CHAPTER 3

Pocket Rockets: The Past, Present, and Future of Children's Portable Computing

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This chapter takes a broad look at the category of small digital devices used by children up to age 15. It begins with a look at how one child uses a Web-enabled cell phone and discusses the need to redefine the digital immigrant/digital native classifications. An examination of existing devices follows, with a categorization of 11 types of devices, along with a chronological listing of 44 noteworthy products. Several scenarios are provided describing how these devices might influence the children of the 21st century, along with a reminder that every educational reformer seems to find a champion in a gadget.

GOOD THINGS COME IN SMALL PACKAGES THESE DAYS

Good things come in small packages, at least when it comes to the latest phones at the Verizon store in Flemington, New Jersey. One example is my 13-year-old daughter's LG enV(2) cell phone—called "envy 2" on the school bus—that has features on par with a contemporary desktop computer. They include a tiny QWERTY keyboard, two screens (inside and outside), Bluetooth, voice recognition, GPS, stereo speakers, Internet access, a micro SD input port, and a two-megapixel camera. All these features come in a single device smaller than a deck of cards that weighs about the same—4.2 ounces. Though the engineering that went into creating these phones is impressive, it is the way my daughter's cluster of friends uses them that is more interesting. (Note that the LG enV(2) has since been replaced by the Voyager VX10000 with a touch screen and haptic feedback and is already in the hands of some of my daughter's classmates. Don't overlook

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FIGURE 3.1
On a rainy summer day, my daughter and I were returning from a birthday party when a rainbow appeared over the trees. My daughter used her phone to snap a photo, sending it to herself for her Facebook page, with a copy to me. The next day I found this image file in my email.

the cultural implications of the word *envy* in the product name.)

Using the phone's microphone, they can directly record bits of songs from the free trials on Apple's iTunes for use as ringtones or for practicing piano lessons, and they take thousands of photos that they email to friends.

The use of such a device is as diverse as the individual functions. As an interpersonal crutch, the calendar feature can remind a child of a friend's birthday, or it can deliver a reliable wakeup call each morning. It's a dinner bell for parents who have learned that it can be more effective to send a text message to a child's phone than to shout upstairs, or it can deliver automatic Short Message Service (SMS) reminders an hour before an orthodontist appointment. Children can text message with two thumbs nearly as fast as their parents can type with both hands—a skill they've acquired with no formal school instruction, using an invented language that defies the conventional rules of spelling. They even use the light of their cell-phone screens as flashlights to see what's hiding under the bed.

Such a phone can coordinate rides with busy parents, arrange play dates with friends, or set up an impromptu algebra tutoring session for a difficult homework problem. Each of these features brings an entirely new set of research questions for educators, psychologists, and anthropologists.

The material that follows is an attempt to classify these devices by both time and function, followed by some discussion about which attributes hold the most promise for a developing child.

UNPACKAGING THE NOTION OF DIGITAL NATIVE VS. DIGITAL IMMIGRANT

It is useful to acknowledge and understand the digital native/digital immigrant classification—terms designed to acknowledge the fact that if you grow up with any technology, you're likely to be more comfortable with it than if you don't.

The person often associated with the two terms *digital native* and *digital immigrant* is Marc Prensky, an author and educational futurist (Prensky, 2001). Prensky reminds his readers that he wasn't the first to use the two phrases, but he was the first to use them together and to popularize them (see Prensky's blog

entry at www.marcprensky.com/blog/archives/000045.html for a discussion). The trouble with this frequently used classification, which Prensky acknowledges, is that it attempts to explain a continuous relationship in binary terms. You're either a native or an immigrant, with no gray area, despite the evolutionary nature of technological change and cultural development.

> If you were born with a certain level of technology, you'll have a certain comfort level with it that is higher than for somebody who wasn't. That helps define the difference between a digital native and a digital immigrant. But people started to object that these terms divide people; for example, you have older people who are tremendously advanced, or younger people who can't find a file. I think that we are essentially birthing a new kind of person. And that person I'm calling something like somewhere between digital human and homosapien digital, which translates to digital wise man, meaning a generation of people who gets its wisdom from digital tools. As parents and teachers, we want to raise digital smart people, and not digital dumb people. What's interesting is that the technology helps make us wise. Some people worry that technology will somehow make us dumber because it takes away something we don't have; which is like when Socrates said that writing will ruin our memory. But that line of thinking would mean giving up your car, watch, clothing; because these are all technologies. The advantage to thinking about the digital human or homosapien digital is that we can all get there at different rates. (Prensky, 2008).

It is helpful to consider the gradual evolution of technologies as they interact with the larger sociocultural context into which today's child is born. One could think of this technology-inspired change as rising water continually pushing against the cultural beachheads of schools, families, churches, and libraries.

