By Hayden Porter

Pocket-size Powerhouses

Handheld computers provide educators and students with portable, affordable musical tools.

Handheld computers, often known as PDAs (portable digital assistants), started to become popular among consumers with the release of the Palm Pilot in 1996. By 2000, Palm began to explore the use of its products in the educational market. Palm has since provided many grants to schools throughout the United States for the purchase of handheld computers, including for their use in music education. Although non-Palm handheld computers, such as PocketPCs, have had tremendous impact in the business world, PDAs based on the Palm operating system are still more widespread among educators.

WHY USE A PDA?

Although not necessarily a replacement for desktop or laptop computers, PDAs offer a number of advantages for grade-school educators. PDAs are much less expensive than desktop or laptop computers, with prices starting at $100 each. Even advanced, feature-laden models are widely available for less than $500.

The most obvious advantages of PDAs are their compact size and portability. They require minimal storage space, and students and teachers can take them almost anywhere—to the library, on field trips, and so on. PDAs are easier to operate than more complex computers, and many students are already familiar with handheld-computer games and consoles. The PDA point-and-tap, stylus-driven interface is intuitive for many

people, although others prefer a keyboard. To that end, most PDAs offer a virtual onscreen keyboard that lets you tap in data with a stylus, and many support detachable keyboards that allow traditional typing. A few, such as Hewlett-Packard's iPAQ PocketPC h4355, even have a physical keyboard built in.

Many handheld computers support some kind of wireless networking. Potential applications include distributing files to all students in a class, enabling students to access the Internet through a wireless network, using a Web server for playing streaming music over the network for in-class music appreciation, and saving ear-training quiz grades to a database running on the classroom Web server.

Most handhelds have built-in speakers, headphone jacks, and microphones for voice recording. Many newer handhelds can play MP3 audio files, MIDI files, and videos, and can even take digital pictures through a built-in camera (some of these functions, however, require optional equipment). As a result, handheld PDAs are well suited for self-paced skill-building exercises such as ear training, keyboarding, naming notes on the staff, and learning basic music theory. Students can also use them for recording, composing, and learning music appreciation.

A word of warning: not all software and hardware for PDAs works with every model. Just because your PDA uses the Palm OS doesn't mean that all Palm software will work with it. The main determinant is the OS version, but some programs also require specific hardware features, as well. So as with laptop and desktop computers, you would be wise to consider which applications you want to run and how you will use your PDA before settling on a particular model.

PDAs IN THE SPOTLIGHT

Brandt Schneider, who teaches choir and band at Derby High School in Derby, Connecticut, received a Palm Educational Pioneer grant in 2001 to purchase handhelds for use in his music classes. He has been evolving his teaching approach with PDAs for nearly four years.

"Most important is portability and access to content," says Schneider. He requires that his students be able to play selections of their musical repertoire on a real piano, but most kids do not have pianos at home. "Palms allow these students to practice in places where they normally couldn't," he says. To help students learn to read music and perform basic keyboard skills, Schneider uses Arcsoft's EbonyIvory freeware for the Palm computer (see Fig. 1). This simple application turns a Palm into a virtual piano keyboard that students play by tapping the onscreen keys with a stylus. With each stylus tap, the handheld plays the note, shows the note name, and displays the note on a staff.

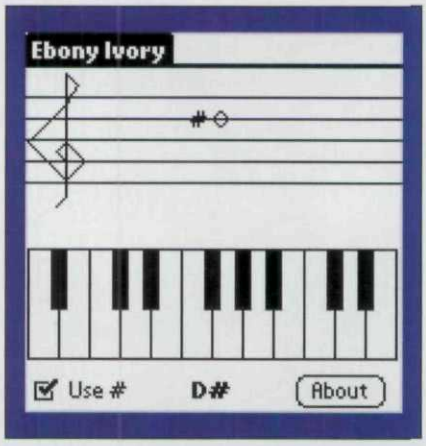


FIG. 1: Arcsoft's free EbonyIvory turns a Palm PDA into a virtual piano keyboard.

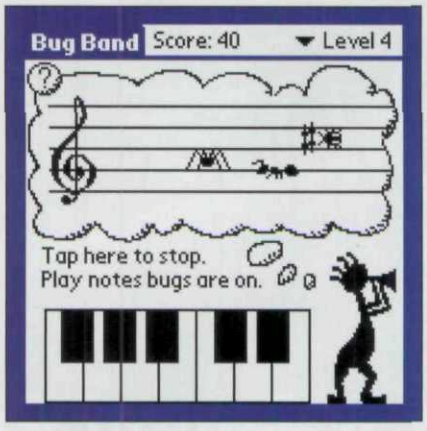


FIG. 2: MiniMusic's BugBand note-reading game for the Palm teaches how to read notes using animated bugs that march across the staff.

