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# A Multi-Platform Application Suite for Enhancing South Asian Language Pedagogy

Tao Bai

Christopher K. Chung

Konstantin Läufer

*Loyola University Chicago*, [klaeufer@gmail.com](mailto:klaeufer@gmail.com)

Daisy Rockwell

George K. Thiruvathukal

*Loyola University Chicago*, [gkt@cs.luc.edu](mailto:gkt@cs.luc.edu)

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# Using Handheld and Wireless Technology for Classroom and Community-Based South Asian Language Pedagogy

*Project Report, September 2003*

Christopher Chung  
Department of Computer Science  
University of Chicago  
chriskchung@hotmail.com

Daisy Rockwell  
Center for South Asia Studies  
University of California at Berkeley  
daisyr@socrates.berkeley.edu

Tao Bai, Konstantin Läufer (contact author), and George K. Thiruvathukal  
Department of Computer Science  
Loyola University Chicago  
tbai2001@yahoo.com, laufer@cs.luc.edu, gkt@cs.luc.edu

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## Abstract

This interdisciplinary project explores the potential for handheld/wireless (H/W) technology in the context of language education within and beyond the classroom. Specifically, we have designed and implemented a suite of multi-platform (desktop/laptop, handheld, and browser) applications to enhance the teaching of South Asian languages such as Hindi-Urdu. Such languages are very difficult to learn, let alone write, and H/W devices (with their handwriting/drawing capabilities) can play a significant role in overcoming the learning curve. The initial application suite includes a character/word tracer, a word splitter/joiner, a smart flashcard with audio, contextual augmented stories for reading comprehension, and a poetic metronome. We have received preliminary user feedback and are planning to conduct more formal experiments to test the effectiveness of our applications. To facilitate building ubiquitous learning communities, we are planning to

enhance our existing applications to leverage wireless connectivity, as well as identify additional applications that will benefit from this capability.

## Keywords

Collaborative Learning, Handheld Devices, Handwriting Instruction, Handwriting Recognition, Higher Education, Modern Languages, Multi-modal Applications, Personal Digital Assistants, Small-screen Devices, South-Asian Languages, Usability Research, User Experience, User Interface Design, User-centered Design, Wireless Applications, Wireless Devices.

## 1 Introduction

Walking around any college campus today, the acceptance and usage of handheld/wireless technology is readily apparent. Students use these devices to talk, message (or even see) whom they

want, what they want, and when they want. But despite the widespread acceptance of the technology by students, handheld/wireless technology has barely made a dent in our classrooms: during lectures, these powerful devices are sitting idle, silenced, and unutilized.

Furthermore, the past several years have seen a convergence between two technologies that had developed separately during most of the nineties: wireless communication devices (pagers, mobile phones) and handheld devices (personal digital assistants, PDAs). Recently, a number of mobile phones and other wireless devices with PDA capabilities have been introduced; conversely, more and more handheld devices now come equipped with wireless capabilities. The combination of these two paradigms, handheld computing and wireless communication, suggests enormous potential for collaborative learning, especially given how comfortable college students already are with these technologies.

In this paper, we explore the possible use of handheld/wireless technologies for collaborative learning in the classroom of the future. The broad context of this work is a project to create a real-life classroom that is enabled by suitable technology and intelligently designed, interactive applications. The classroom itself would comprise of wireless connectivity, tablet computers, embedded devices, advanced wireless display technologies, and wireless handheld devices.

This paper focuses on a specific case where we argue that handheld/wireless technology would be a compelling enabler for learning. As a joint effort between the Computer Science and Modern Languages departments at Loyola University, we have designed a suite of collaborative applications to enhance the learning of South Asian languages, in particular, Hindi-Urdu language<sup>1</sup>. Such languages are tremendously difficult to learn, let alone write, and the methods of instruction in this field have not changed significantly in hundreds of years. We believe that handheld/wireless devices (with their

handwriting/drawing and communication capabilities) can play a significant role in overcoming the learning curve.