Looking back over the past 30 years or so, we can spot the larger waves of change and their effects. The Apple II helped inspire the IBM PC, and LOGO (a programming language developed for children, led by Seymour Papert) helped people feel less threatened about programming a computer. In the 1990s, parents freely spent $40 each on software titles like *Math Blaster* (Davidson & Associates) and *The Living Books* (Brøderbund) to help children learn with technology. Most computer-literate people over age 40 remember the first Macintosh Super Bowl advertisement and the first time they used a mouse.

Services such as AltaVista, CompuServe, and America Online in 1998 paved the way for Google, Amazon.com, and eBay in 2003; today these are some of the most recognizable brands in the world. The past five years have seen a dramatic surge in the frequency of the waves. Stronger lithium-ion batteries, clearer liquid crystal display (LCD) monitors, faster wireless technology, and cheaper memory have given inventors and publishers new vehicles with which to reach children. By combining infrared, Bluetooth, and accelerometers, Nintendo was able to turn the videogame industry inside out with the Wii game console.

From a developmental perspective, the generation of children born in the mid-1990s will be the first generation of formal operational thinkers to have access to such powerful, multilayered devices as the iPhone and the LG enV(2), which arrived in a wave in 2008. Today's 11- to 13-year-olds are the first generation of "connected natives"—people used to having their email, Google, YouTube, Twitter, and Facebook in their pockets. In other words, in 2007–08, a pocket-sized technology genie was let out of a bottle.

As the innovative waterline continues to rise, additional waves are on the horizon. Some are easier to spot than others, and they can vary in size and significance. The way they will influence future generations of children cannot be determined, but it is clear that the current generation of educators and parents has the involuntary job of sorting it all out.

A BRIEF HISTORY OF CHILDREN'S PORTABLE COMPUTING DEVICES

The good news is that if you're older than 30, you've personally witnessed a critical time span in the life of children's portable computing devices. The even better news is that if you consider just the past five years, you've seen over 90% of it already. A glance at the timeline of these devices (Table 3.1) reveals some key products that often coincided with specific technological advances.

The notion of giving each child access to a powerful, portable computing device is not new. In 1978, Alan Kay, then working at Xerox Palo Alto Research Center (PARC), sketched out plans for a Dynabook (Kay, 1999). That same year, toy designers released Simon, a handheld memory game, and the electronic computing device race was on, with each new device laying the groundwork for the next. This was a time when the literature was thick with optimism about technology. Books had titles like *Mindstorms* (Papert, 1980), and educators and reformers wrote about the Golden Age of education (Paige, Hickok and Patrick, 2004; Banet, 1978), when every child could reach his or her potential using affordable and portable technologies.

Since that time, some leaders have emerged, representing both the videogame and toy industries. Companies such as LeapFrog, Tiger Electronics (a division of Hasbro), Jakks Pacific, and VTech have been active in producing microprocessor-based products that cost less than $100 and deliver interactive experiences. Today educators still dream of a Golden Age of learning looming somewhere in the future, and technology plays a central role. (See Banet, 1978, for an early reference to the Golden Age.)

The Spring of 2003 saw a particularly large wave of products from the toy industry. That was when four handheld devices hit the market: iSprout from The Original San Francisco Toy Co., Nintendo's Game Boy Advance SP with its color flip-up screen, the now defunct Pixter Color from Fisher-Price, and the Leapster from LeapFrog. Of these, only one—the Leapster—is still being produced.

Table 3.1 A Timeline of 43 Portable Computing Devices Marketed to Children, 1971–2008

1971	Pocket calculator (Sharp, Texas Instruments, Mostek, and others). It can add, subtract, multiply, and divide and display the results on an LED.
1978	Simon (Milton Bradley) pairs a single-chip microprocessor with four light-up buttons to create a popular self-correcting memory game.
1978	Speak & Spell (Texas Instruments) offers the first voice synthesizer in a learning game.
1978	VTech (Video Technology International) launches its first electronic game. Today VTech produces the VTech TV Learning System and the V.Smile Motion.
1979	Dynabook is conceptualized by Alan Kay at Xerox PARC but is never released.
1983	Apple IIc (Apple Computer) offers a portable version of the Apple Iie for about $2300.
1986	Spelling Ace Spelling Corrector (Franklin) is released. Franklin is eventually purchased by Casio but continues to create talking translators, dictionaries, and spelling helpers.
1989	Game Boy (Nintendo) has a black-and-white LCD screen and comes bundled with Tetris.
1989	Macintosh Portable (Apple Computer) is released for $8,900.
1992	ThinkPad 700 (IBM) is released.
1993	AlphaSmart (Intelligent Peripheral Devices, Inc.) offers teachers a one-device-per-student solution with a full-size keyboard.
1993	Apple Newton (Apple Computer) advances handwriting recognition.
1995	Phonics Desk (LeapFrog) is created by Mike Wood to help his son learn to read. Wood goes on to start Leapfrog Enterprises.
1996	Tamagotchi (Bandai) releases a stopwatch-sized virtual life toy with an LCD screen that is treasured by millions of children, whose parents worry that their child's virtual pet might die.
1997	eMate 2000 (Apple Computer) is a failed attempt to repackage the Newton technology for schools. But it helps inspire the Palm.
1999	LeapPad (LeapFrog) uses NearTouch technology, allowing children to hear printed words read aloud with the touch of a stylus.

