by Chu 1996)

8. **Step into China (SC, version: dialog 2.4)**
   RUIC Inc.
   Publisher: Superlan Technology Co. Ltd.
   Distributor: Summit Computer Technology Co., Ltd.
   Phone:: (886-2) 6436226;
   Fax (886-2) 643-6221.
   www.inet-images.com/ruic/cstep
   $79.95/64.95 (student price)

A self-study course targeting the traveler to China. Includes conversations on travel-related topics, as well as guides to pronunciation and character writing. Features include matching games, tests, recording, animated character writing, on-line dictionary, printing, audio/video effects and choice between simplified and original characters.

Graded vocabulary and lack of redundancy leads to insufficient on-line vocabulary help, especially if the course is not followed sequentially. English, terminology and ergonomics leave much to be desired. (Reviewed by Chu 1996)

9. **The Rosetta Stone (TRS)**
   Fairfield Language Technologies
   122 South Main Street
   Harrisonburg, VA 22801 USA
   Phone: (540) 432-6166 (or 800-788-0822 USA and Canada)
   Fax (540) 432-0953
   info@trstone.com OR info@The RosettaStone.com
   $395

A whole course built around various association of voice, text and still color photos. Noteworthy for its rather unusual decision to not include identification and explanation of vocabulary and grammar, the option of direct presentation with no intermediary of the text and the possibility of taking tests before initial introduction. Choice between Pinyin, simplified or traditional character text and that between teacher-determined and user-selected sequence of activities. With detailed documentation and teacher manual.

Lack of explanation of vocabulary and grammar may hinder comprehension. Unnatural language.

10. **Wenlin (WL)**
    Wenlin Institute
    Phone: (510) 534-1675
    E-mail: wenlin@wenlin.com
    http://www.wenlin.com
    $150

A powerful learning environment with many uses but mainly an all-format (GB, Big5, Unicode, HZ, ASCII) text reader/editor linked to a huge database of words and characters, with information on their collocation, composition, related items, frequency of occurrence and etymology. Most notable for its instant bi-directional lookup and the amount of information provided. Multimedia features include digitized audio, pictures of oracle bone and bronze inscription style characters, animated demonstration of character-writing, character-recognition for input and testing. Other notable features include ability to added entries, user-assembled flashcards with testing facility, local and global file searching, inclusion of advanced level texts (Essays and stories of Lu Xun, Hua Xia Wen Zhai downloaded from the
Internet. Simple and fast navigation. With detailed documentation.

Addition of texts for beginners would enhance its use potential for beginning students. (Reviewed by Chu 1996)

References


Notes

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1. The CALL programs mentioned in this paper are limited to what I could locate at the time of writing, following the suggestions of some subscribers to the listserv group of Chinese@kenyon.edu. A more complete list of titles can be found in Chu (1996)'s review, as well as Yao (1997). Due to the logistics of obtaining review copies, I do not have any CALL programs from overseas. While the writing of the paper has benefited greatly from the Internet, the present paper has left untouched the whole new and exciting world of on-line Chinese language programs and resources. For obvious reasons, I did not include two of my own contributions to the field of CALL.

2. Apple's Chinese Dictation Kit ($99) is for the inputting of Chinese into text editors with voice. While it does work, the user has to train it for three hours by reading pages of text. The dictating has to be done with slower than normal speed and correct pauses between phrases. It is available in North America exclusively from AsiaSoft (1-800-882-8856).

3. ELIZA, described in Weizenbaum (1984), is the creation of Joseph Weizenbaum, an artificial intelligent researcher. With the ability to respond to open-ended language input, it appears to be an intelligent conversation partner.

4. Phillipe is developed at Athena, the computing center at MIT.

5. So, while the vowels represented by the pinyin symbol of 'a' and 'i' look different on the wave forms, due to the generally greater sonority of 'a', 'a' and 'o' and 'e' may not look all that different. Nor do 'i' and 'u', which have similar sonority. The different stops and fricatives also will not look appreciably different among themselves. Nor among the nasals and the liquid sounds.

6. This is what NJstar has to say about the two features on its website: Chinese-English Dictionary: Chinese to English and English to Chinese two-way fast lookup, with 50,000 entries in the dictionary. Learning Chinese: with HanziInfo function; Converts a block of
7. Chinese Speech Partner ($89) by TwinBridge Software Corporation, Phone: (213) 263-3926; Fax: (213) 263-8126.

8. The small program is included on the Hanzi Assistant CD-ROM developed at Dartmouth College.

9. Strictly speaking, we may want to separate both drills and games from tests. While drills and games both incorporate immediate feedback, tests should not, if they are to mirror conventional tests and adhere to the purpose of testing and not learning. But since the tests in CALL programs are for the most part self-tests, which are intended for learning rather than testing, we will not insist on the distinction either.

10. Two handwriting recognition software:
    Twinbridge's WisdomPen (V2.5, $299).