Our research is timely in terms of technology and content. Microsoft has just unveiled its tablet PC operating system, which it is hailing as the future of personal computing (a magnanimous claim that many agree has some merit, despite having much in common with a previous but premature effort—the Apple Newton). Even the Linux community has pledged to support the Tablet PC initiative—Linux already runs on such devices.

Separately, after the tragic events of September 11th, the U.S. Government has taken a great interest in Middle Eastern and South Asian languages as part of the campaign against terrorism. There is a national need to develop modern programs for learning languages effectively and efficiently [6]. For this campaign to be successful, fluency must be developed at every level: speaking, reading, and writing. Reading and writing of Arabic, Indic, and most Asiatic languages (e.g. Chinese and Japanese) is where most non-native speakers usually get discouraged and abandon the pursuit. The reason: it can take months just to learn the basics of the alphabet.

Handheld and wireless technology can be a key enabler to learning a language. Perhaps most interesting and intriguing to us is that a number of old methods for learning a language (flashcards, writing, etc.) can be much more successful with the help of handheld/wireless technology. For example, in an introduction to Hindi-Urdu class, it is possible that students could be working on a writing exercise and receive spontaneous feedback. The ability for the professor/instructor to ascertain (immediately) what students are having trouble would certainly appear to help focus one's teaching efforts. This is just one of many applications we envision and describe in detail in Section 5.

The remainder of this paper is organized as follows. In Section 2, we will present some additional background and context to motivate this work. In Section 3, we will provide an overview of the handheld/wireless devices available today. While this is an ever-changing environment being augmented with new capabilities, we believe the market is beginning to achieve greater definition and is likely to have a core feature set upon which any archi-

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<sup>1</sup>Hindi and Urdu are the same language when spoken, but use two different writing systems. While Hindi is written using the Devanagari syllabary (the same system which is used generally for writing Sanskrit), Urdu is written using the Nastaliq script, a script based on the Arabic writing system.

ecture could be based. In Section 4, we describe our goals and the significance and relevance of this work. In Section 5, we present the details of the applications on which our current effort is being directed. In Section 6, we describe preliminary user experience and planned experiments. We close with a discussion of future work, including our vision of using handheld/wireless technology to build ubiquitous language learning communities.

## 2 Background and Context

In this section, we provide the background and context for this project.

### The National Language Resource Center

Since September 11th, the need for up-to-date and effective pedagogical materials for South Asian and Middle Eastern languages has become quite clear. South Asian languages are taught at only a small number of institutions of higher education and the materials which exist for teaching those languages are often created on an ad hoc basis by instructors or based on outdated textbooks. In response to this problematic state of affairs, the US Department of Education recently approved funding for a comprehensive National Language Resource Center (NLRC) for the development of South Asian language pedagogy and pedagogical materials.

The NLRC, based at The University of Chicago, run by a board of specialists from universities around the country, has been mandated not only to create new and improved texts, to create new ways of learning South Asian languages through new technologies. It is hoped that as a result of grants administered to individuals, groups and institutions by the NLRC, a wide variety of new materials will be developed for all different South Asian languages. A particular mission of the NLRC is to make these technologies widely available through the web via, for example, audio and video streaming. The items such as the new texts, recordings, are under development and should not require excessive investment in equipment on the part of educators and institutions, but should be easy to deploy in a variety of settings.

### Loyola University Chicago's Hindi-Urdu Class

Our Handheld and Wireless project has evolved as a conjunction of two factors: 1) The need to develop PDAs as effective teaching tools; and 2) The need, in response to the initiatives of the NLRC South Asian languages projects, to develop more effective methods for teaching the languages of the region in general, and the Urdu language in particular. Urdu, the national language of Pakistan, and a national language of India, is an Indo-European language which is grammatically identical to India's official language, Hindi, but while Hindi is written in the *Devanagari* writing system (a phonetic system written from left to right), Urdu is written in a Perso-Arabic script called *Nastaliq*.