(Continued)

Table 3.1 **A Timeline of 43 Portable Computing Devices Marketed to Children, 1971–2008 *(Continued)***

1999	Music Blocks (NeuroSmith) is released, the first of a series of innovative electronic learning toys. Jan Davidson advises the company.
2000	Cyber Cartridge (NeuroSmith) is a cradle that delivers content to toys via the Internet.
2000	MindLink (LeapFrog) delivers content to toys via the Internet.
2000	TurboTwist Spelling (LeapFrog) puts the drill inside a tactile "twist" interface. It is one of many innovative toys that Leapfrog releases during this post-LeapPad time.
2001	Game Boy Advance (Nintendo) runs existing Game Boy cartridges and features a clear color screen.
2001	Pixter Creativity System (Fisher-Price) offers a touch screen and a small library of cartridge-based software. The Pixter Color is released in 2003, and Fisher-Price tries to use it to compete with the Leapster.
2001	The first iPod (Apple Computer) is released, along with a version of iTunes for Windows computers.
2001	iQuest (LeapFrog) delivers stored thousands of school-related skills in multiple-choice format and helps lay the foundation for the Leapster and the Learning Path.
2003	Franklin's Spelling Ace and Thesaurus (Franklin Electronic Publishers) puts thousands of words in your pocket.
2003	Game Boy Advance SP (Nintendo) combines a folding design with hundreds of cartridges and rechargeable batteries.
2003	Leapster (LeapFrog) features a touch screen and cartridge-based software. It is marketed as the "educational Game Boy."
2003	PowerTouch Learning System (Fisher-Price) ups the ante on the LeapPad by replacing the stylus with a child's finger.
2003	Story Reader (Publications International) reads picture books out loud on a page-by-page basis.
2003	iSprout (The Original San Francisco Toymakers) is announced, along with portable versions of JumpStart software. But it never reaches the market.
2004	Nintendo DS (Nintendo) offers a touch screen, microphone, and wireless connectivity. It also runs Game Boy Advance software.

Table 3.1 **A Timeline of 43 Portable Computing Devices Marketed to Children, 1971–2008 *(Continued)***

2004	Sony PSP (Sony Computer Entertainment America) comes with Wi-Fi, a 16:9 screen ratio, and the ability to play movies. It is upgraded in 2007.
2004	V.Smile TV Learning System (VTech) is released at Toy Fair. The low price and ease of use are attractive to parents, and a portable version is released the next year, to compete with the Leapster.
2005	VG Pocket (Performance Designed Products) is an all-in-one pocket videogame system that comes preloaded with 50 8- and 16-bit arcade games, viewed either on the built-in color screen or on your TV screen.
2005	FLY Pentop Computer (LeapFrog) uses Anoto's dotted media technology.
2005	TicTalk (LeapFrog/Enfora) is one of the first cell phones designed for children that combines earned minutes with drill.
2005	V.Smile Pocket Learning System (VTech) competes with the Leapster with a clear color screen and the ability to plug into a TV for play in the living room or in a car.
2006	Kid-Tough Digital Camera (Fisher-Price) presents the first digital camera designed specifically for preschoolers, with a preview screen.
2007	Nintendo DS Lite (Nintendo) offers a brighter screen and stronger batteries.
2007	Intel ClassMate PC (Intel) presents a sub-$500 laptop targeting schools, an alternative to the XO concept. Within the year, there are over a dozen sub-$500 laptop computing options such as the Asus eeePC.
2007	iPod Touch and iPhone (Apple Computer) provide wireless Internet access, bringing such applications as YouTube and Google Earth to a child's pocket on a much larger, clear touch screen.
2007	XO Computer (www.laptop.org) helps further the notion of one laptop per child. In 2008, a touch screen model is announced for 2010.
2008	Didj (LeapFrog) offers grade-specific drill for upper elementary-age children.
2008	LeapFrog Learning Path (LeapFrog) integrates handheld toys with a USB connection and online links to one curriculum.
2008	Pulse SmartPen (LiveScribe, Inc.) combines letter recognition abilities with a clear sound recorder in a device the size of a marker pen.

FIGURE 3.2
Four handheld devices were introduced during the American International Toy Fair 2003, featured on that year's March/April cover of *Children's Software & New Media Revue* (Buckleitner, 2003).