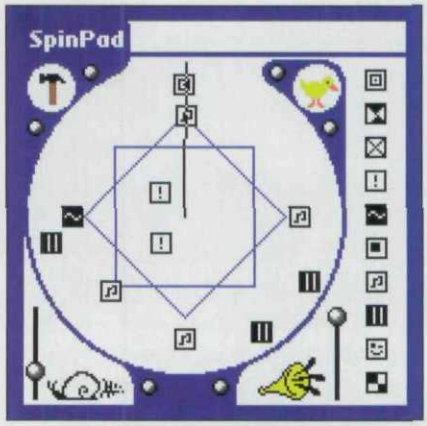


FIG. 3: SpinPad is one of miniMusic's latest offerings for the Palm. This sequencer has an unusual interface that allows highly flexible note placement.

Because each student in Schneider's class has a handheld with EbonyIvory software, they can practice their music independently and at their own pace, within the limits of the virtual keyboard. Once they have mastered basic keyboarding and note reading on the handheld, they are ready to play the melody on a real piano. The handheld computer makes it feasible for all students in the class to work with a keyboard for as much time as they need to master the basic skills of playing a short melody.

PORTABLE EAR TRAINING

Ear training is another example of using handhelds for skill-building exercises. Wilson Chang's MusicEar 1.0 (shareware, $9.90) is no longer under development; it is, however, still available. You also might find Lily Tears's Ear Trainer 1.0 ($11.95) and Artisan Interactive Simon Sayz ($6) helpful. All of these programs can help students develop interval recognition and rhythmic identification.

Schneider challenges his students with Palm-based melodic- and rhythmic-transcription exercises, loading prerecorded melodies onto the handhelds by "beaming" the files via the PDAs' infrared feature (see the sidebar "Handheld Computer Terminology"). He then instructs his students to transcribe the melodies on paper. The portability of handhelds makes it possible for each student to work individually and at his or her own pace to master the exercise. That can be more efficient than the teacher having to repeatedly play

intervals or melodies on the class piano for the entire class.

RECORDING WITH PDAs

Handhelds are also good tools for portable audio recording and playback. Many PDAs come equipped with voice-recording software and a built-in microphone that enable students to record themselves during performances or practice. Although the audio quality is not good enough for CD production, it's good enough for students to evaluate their own progress as they practice.

That has numerous educational applications. For example, Schneider's students compile a digital portfolio of scales and selected passages throughout the year, so they can compare how they sounded at the start of the school year with the way they sound at its end. Students can put the Palm on their music stand and record themselves during a choir rehearsal, and then go into a practice room and work with their recordings. They can transfer the files from their PDAs to a laptop or desktop computer and have recordings of all of the class's music. Students can record themselves at any time and can continually self-assess their work, which means they can record composition ideas whenever inspiration strikes.

In addition, Schneider loads the PDAs with prerecorded sound files that demonstrate the correct performances of scales and rhythms, along with other music excerpts. That enables students to use their handheld computers to compare their own recorded performances with a proper performance of an exercise.

THE MINIMUSIC SUITE

Currently, miniMusic (which offers six music-software titles) is the only company dedicated to making commercial music-learning and composition software for the Palm. The company also offers hardware for connecting MIDI devices to some Palm computers.

BugBand 1.0.5 ($11.95) is a game that teaches how to read notes on the musical staff. You are presented with a staff and a virtual keyboard or guitar fretboard (see **Fig. 2**). Bugs, representing notes, march across the staff from right to left. You must identify the "bug note" by tapping the correct piano key before it reaches the end of the staff. The game keeps score, has multiple levels of difficulty, and teaches note reading on the treble and bass clef.

EarTrain 1.0 ($11.95) is a multiple-choice game for identifying melodic intervals. EarTrain plays intervals on its whistle, and your goal is to identify the correct interval from those listed on cars attached to the EarTrain. The more quickly you identify the intervals, the faster the train travels. You can use the default settings or configure the range of intervals for each level. EarTrain plays melodic intervals up or down ranging from minor seconds through octaves.