Urdu, and other languages written in Perso-Arabic scripts, is considered particularly difficult for learners accustomed to languages written in the Roman alphabet, such as English and most European languages. The Persianate *Nastaliq* style script, like Arabic, is written from right to left. A particular challenge for learners of the script is the cursive style of *Nastaliq*, in which a complex set of rules governs the method of connecting different types of letters, and many letters have as many as four possible forms, depending on their sequence in a word. Memorizing these multiple forms and rules for connection can be very frustrating to students, and it is to this issue in particular that we wish to address our attention with the Wireless project.

Using Loyola University Chicago's Hindi-Urdu 102 class as a pilot learning environment, we plan to initiate an experiment in which students will test the effectiveness of PDAs for the pedagogy of the Urdu, or *Nastaliq*, script. We are planning a series of exercises that lead students through the most challenging aspects of the writing system. In addition, more advanced projects are in the works, to be tested on Loyola's Hindi-Urdu 270 class, which teach students how to read and understand couplets of well known Urdu poetry through a variety of useful and engaging devices.

## Related Work

A source of guidance for the handheld and wireless devices was provided by the ActiveCampus project [3] and the ActiveClassroom project [7]. Seeing how they used devices in large classrooms led us to ask the next question, could these devices increase collaboration and communication in small classrooms? Georgia Tech has various projects for enabling the classroom [1, 2, 5].

## 3 Devices

In this section, we discuss the types of devices that we target in this project.

### Handheld Devices

Handheld devices have been an exciting technology to watch with advancements in display technology, interface design, powerful processors with reduced power consumption, and multimedia inputs such as audio and voice capture. Today's handhelds roughly equate to a top of the line desktop PC only five years ago.

As rapidly as the hardware advances so do the applications for this wonderful platform. ActiveCampus [3] has shown how an entire university campus can become enabled with location-based services and classroom applications that provide improved interaction in classrooms with large enrollment.

### Tablet PCs

The Tablet PC is the next major Microsoft initiative. Task-specific tablet computers have existed, but Microsoft is providing SDKs for general functionality for pen-based applications. Microsoft believes that tablets will replace laptop devices because of more natural interfaces and a more desirable form factor.

The Tablet PC shares many qualities of the handheld. The Tablet PC differs in its increased computational power, the larger and higher resolution display/touch surface, and a high-level SDK for developing pen-based applications. The additional functionality makes it an ideal device for classrooms

where mobility is a less serious concern and the additional screen surface can be used to allow user a larger input surface and display surface.

### Desktop PCs

Desktop PCs are currently far more common than either handheld or tablet. With this in mind, applications built with direct interfaces must have a desktop alternative in order to allow any pedagogical material to be available to the lowest common denominator. We are planning for all of our applications to support the standard mouse/keyboard interface.

In addition, Wacom offers a stylus/pad device, a nice low-cost alternative to the Tablet PC that offers many benefits for learning to write characters. The stylus/pad is a definitive improvement in the attempt to make interfaces more natural. Studies have shown that direct interfaces are dramatically more effective and efficient for GUI applications [4]. Direct touch interfaces are especially effective for teaching people how to write characters and words. This advantage is the basis of our Character Tracer application.

## 4 Objectives and Relevance

The work that has been described is both novel and relevant from the perspectives of teaching and research for a number of reasons. We will consider each of these briefly and dedicate a subsection to each.

### Ubiquitous Learning

First and foremost, handheld/wireless applications enable ubiquitous learning. The bounds of the classroom can now be extended to the limits of wireless networks. 802.11 (a suite of WLAN protocols) coverage is becoming more widely available, and existing infrastructure can be leveraged to utilize the resources of the Internet as well, making the overall experience even more ubiquitous.

## Building a Learning Community

Second, handheld/wireless can add a much-needed dimension to learning: community. It is well known and documented that today's generation of students uses text chat and mobile phones to communicate and to provide awareness of when their friends are available. Their buddy lists represent a community. Providing communication and awareness functionality into handheld devices will generate communities around education, encouraging and enabling communication, collaboration, ubiquity, and awareness. Language learning in particular benefits from greater sense of community by allowing students to discuss problems and test their languages skills with other students.