The passage of five years has resulted in significant improvements in capability at a lower cost. Children now have a digital delivery system in their pockets in the form of cell phones, and each device has created a niche market for related software. Cheaper, more powerful rechargeable batteries, LCD touch screens, and memory have given toy designers abilities of which they could have only dreamed a few years ago. Table 3.1 presents an historic look at the category of children's portable electronics. Note that this is not a comprehensive listing. Only key products (viewed from the perspective of the author) have been listed.

Table 3.2 Timeline References

A description of various Franklin handheld devices: www.franklin.com/about/profile.asp
A discussion of the history of game consoles: www.thegameconsole.com/videogames96.htm
An illustrated timeline of laptop computers: http://images.businessweek.com/ss/08/02/0215_laptop_history/index_01.htm?chan=rss_topSlideShows_ssi_5
A history of LeapFrog: www.fundinguniverse.com/company-histories/LeapFrog-Enterprises-Inc-Company-History.html
Nintendo's history: www.nintendo.com/corp/history.jsp
Palm's history: http://www.palm.com/us/company/corporate/timeline.html
The Speak & Spell story: www.ti.com/corp/docs/company/history/timeline/eps/1970/docs/78-speak-spell_introduced.htm
VTech's history: www.vtech.com/about_vtech/history.php

Sources for the timeline in Table 3.1 included the *Children's Technology Review* database, with 11,030 products dating back to 1985 (Buckleitner, 2008). Here are some links (accurate as of October 2008).

A GUIDE TO CHILDREN'S PORTABLE COMPUTING DEVICES

There's a battle going on right now among some of the world's largest corporations. The prize is the right to have their computing platform in your child's backpack.

Eleven types of children's mobile devices

A visit to a retail or wireless store reveals a variety of such microprocessor-embedded products, often heavily marketed to both parents and children themselves. Though products don't always fall neatly into specific categories, and sometimes one product falls into two categories, the emerging industry has developed its own set of terms, making it easier to tell one product from another. Here's an attempt to categorize these devices using trade-show vocabulary:

- *Cell phones.* They come in all shapes and sizes and do a lot more than make phone calls. Cell phones, also called *mobile phones,* are generally "free" or sold at a reduced price along with a commitment to a monthly plan that can cost $50 to $100 a month. The latest generation of phones can include Internet access, GPS receivers, Bluetooth connectivity, and the ability to download music, games, movies, and email. Other features can include a camera (still and video), QWERTY keyboard, and voice recognition. Cell-phone hardware represents a set of licensing relationships between bundlers such as Verizon and Sprint and hardware makers such as Samsung, LG, Motorola, Research in Motion, Apple, and, most recently, Google.
- *TV toys.* Sometimes called "plug-and-play" toys, these devices are often powered by batteries and require the sound and graphic abilities of a TV. Since 2003, this category of TV toys has grown significantly in number and sophistication. They include all-in-one game controllers such as Namco Featuring Pac-Man or Atari Paddle TV Games, or they can be more sophisticated, with the ability to function away from the TV with onboard speakers and screens, or they can play different software titles, forming a set of "micro-platforms." Such a micro-platform is defined as having 30 or fewer non-third-party software titles. Examples include the ClickStart (LeapFrog), V.Smile Pocket (VTech), and Smart Cycle (Fisher-Price).
- *Tablet PCs.* This term refers to laptop computers with touch screens. The term was associated with Microsoft in 2004 with the release of a tablet-based adaptation of Windows that offered handwriting recognition features. Increasingly, phones such as the iPhone or the Google G1 have started to encroach on the tablet PC category with their touch-sensitive screens and ability to recognize print.
- *Laptop computers.* Also called *notebook computers*, these portable computers have been shrinking in size and price while increasing in power. Current laptop computers have wireless (Wi-Fi) Internet access and large hard

drive storage and can double as media players and telephones (see Skype). Examples include the XO (www.laptop.org); Asus eeePC (www.asus.com), a Taiwanese import that costs less $400 and runs the open source Linux operating system; or the more expensive MacBook (Apple Computer, $800 and up). An additional category of toy laptop computers with QWERTY keyboards and LCD screens can be found in dollar stores from companies such as Oregon Scientific (see the Barbie Computer).