NotePad 1.2.1 ($29.95), not to be confused with Makemusic's Finale NotePad notation software, is a MIDI sequencer that displays music with up to four voices in grand-staff notation

Handheld-Computer Terminology

Beaming. Transferring files between two devices by means of their infrared ports.

Bluetooth. A low-cost, short-range, radio-frequency wireless networking system that enables multiple devices to transfer files and interact with each other. Bluetooth is commonly used for transferring data between two handhelds or from a source device to a peripheral such as a printer or wireless headphones. Bluetooth does not require a network node, as Wi-Fi does, nor does it require a line-of-sight connection, as with infrared. With the most common version of Bluetooth, the maximum range is 10 meters (approximately 33 feet), with transfer rates of up to 720 Kbps.

Infrared. Infrared is the most common form of wireless data transfer for handhelds and is also supported by many laptop computers, as well as some kiosks and printers. It is limited to a range of one meter (approximately three feet). Infrared ports communicate via a light beam, so they require a line-of-sight connection.

Microbrowser. A Web browser for devices with limited CPU power and RAM, such as a handheld computer. Most microbrowsers do not support all the features common to regular computer browsers, such as media-player plug-ins. Common microbrowsers are Netfront 3.1 for Palm OS and PocketPC, Microsoft Pocket Internet Explorer for PocketPC, and Opera for cell and smartphones using the Symbian OS.

PDA. Portable digital assistant. Synonym for handheld computer.

Smartphone. A handheld device that combines voice communication and PDA capability.

Stylus. A penlike pointer used to input data by tapping on a handheld's touch-sensitive screen. The stylus is roughly equivalent to a mouse on a desktop or laptop computer.

Syncing. In this context, updating files between a handheld computer and a laptop or desktop computer so that both have the most recent copy of a given file. *Hot syncing* is a Palm OS–specific term; *active syncing* is the equivalent Microsoft term.

Wi-Fi. Abbreviation for *Wireless Fidelity*, also known as IEEE 802.11. This specification is rapidly becoming the most popular method of establishing a wireless local-area network (WLAN) with a laptop or handheld device. By setting up a public-access point, or hot spot, students and teachers can access the network from any Wi-Fi-equipped device. There are currently two versions. IEEE 802.11b (known to Macintosh users as AirPort) operates in the crowded 2.4 GHz frequency range, has a maximum range of up to 150 feet, and provides a maximum data throughput (transfer) rate of up to 11 Mbps. The enhanced 802.11a (aka AirPort Extreme) operates in the less-crowded 5 GHz band, has a range of up to 350 feet, and can transfer data at up to 54 Mbps, which is roughly comparable to the speed of a 10BaseT Ethernet connection. The actual transfer rate depends on the device's proximity to the access point, and is affected by interference from obstructions, such as walls, and (especially in the 2.4 GHz range) by conflicting signals from cordless phones, microwaves, and so on.

or on a piano roll. In many ways, it is like a modest version of conventional MIDI sequencers for the Mac and Windows. It supports handhelds with built-in sound cards and, as a built-in, polyphonic software synthesizer that plays sound through a compatible PDA's speaker or headphone jack. Primarily a music-composition tool, it could also be used for teaching multipart music notation.

BeatPad 1.0.7 ($29.95) is a pattern-based MIDI sequencer that lets you record and play back up to 32 patterns, each containing up to 16 events. You can assign a pitch, octave, duration, and volume to each event in each pattern. For example, Bogue Bogue, who teaches at the Libby Center in the Spokane Public Schools in Washington state, uses BeatPad to teach basic rhythm exercises before introducing rhythmic patterns in standard notation. Bogue's students build rhythms in BeatPad by assigning durations, pitches, and accents to musical events on a timeline and can play back the patterns they have created. Bogue reports that for beginning music students, interpreting rhythmic subdivisions on BeatPad's grid can be more intuitive than viewing the rhythms in standard music notation. Once students have a basic understanding of how to subdivide rhythm, they can then transfer this concept to sheet music, matching music-notation symbols to their aural understanding of rhythmic subdivision.

FIG. 4: Mike McCollister's McChords is Palm shareware designed for learning piano chords and scales.

SpinPad 1.0 is currently a free public beta; the shipping version ($19.95) is expected to be released soon. This pattern sequencer features an unusual circular graphic user interface (see Fig. 3). Instead of every pattern being a set number of steps in length, SpinPad lets you freely place up to 200 notes on the beat, far off the beat, or anywhere in between. You can drag notes around the graphic interface, and a spinning arm hits each note as it plays. Placing the note a different distance from the center of the circle can change the pitch, volume, duration, or even MIDI channel.