## Enriching the Classroom Experience

The second point leads to a third point: enriching the classroom experience. As handheld/wireless enables peer-to-peer communication, students will have a way to interact directly with one another (yes, we realize that they can exchange obnoxious messages about the professor or one another). But a huge positive feature is that students can ask each other questions when they are confused or post the questions to the teacher without interrupting the lecture. This obviously has an implication of asynchronous and interrupt-driven classroom experiences, which must be carefully managed to ensure chaos does not ensue. With the tremendous mobile phone penetration and PDA sales, these devices will be in the classroom; instead of treating them as an annoyance we should leverage the power of the device.

## Enriching the Teaching Experience

As well, the second point leads to a fourth point: enriching the teaching experience. There is the real potential to have real-time analysis and feedback. A lecture on handwriting could be taking place and a teacher could receive an alert when a student is having problems. The teacher may help the student during the lecture or wait until after; in either case, the teacher now has a high-resolution picture of the each individual student in real time. Another important form of feedback might occur when

the teacher sees that a large majority of the class is having difficulty with a character or word. This real time information can allow teachers to try a different approach. In either case, wireless devices can provide a powerful awareness device for individual students and the entire class. Many students in classes—especially of the larger variety—tend to be quiet and never express the fact that they don't understand a particular topic until it is too late (usually after doing poorly on an exam). In the classroom of the future, tests may be entirely eliminated as the teacher can have constant awareness of their students' progress.

## Potential Overall Impact

Handheld/wireless devices are or soon will be in our classrooms. Learning how to leverage the technology and create positive applications must also be co-developed with systems that will limit negative impact on the classroom. We believe the applications we are working on will make an immediate and positive impact on how South Asian Languages are taught and learned.

## 5 Applications

In this section, we describe our initial suite of applications, most of which we have prototyped on several platforms, including a standard laptop computer for demonstration purposes, a standard web browser with a Macromedia Flash plug-in, and a Pocket PC. We provide screen shots for selected applications.

### Character Tracer/Word Tracer

The device displays a letter/word. Students practice writing the letter/word by tracing the stylus over the display. In the classroom, the wireless communication will allow the instructor to give immediate feedback and see who may be having problems writing any character (planned future enhancement). Furthermore, audio will provide pronunciation hints. Figure 1 shows this application running on a Pocket PC.