- *Educational gaming platforms.* This category of devices, also called *electronic learning aids,* or ELAs, are designed specifically to deliver engaging arcade-style games along with school-rated content. They can also be TV toys. Examples include the V.Smile Pocket (VTech), Leapster (LeapFrog), and Didj (LeapFrog), each with its own library of software titles that reinforce specific school subjects such as math and reading.
- *Electronic learning aids.* Since the days of the first Speak & Spell (1978) and the first calculators, electronic learning aids have emerged as a significant market sector, both in and out of school. Examples include the GeoSafari Quiz Bowl (Educational Insights), Crammer (LeapFrog), Hyper Dash (Wild Planet), Kidi Art Studio (VTech), and EyeClops TV Microscope (Jakks Pacific).
- *Portable gaming consoles.* These pocket-sized game delivery systems feature clear color screens and rechargeable batteries. The Nintendo DS has the most interactive features, with a touch screen and voice input; the Sony PSP (PlayStation Portable) doubles as a movie or music player. Note that mobile phones and portable media devices can also deliver game experiences.
- *Smart toys.* Starting with Thomas Edison's talking doll in 1890, inventors have struggled to amuse children with technology toys. Today's microprocessor-embedded toys can come with sensors and accelerometers, so toys "know" whether it is light or dark and whether they're standing or laying down. Fridge Phonics (LeapFrog) or Elmo Live (Fisher-Price) represent a new generation of microprocessor-embedded manipulatives.
- *Digital cameras.* Both toy and camera makers have recognized children as a viable market for digital cameras. For younger children, features might include a simplified interface with a large shutter button and the ability to survive multiple drops. As they enter elementary school, children can start using point-and-shoot cameras with better lenses, rechargeable batteries, and the ability to change memory cartridges. Examples include the Kid-Tough Digital Camera (Fisher-Price) and the Kidizoom (VTech).
- *Portable media players.* This diverse category includes DVD players, MP3 players, and iPods. Many of the features of portable media players have been incorporated into laptop computers and cell phones.
- *Electronic book readers.* These either work with plastic clamshell book holders such as the LeapPad or fit inside a fat battery-operated stylus. Examples include FLY Pentop Computer and Tag Reading System (LeapFrog) and Poingo (Publications International).

For discussion: six existing devices to watch

What will the digital future look like? Looking at existing devices is a good place to start, perhaps with consideration of Alan Kay's comment, "The best way to predict the future is to invent it" (Kay, 1991; see www.ecotopia.com/webpress/futures.htm for one of the many references to Kay's quote, originally used as advice to a group of Xerox executives). Here's an attempt to take a closer look at five devices—each currently on the market— that are currently shaping the future of children's interactivity.

- *The Nintendo DS.* Since its launch in the United States on November 21, 2004, Nintendo has shipped 84 million Nintendo DS units worldwide (Nintendo, 2008), making it the most widely used children's computing platform. These impressive sales numbers are evidence that the real $100 laptop (actually $120) was designed by Nintendo rather than the MIT Media Lab. Weighing 218 grams, the DS has two backlit, 3-inch TFT color LCDs with 256 × 192 pixel resolution and .24 mm dot pitch, capable of displaying 260,000 colors, plus a wireless range from 30 to 100 feet, letting multiple users play multiplayer games using just one Nintendo DS game card, depending on the software. They can also connect to the Internet using Wi-Fi. Other features include a microphone for voice recognition and both stereo speakers and a headphone jack. The embedded PictoChat software allows up to 16 users within local range of one another to chat at once, for as long as 19 hours of play on a four-hour charge. The startup screen offers six languages: English, Japanese, Spanish, French, German, and Italian. It is interesting to contrast the Nintendo DS with the Sony PSP, which was released the same year with a larger, clear 16 : 9 ratio screen that is ideal for playing movies, music, or videogames. Like the DS, the PSP comes with Wi-Fi, but it is harder to use and lacks a touch screen.
- *The iPhone 3G (Apple) and the Google gPhone.* The embodiment of Alan Kay's quote may be best represented by the iPhone Multi-Touch interface, which was introduced to the public in July 2007 and implemented later that fall for the iPod Touch. The latest iPhone edition, the 4.7 ounce iPhone 3G, can access either cell-phone or Wi-Fi signals and works as a GPS navigation device, showing a location as a dot on a map. The color screen can be used to display a variety of text, image, and movie files, including Microsoft Word or PowerPoint files, PDFs, and Excel. Built-in sensors can capture motion (an accelerometer), proximity (via GPS), and light (via an ambient light sensor). Many of these same features come in Google's gPhone, which represents pocket-sized hardware-wrapped customized content harvested from sources such as YouTube, Facebook, and MySpace. The open source operating system Android breaks open the way software is created, and the touch-screen interface opens playing games. The Facebook and MySpace contacts integrate into address books without having to launch a separate application. There's little doubt that other existing phone hardware companies, such

as LG, Samsung, Nokia, and Motorola, will follow with similar large-screen devices, but the winner is most likely to be the device that attracts the largest number of third-party programmers to create innovative content.