SynthPad 0.3.1 is a simple, monophonic audio sampler for Palm OS 5. Like SpinPad, it is currently a free public beta, but no ship date or price has been announced. To use it, you tap the Record button, and the program gives you a countdown to the start of recording. After recording your sound, the length of which is limited to a few seconds, SynthPad calculates new waveforms for each

note on the onscreen one-octave virtual keyboard. When you see the waveform onscreen, you can play back the sound from the keyboard. You can even trim the beginning of the sample to eliminate "dead air."

MORE FOR THE PALM

There is a wide range of other music-education freeware, shareware, and commercial software on the market for Palm (see the sidebar "Contact Information"). For example, Mike McCollister's McChords (shareware, $10) is designed to help students learn chords and scales on the piano. The application displays the notes of 60 chords and 48 scales and offers a 4-octave virtual piano keyboard (see **Fig. 4**).

If you have digital media files such as AVI, DivX, Macromedia Flash, MPEG-1, MPEG-4, or QuickTime and would like to play them back on a Palm handheld, you need two pieces of software: Kinoma's Producer 2 v.2.2 for Windows and Mac OS X ($29.99) converts the files into Kinoma's native format, which allows them to be played back on the free Kinoma Player 2 v.2.2.2 for Palm OS.

If you want to go a big step further, check out Tribeworks' iShell Mobile authoring software for Mac OS X and Windows ($395). With this software, you can intuitively create interactive learning applications containing video, sound, graphics, and text that will play back on Palm PDAs using Kinoma's Player 2.

PREPARING WEB PAGES

In addition to the aforementioned musical applications for PDAs, you can take advantage of their networking and wireless communications features. All handheld computers with Wi-Fi or Bluetooth networking capability also have a built-in Web browser called a *microbrowser*. You can create small-format Web pages, stored on the PDA, that students can browse locally without having to connect to the Internet. Students can also learn about making Web pages by creating Web sites for the built-in microbrowser.

At this time, most microbrowsers for Palm PDAs do not support audio plugins of the sort that regular Web browsers offer, so it is unlikely you will be able

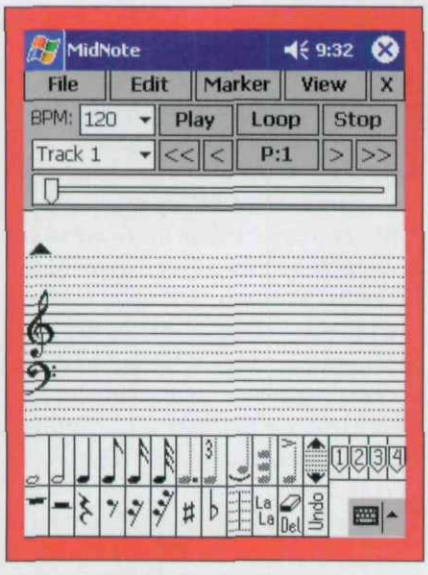
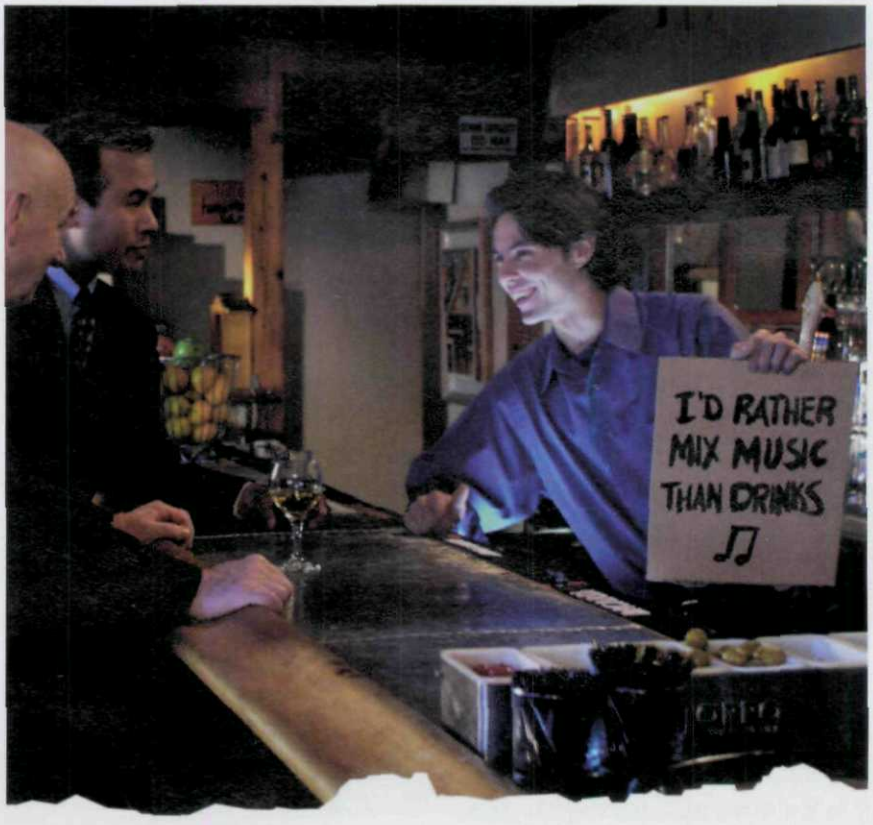