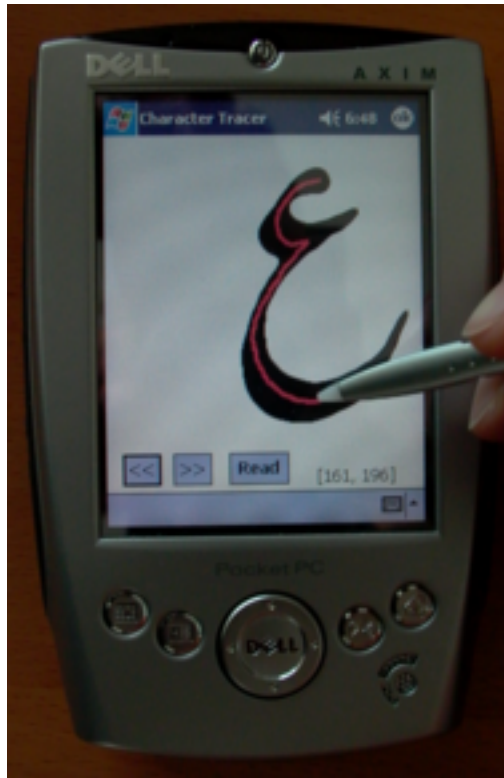


Figure 1: Character Tracer application running on a Pocket PC

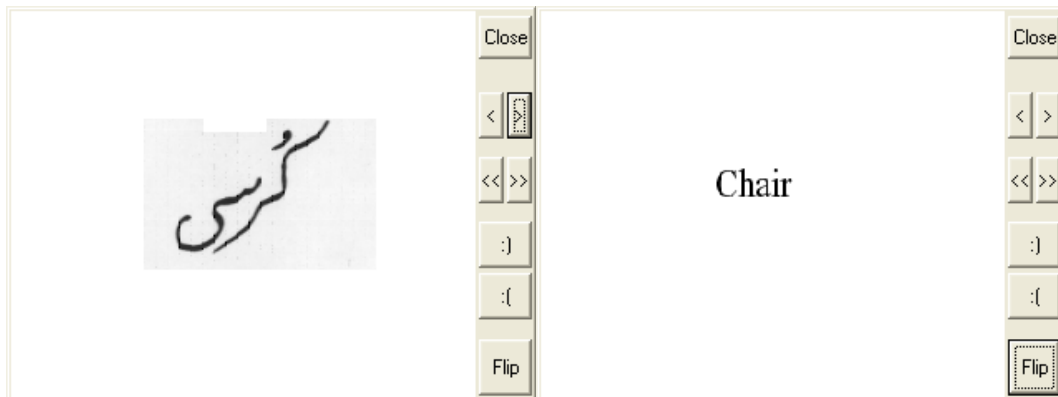


Figure 2: Front and back of Smart Flashcard application running on a desktop PC

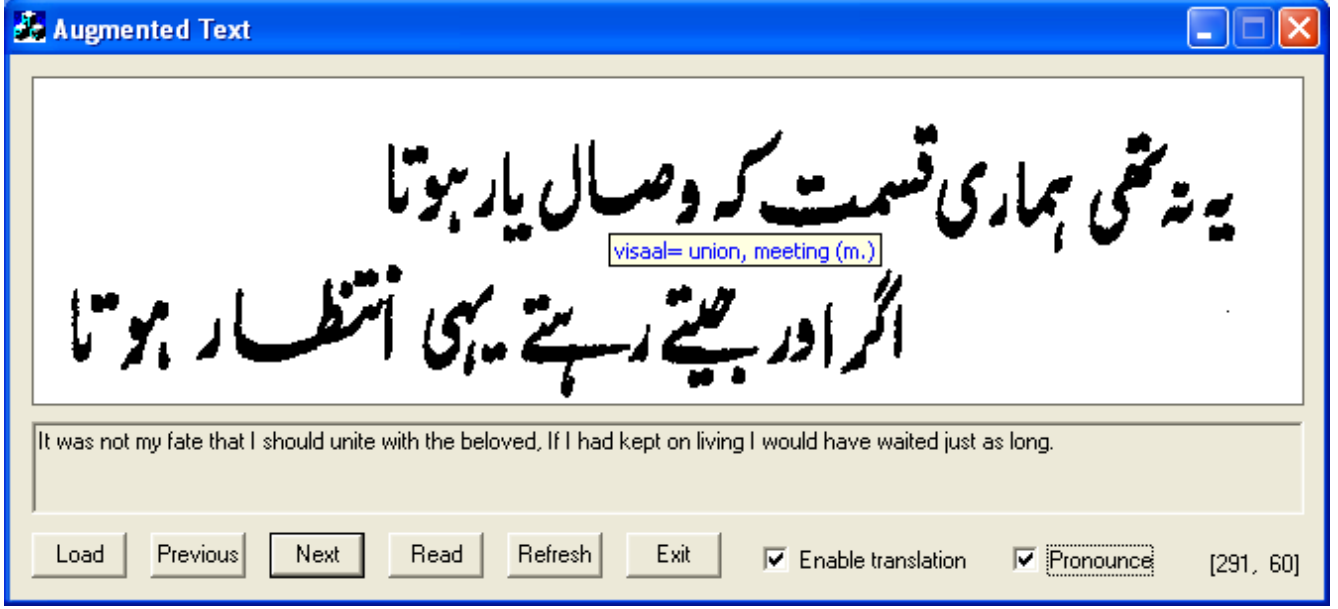


Figure 3: Contextual Augmented Text application running on a desktop PC

### Word Splitter/Joiner

Using the digital display and animation, the words can be broken down to or formed from the letters, a key challenge for learners of the Urdu writing system. Audio input will also be used to validate correct pronunciation and/or perform speech recognition.