- *The Pulse smartpen*. Putting a computer inside a pen has been the dream of inventor James Marggraff since his days at LeapFrog, where he headed up the FLY Pentop computer team. Inside the anodized aluminum case of the Pulse smartpen (www.livescribe.com), released in Spring 2008, is a 32-bit, 150 MHz processor with an infrared camera that can take 70 pictures per second. The 2 GB memory can store 200 hours of audio, and the rechargeable lithium battery lasts two days. The pen has symphonic-grade audio with a 3-D recording headset for either binaural or stereo recording, a speaker, an audio jack, and a USB mobile charging cradle. The recorded audio can be played back by touching the print on the page. Both the audio and a copy of the printing can be transferred to a Macintosh or Windows computer or uploaded to a server. The pen weighs 1.3 ounces, and it can function as a regular ballpoint pen. It is interesting to note the similarity in price of high-end ballpoint pens, such as the $155 Apogee collection from Cross (www.cross.com). (For more on this topic, see Chapter 9 in this book.)
- *Mark-My-Time Digital Bookmark*. This device, first released by Mark-My-Time LLC in 2005, exemplifies the way microprocessors can crawl inside existing objects themselves to enhance their function, for a nominal fee. (The other example is greeting cards.) The Mark-My-Time Digital Bookmark costs $9 and keeps a running tab on the number of minutes a child reads from traditional books. A second product from the same company, the Mark-My-Time for Music Digital Metronome ($20), adds a metronome and tuner and is designed to clip onto a music stand. See www.mark-my-time.com for more details on both devices.
- *eeePC*. Few categories of electronics have benefited more from advances in microprocessor-related technology than laptop computers. This year, solid-state hard drives and mainstream computing applications, running on open source operating systems such as Linux, have great potential to bring power to every child's backpack. Why pay $300 for an iPhone or iPod when, for just $80 more, you can get an entire computer, with Wi-Fi? The eeePC, from Taiwan-based Asus Computer (www.asus.com), is one such model that first started turning heads back in 2007. In case you're wondering, the three *e*'s stand for *easy to learn, easy to play,* and *easy to use*, giving this laptop its unconventional name. Weighing in at just over 24 ounces, the first edition of the white glossy computer came preinstalled with a host of open source applications, including Linux, Open Office, Skype, and the Firefox browser, making it possible to nearly sidestep expensive Microsoft applications altogether. Like Nicholas Negroponte's XO computer, there's a version with a solid-state hard drive and no moving parts.

THE FUTURE: HOW PORTABLE TECHNOLOGIES COULD CHANGE THE CULTURE OF CHILDHOOD

Twenty-five years ago, Shirley Brice Heath (Heath, 1983) provided an ethnographic description of the literacy activities in two low-income communities, Roadville and Trackton. This work has become standard reading in educational psychology courses, helping educators consider the overarching cultural influences of low income on literacy. At the time of her study, it was common for a literacy researcher to attempt to quantify the literacy threshold in a child's home as a continuous variable. One means of doing this was to attempt to count the number of books in the home.

Visiting Trackton and Roadville today, researchers would find homes with pixels as well as ink, and the task of an ethnographer trying to replicate Heath's study would be more complex. Some families might have broadband Internet access and cell phones, and perhaps more significantly, cell phones unconnected to the digital world.

Based on the trajectory of the types of devices available today and considering the constant backdrop of human development, it is possible to make some fairly safe assumptions about what lies ahead.

Let's start with views about how children learn. Any conversation about children and technology should start with clear definitions of both. Children vary considerably between ages birth and 15, and there are 11 categories of portable technology devices, each with a different function. In addition, educators and educational researchers have been known to approach a single learning task very differently, depending on how one thinks children learn best.

It's fun to imagine a modern-day roundtable discussion with guests such as Edward Thorndike, Jean Piaget, B. F. Skinner, Lev Vygotsky, Howard Gardner, John Dewey, and perhaps Benjamin Bloom, each with 10 minutes to deliver a PowerPoint presentation on the implications of the iPhone on childhood. Thorndike and Skinner would probably coalesce around the potential for reinvigorating the concepts of mastery learning by downloading just-in-time, easy-to-measure skills and a format that adapts to an individual child's abilities. Vygotsky would most likely be intrigued by the iPhone's ability to run Twitter and Facebook, creating a connected culture of shared competence where an individual could have access to an unlimited supply of "more capable others." It's safe to say that Piaget would not overlook the power of such a device as an open-ended representation tool, complete with a camera. Each of these theoretical frameworks helps contribute to a discussion of the potential uses and misuses of these devices.

Another assumption is that hardware will continue to improve, following the path predicted by Intel scientist Gordon Moore (Moore, 1975), who predicted an exponential growth in the number of transistors per integrated circuit. The

associated computer processing power, measured in millions of instructions per second (MIPS), has increased because of increased transistor counts, lower cost, and smaller form factors. Combined with other innovations, such as smaller motors, LEDs, carbon-fiber construction, lithium-ion batteries, touch screens, and voice recognition, silicon-based technology will become more plentiful and powerful and more seamlessly integrated into a child's life. Many of these items have already been invented; others are simply fun to imagine. Here's a brainstorm.