FIG. 5: PDAMusician's MidNote for PocketPC is a 10-track music-notation program with graphical editing and Standard MIDI File import and export.



to embed or link to audio files in a Web page viewed in a microbrowser. However, Microsoft Pocket Internet Explorer for PocketPC-based PDAs does support audio plug-ins and can play sound embedded in a Web page.

Therefore, unless you and your students are using PocketPC handhelds, Web pages are mostly useful for reading-based learning, such as student reports or music-appreciation reference works. For example, students could create a simple music-history timeline showing the dates of each time period. Clicking on parts of the timeline could open another Web page with more detail about the selected time period, its composers, and commonly used instruments of the period. Students can then use this Web site as a portable music-history reference.

MACROMEDIA FLASH FOR PDAs

The Macromedia Flash multimedia platform is almost ubiquitous in Web browsers and is now becoming available for handheld computers. The Flash player is available as a plug-in for Pocket Internet Explorer in PocketPC handhelds and is built into many Sony Clié Palm OS devices. Flash can be an effective tool for building your own learning materials because it has a modest learning curve, supports interactivity with graphics and sound, and can be created relatively inexpensively using SwishMax for Windows or Macromedia Flash MX 2004 for Mac OS X or Windows.

> THE MOST OBVIOUS ADVANTAGES OF PDAs ARE THEIR COMPACT SIZE AND PORTABILITY.

For example, I created a music-appreciation presentation using Flash for Sony Clié devices that allows students to learn about African drumming music (see Web example 1). Students can control the volume of each instrument in an African drumming ensemble to appreciate each part and learn how it fits into the ensemble. The presentation also includes information about each instrument and provides cultural information about Ghana, West Africa.

A PC IN YOUR POCKET

Currently, Palm OS computers are the most commonly used PDAs for education. The main competition is the PocketPC, which runs various versions of Microsoft's Windows Mobile or Windows CE operating systems.

PocketPCs have made recent gains in the business- and personal-use market—in fact, they are probably supplanting Palm OS machines for business applications. But they have not yet become as common as Palms in the education market.

Because of their popularity in the business world and their use of a Microsoft Windows operating system, many PocketPCs are more powerful than most Palm machines, including the previously mentioned Web browser support for embedded audio, more models with Wi-Fi wireless networking (sometimes simultaneously usable with Bluetooth), and higher-end (and more expensive) CPU chips.

We can expect that more software developers will release software for the PocketPC platform, and more teachers and schools will probably invest in it. Already there are useful applications for creating music on PocketPCs, and there are a few freeware music utilities available, such as guitar tuners and metronomes.

At the PDAMusician Web site (www.pdamusician.com), for example, you will find an assortment of music applications for PocketPC. The prices given here are for the CD-ROM version; downloadable

Product Contacts

Access Systems (Netfront) www.access-us-inc.com

Arcsoft (Ebonylvory) www.palmblvd.com/software/pc/Ebonylvory-1999-02-22-palm-pc.html

Artisan Interactive (Simon Sayz) www.playai.com/newsite/client-p3.html

Hewlett-Packard www.hp.com

Kinoma www.kinoma.com

Macromedia (Flash MX 2004) www.macromedia.com

Mike McCollister (McChords) www.mikemccollister.com/palm/#McChords

Microsoft (Pocket Internet Explorer) www.microsoft.com

miniMusic www.minimusic.com

Opera Software (Opera for smartphone/PDA) www.opera.com/download/index.dml?platform=symbian