### Smart Flashcard

Using a digital display and audio feedback, Smart Flashcard is a twist on an age-old study technique. The device could have millions of flashcards stored with the corresponding audio. Figure 2 shows this application running on a desktop PC.

### Contextual Augmented Text

Reading comprehension is always a challenging aspect of learning a new language. Students have been known to get repetitive stress disorder from using Hindu/Urdu dictionaries. An easy and stress-relieving technology, this application displays stories written in Urdu augmented with translations and pronunciations for unknown words on demand through pop-up dialogs and tooltips. Figure 3 shows this application running on a desktop PC.

### Poetic Metronome

Learning a language is more than just learning to read and pronounce words. The meter of a language can often be a stumbling block on the way to functional usage of a language. The audio capability of the device recites the poetic couplets while a bouncing ball moves over the lines of poetry. With advanced speech technology, the device could also analyze the user's meter.

### Summary

This suite of applications does not represent an all-encompassing list but should provide some sense of the enormous potential to utterly transform the way something as intimidating as Urdu can be learned. The work described above ranges from trivial to advanced research. Based on the preliminary applications, we intend to collect data and produce metrics to determine areas for improvement and outcomes that are worthy of publishing/archival.



## 6 Preliminary Experience and Experimental Plans

In this section, we outline our plans for the experimental evaluation of our applications described in Section 5 for different device platforms. For each application, we state our hypothesis and discuss the experimental method.

### Preliminary Experience

We have been conducting informal sessions with users at least once a month since our first application prototypes have been available. Our initial user group is diverse with respect to ethnicity and gender. The group includes beginning and intermediate Urdu learners, as well as native Urdu speakers. These user sessions have helped us considerably in developing the user interface and feature sets for the current application suite.

### Character Tracer

**Hypothesis** The handheld device offers substantial advantages over other devices because of the touch sensitive screen and the one-to-one relationship of touch and display.

### Method

- Pen/Paper: Each one of 10 students is given a kindergarten style worksheet with 10 Urdu characters. The students are told to repeat the each character 15 times and will be given 10 minutes to complete the exercise.
- Handheld: Each one of 10 students will be given a handheld device programmed with 10 Urdu characters. The students are told to repeat each character 15 times and will be given 10 minutes to complete the exercise.
- Mouse: Each one of 10 students will be placed in front of a PC programmed with 10 Urdu characters. The students are told to repeat each character 15 times and will be given 10 minutes to complete the exercise.

- Tablet Pad: Each one of 10 students will be placed in front of a PC with a tablet pad instead of a mouse, programmed with 10 Urdu characters. The students are told to repeat each character 15 times and will be given 10 minutes to complete the exercise.

At the end of the 10 minutes each student will be asked to write down as many characters as they remember on a piece of paper that has their name and the device they used. After this is done, the students will be given a different set of characters and a different device.

### Flashcard Application

**Hypothesis** Simple algorithms for re-arranging flash cards can substantially decrease learning time.

### Method

- Pen/Paper (3x5 Cards)
- Handheld (Flashcard Application Algorithm 1: random sampling)
- Handheld (Flashcard Application Algorithm 2: sequential ordering)
- Handheld (Flashcard Application Algorithm 3: incorrect answers get repeated more frequently)

Each student is given 10 minutes to use the given device. A 15-minute break is given (we will consider lengthening this break to 1 day). Then a test is administered to examine how much vocabulary the students have retained.

### Poetic metronome

**Hypothesis** The additional assistance of the bouncing ball will improve pronunciation and proper meter.

### Method

- Student recites the couplet.
- Student uses the Poetic metronome (with the above couplet loaded) application for 10 minutes.

- Student recites the couplet.

The evaluation is conducted by an expert.

## Text Translation

**Hypothesis** Seamless translation of text will allow students to more fluidly read through foreign text allowing their minds to stay in the context of the text.