The future: Toys

- No more AA batteries. Toys and gadgets might charge automatically with wireless batteries that can absorb energy from electromagnetic frequencies.
- Programmable flying toys can hover and sense obstacles. (See the FlyTech Bladestar, WowWee, Ltd.)
- Plug-and-play TV microscopes that turn a grain of sand into a clear, wall-sized image (EyeClops BioniCam, Jakks Pacific, Inc.).
- Durable, child-friendly digital cameras and digital video recorders will synch with a school's server, a classroom's LCD bulletin board, or a Website.
- A new category of musical instruments, such as the Power Tour Electric Guitar (Tiger Electronics/Hasbro), will have touch interfaces with motion detection, plus they will contain onboard pitch-sensing feedback for ear training. In addition, new interfaces will enable the creation of sounds with motion, increasing a child's creative possibilities. (See Karaoke Revolution, Konami; SingStar, Sony; and Rock Band 2, Harmonix/MTV).
- Talking blocks with embedded accelerometers and haptic (touch) feedback mechanisms will provide more meaningful feedback to younger children.

The future: Prereading and writing skills

- Dotted media picture books will make it so that any picture, map, word, or alphabet strip in a child's environment can be read aloud in a language of his or her choice with the touch of a stylus. (See the FLY Pentop Computer and the Tag Reading System described in this book, both from LeapFrog.)
- Large touch-screen desktops will deliver customized learning activities. (See the Microsoft Surface, Microsoft Corp.)
- Smart pens will come with real-time natural-language translation features and ear buds, enabling teachers to speak in real time to a child who might have recently moved to the country or other remote location. (See the Pulse smartpen, LiveScribe, Inc.)
- Dolls will come with accurate lip-synching capabilities and expansive vocabularies. (See Elmo Live, Fisher-Price.) Eventually teachers and parents can put in a familiar voice rather than that of a Sesame Street character.

The future: Quality of childhood

- Automated smart school buses will come of age that will be controlled by verbal commands and will know whether a child is at a stop or not via radio frequency identification (RFID) bracelets. While on the bus, students can synch their phones with each other or use the touch screens embedded in the back of the seats in front of them to carry on conversations with other passengers. Other screen content would be a day planner and a live video feed to a parent for some reassuring words when needed.
- A new generation of adaptive touch screens and voice recognition interfaces will be developed for children with special needs, to control everything from a wheelchair to a flying simulation.
- A next generation of digital school security products will provide safer, smarter schools.

The future: Assessment

- Portfolio-based systems, such as the Work Sampling System (Meisels, 1993), will flourish when paired with handheld devices such as the iPhone, helping busy teachers document a child's development in real time. Captured evidence could consist of photos, videos, reading and writing samples, and scores on hierarchical rubrics. Parents could have real-time access to this evidence.
- Unlimited amounts of quantitative data can be stored on a school's server. Smart blocks that record how many times they've been moved or manipulated per day or by a particular child, bundled with software that translates this data into meaningful daily "play maps" that report exactly what a child has done each day, with which materials, and for how long.
- Automated attendance systems could use face and/or fingerprint recognition, eliminating the need for login screens or automating such tasks as taking attendance.
- Handheld sensors adapted from technology currently being used at airports can tell whether a child has been exposed to any unhealthy substance, such as gunpowder or lead paint dust. See the GE Entry Scan (or puffer) for such entry devices.
- Clip-on data loggers that link to databases can capture and record huge amounts of information, such as an entire week's worth of audio or the GPS locations showing where a child goes in a classroom. If needed, a teacher or parent could rewind and play back every word a child has heard or spoken over the past year.

Four possible effects of these technologies

1. The definition of "being literate" will continue to broaden. Being literate in the 21st century means who is the fastest draw on a connected phone doing a Google search. Just as the BlackBerry has made the busy executive

more efficient, cell phones have made children more efficient—at being children.

2. Problems of technology inequality will be displayed in interesting ways. Already, children who don't have cell phones face social challenges. At the Mediatech Foundation in Flemington, New Jersey, children who have lost their phone service have been known to carry their nonworking phones with them, just to appear as though they're connected. Another family switched wireless carriers so that their daughter could be in the dominant friends and family plan used by her friends, to avoid surcharges. New social labels such as T-Mobile, Verizon, and AT&T seem to have joined cultural classifications such as Republican or Democrat, Catholic or Presbyterian.
3. As portable devices continue to play a role in social and educational reform initiatives, schools that have been resistant to child-centered, constructivist curriculum approaches could face pressure to change as the faculty roster is joined by freshman teachers who already have blogs, Facebook accounts, and connected phones.