PalmOne (PDA hardware) www.palmOne.com

PalmSource (Lily Tears' Ear Trainer and more) http://palmsource.palmgear.com/index.cfm?fuseaction=software.showsoftware&prodID=55544

PDA Musician (PocketPC software) www.pdamusician.com

PilotZone (Wilson Chang Music Ear and more) www.pilotzone.com/palm/preview/176792.html

SwiSHmax www.swishzone.com

Tribeworks www.tribeworks.com

versions are available from shareware sources for an additional fee.

For example, MidNote ($15) is a 10-track music-notation program with a 6-octave range, graphics editing, and support for drums, chords, lyrics, and Standard MIDI File import and export (see **Fig. 5**). PocketSynth Professional ($14) is a piano synthesizer with MIDI support, chord and pattern editors, and more. Pocket Drums ($14) is a drum sequencer that exports MIDI files. MIDI Control ($2.90) lets you tweak MIDI files by muting tracks and altering the tempo, pitch, and synth sound. Strummer ($11) is a guitar-oriented sequencer that plays back using a sampled guitar (see **Fig. 6**). It lets you create, edit, and save strumming and picking patterns, create pattern libraries, and record and edit songs using your patterns. Once you have created tracks in Strummer, you can mix up to four of them to a WAV file using FourTrack

Further Reading

Bogue Bogue "Potential Artists Learning Music Pilot Program"
www.pdaed.com/vertical/features/Music.xml

Derby High School Palm Usage page www.derbyps.org/music/DHS/palm.html

***Electronic Musician* magazine, "Music in the Palm of Your Hand"**
www.emusician.com/ar/emusic_music_palm_hand

Intel "Perfect Pitch" www97.intel.com/education/odyssey/day_244/day_244.htm

Long-Kytonen, Erin "And the Band Played ... Palms?"
www.ewu.edu/perspective/Archived/Fall2003/pdfs/Palm.pdf

PalmOne "Palm Education Success Story: Derby Middle School"
www.palmone.com/us/education/studies/study28.html

PalmOne "Palm Education Success Story: Spokane Public Schools"
www.palmone.com/us/education/studies/study53.html

Palo Wireless (Bluetooth) www.palowireless.com

Schneider, Brandt and James van Pelt "Handhelds in Music Education"
www.derbyps.org/music/DHS/Brandt%20Schneider's%20article%20on%20handheld%20Technology%20and%20Music%20Education2.pdf

Wi-Fi Alliance www.wi-fi.com/OpenSection/index.asp

FIG. 6: Strummer for PocketPC, from PDAMusician, is a guitar-oriented sequencer that enables you to create, edit, and save strumming and picking patterns and songs.

(free). Finally, SoundCreator and SoundCreator PSP (free) let you design new WAV sounds for Strummer, FourTrack, PocketSynth Professional, and MidNote.

SYMBIAN, LINUX, AND MORE

Palm and PocketPC are not the only operating systems well suited for handhelds. The Symbian operating system is the most widely used handheld OS but is mainly targeted at cell phones and smartphones. It is unclear whether devices using the Symbian OS will be relevant for the U.S. education market because of concerns about allowing students to use phones and pagers in school. On the other hand, the Linux operating system is now employed in a number of handheld devices and could become an important PDA platform in the future due to its low cost of implementation.

In addition to these operating systems, consumer electronics devices like Gameboy and Leapster's Leapfrog system are sometimes used in K–12 education, but there are currently no music-specific applications for these platforms.

GIVE THEM A HAND(HELD)

Clearly, handhelds are great tools for educators. Although PDAs lack the computing power, RAM, and storage capacity of a laptop or desktop computer, and they don't have large screens and comfortable ergonomic keyboards, they have the distinct advantages of being relatively inexpensive and small. Even without Wi-Fi and Bluetooth, their uses are legion.

Furthermore, it's surprising how much music and audio freeware and shareware and reasonably priced commercial software is available for Palm and PocketPC handhelds. I've mentioned many of the more popular music programs of interest to educators, but you can find more if you surf the Web. Pick up a PDA for yourself sometime and check it out.

Hayden Porter *is a Web developer and musician who has written extensively on the use of sound in new media. He is the editor of Sonify.org, the leading resource for Web and mobile-device audio.*