### Method:

- 10 students read the text with a dictionary.
- 10 students read the text on the application with context sensitive translations.

A comprehension test is given to evaluate the students' understanding of the text.

## 7 Future Work

### User Studies

In the next semester (Spring 2004), we will begin conducting user studies on the applications in for use in a course on Urdu. There are three major goals in doing the user studies.

- First, we aim to understand if the applications can be improved with identification of new features or interface changes.
- Second, we would like to flesh out the advantages of the variety of devices and their features, e.g., understanding direct-touch applications versus the mouse interface or the indirection of devices like the Wacom pad for desktops.
- Finally, we would like to identify new applications that will offer the maximum improvements.

### Relationship Between Device Usage and Age

In understanding how to leverage new technology for learning, one aspect we look forward to exploring is the relationship between the device and

age. Some technologies have obvious limiting factors, such as the touch screen and young children (and some adults like ourselves) who lack the proper motor skills to control a stylus. Understanding the limitations and advantages of each technology relative to the age of the participant is a question we will soon be examining carefully.

### Leveraging Additional Device Capabilities

Our applications have been designed to be highly portable from one platform to the other. As more devices become available, we would like to learn how to leverage new technology to aid people in language learning. One technology we would like to incorporate into our applications is speech. An interesting feature that we would like to add to many of our applications is a speech component that will interpret the speaker and help them correct their pronunciation. This application would be difficult requiring expertise in speech recognition as well as carefully thought out visualization schemes.

### Building a Ubiquitous Learning Community

In this section, we share our vision of using handheld/wireless technology to build a ubiquitous language learning community.

A key feature of handheld devices is their ubiquity. Language learning benefits from high-frequency exposure, namely, it is better to have frequent and short interactions than infrequent and lengthy interactions. Students will be able to carry a tutor with them in their pocket and practice their Urdu on the train, on the beach, or anywhere. Not only will students be able to learn more, unhindered by textbooks or paper, they will also be learning to integrate technology into their life.

In addition, wireless connectivity is a crucial enabler for making language learning collaborative. Students will be able to learn in groups, and instructors will be able to interact more effectively with individual students while keeping track of the whole class. Not only will students be able to learn anywhere, but they will be able to do so with the entire support of the community.

At the same time, it will be necessary to be prepared for the potential drawbacks of the pervasive use of this technology:

- The use of collaborative technology during a lecture might detract participating students attention from the lecture. In practice, it may turn out that a student can either listen and follow the lecture, or write on his or her PDA to participate in another discussion. Therefore, it remains to be seen how effective wireless connectivity will be in the classroom.
- Having constant monitoring of student behavior build into the handheld technology practically amounts to continuous testing. However, there are situations in which a student would prefer not to be monitored. Applications must give students the option to practice and make mistakes in privacy.

We believe that this powerful combination of mobility and connectivity will turn out to be a key enabler for language learning. We are planning to enhance our existing applications to leverage wireless connectivity, as well as identify additional applications that will benefit from this capability. We are planning to design and conduct experiments that study the ability of these applications to build communities that enhance and transcend the traditional classroom.

## 8 Conclusions

Learning to incorporate handheld/wireless technology fully and effectively into a collaborative classroom has been an exciting and challenging experience, reminiscent of the early days of television: Initial programming consisted simply of televised radio shows, until TV networks figured out how to leverage the new technology. In our project, based on the close collaboration between the computer science and modern languages departments, there has been an interesting dynamics between three forces: hardware capabilities, feasible application features, and actual classroom demands. According to our experience, language applications benefit dramatically from devices that provide rich visual and audio media in conjunction with touch-sensitive screens.

We have been regularly meeting to brainstorm, discuss ideas, and begin the proof-of-concept design phase. During our meetings there is an excitement around this idea because we feel it is timely, relevant, and exciting research. Furthermore, there are so many challenges and problems to be solved that there are opportunities (including funding) for many individuals from many institutions to participate. We are all anxious to move on to the next phase of bringing this compelling platform into reality in a real classroom setting and to maintain (or increase) the current momentum of this project.

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