   Open-source social tools such as student blogs, wikis, and Moodle are helping supplement or replace a stale school curriculum, and textbook publishers are increasingly delivering their curricula in both printed and online formats. One such curriculum, EnVision Math (Pearson Education, 2008), includes 1200 Flash-based lessons for grades K–6, designed specifically for small or large whiteboards. According to Marc Nelson, the Director of User Experience for the project, "If you can run a browser, you can get connected" (Nelson, 2008). See the demonstration at www.envisionmathtexas.com. As digital materials continue to be used by proponents of change, it is useful to recall the story of the Trojan horse (Olson, 2000):

> After trying for ten years to break into the city of Troy with brute force, a Greek commander named Odysseus came upon a scheme to infiltrate the city by tricking the guards, with a giant artistic wooden horse statue by the artist Epeius, that had been hollowed out so that soldiers could hide within it. The rest of the Greek fleet sailed away, so as to deceive the Trojans. One man, Sinon, was left behind to pose as a traitor. When the Trojans came to marvel at the huge creation, Sinon pretended to be angry with the Greeks, stating that they had deserted him. He promised the Trojans that the wooden horse would bring them luck. Two people, Laocoön and Cassandra, spoke out against the horse, but they were ignored. The Trojans celebrated what they thought was their victory, and dragged the wooden horse into Troy. That night, after most of Troy was asleep or in a drunken stupor, Sinon let the Greek warriors out from the horse, and they killed the Trojans. (See www.stanford.edu/~plomio/history.html#anchor204279.)

Needless to say, paradigm shift change happened in Troy. In recent educational history, frustrated constructivists such as Seymour Papert

have struggled against the measurement-based thinking that has often led to a "teach to the test" pedagogy. More recently, Nicholas Negroponte has been attempting to use mass-produced laptop technology to improve Internet access in developing countries (Negroponte, 2008).

Today there's a new Trojan horse. A new tempting gadget, too curious to avoid, is being smuggled into schools inside student pockets and backpacks. Once inside the school walls, these connected devices can use invisible, external cell-phone towers on distant hillsides to deliver Google to the curious minds that have been starved of current knowledge—providing the ability to check a teacher's facts or find out what is happening outside the school's firewall.

4. Function will trump the form of more computer-related technologies. We'll start to see fewer mice and QWERTY keyboards and more touch screens or handheld materials with embedded microprocessors. Hardwired computer labs, which emphasize technology, will dissolve into the classroom as Wi-Fi networks proliferate in schools. Increasingly, teachers will demand and provide feedback on the quality of interactive materials, much as they have traditional supplies, and competition will drive innovation. Some interactive products will work and others won't, and instant reviews will help publishers fix problems. With time, the better products will prevail over those that are less effective. The present-day teacher will start to worry less about hardware and more about the experiences on the screen or inside the device, thinking about making the best match between the experience and the child. In a way, it is a return to the first basic task of parenting and teaching: to make sure that every child succeeds with the most appropriate materials.

CONCLUSION

No technology will replace the joy of a bedtime story read from a battery-free book by a loving parent. There's no argument about whether the well-established developmental milestones, such as learning to walk, talk, and ride a bicycle, will continue into the future. What is much more uncertain is the degree to which digital technology can influence a developing child in either positive or negative ways; both outcomes have cultural bias and are open to interpretation. Today we enjoy technologies that were the dreams of yesterday's generation, offering countless possibilities to improve the quality of childhood. The job for parents and educators is to match quality technology-based experiences to each individual child.

Let's end where we started. At the very dawn of educational technology, when the potential of microprocessors offered endless blue sky for learning, educators and philosophers were intrigued. One of these was Patrick Suppes, who in 1966 predicted, "In a few more years, millions of schoolchildren will have access to what Philip of Macedon's son Alexander enjoyed as a royal prerogative: the

personal services of a tutor as well informed and as responsive as Aristotle" (Suppes, 1966).

In reality, those "few more years" turned out to be about four decades. It's fun to think that today such a tutor has arrived in the form of a search engine window silently waiting in your child's pocket. And there's a bonus because that same device can carry your voice to your child's ear, anyplace, anytime.

Connecting to you

- Over the past five years there has been a significant increase in the quantity and quality of portable technology devices for children.
- There is a direct relationship between the number of types of portable devices and opportunities for teaching and learning.
- There's a broad spectrum of "digital natives" to consider with different needs, skills, and access to a variety of technologies. A wave metaphor might be more accurate than a spectrum, with the class of 2012 being the first "connected natives" because they are the first to have reached cognitive maturity the same year that Web-capable phones and services such as YouTube and Facebook became mainstream.
- A conversation about children and technology should start with clear definitions of both. Children vary considerably between birth and 15 years of age, and there are 11 categories of portable technology devices, each with a different purpose.
- The enthusiasm for children's portable technologies is not new. There has never been a shortage of visionaries promising better results from newer, better technology.
- No technology can replace the joy of a bedtime story read from a battery-free book by a loving parent. It is not known how technology can influence a developing child in either positive or negative ways.

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