Plato Revisited

Learning Through Listening in the Digital World

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Abstract

In our era, new technologies are challenging traditional definitions of what it means to be literate. Reading and writing remain important facets of literacy but are not themselves synonymous with literacy. Specifically, digital media have revived the importance of listening and oral literacy. This is happening at the same time that brain imaging technologies have radically altered our understanding of how the brain works and learns. We now see the way in which three brain networks coordinate how we listen and how listening helps us learn. Many areas of the brain are involved in listening, and skillful listening involves a complex and varied set of activities.

Because individual learners approach the same learning task in widely varied ways, it is essential to provide multiple means for achieving success. Learners need multiple ways of recognizing important information, variety in how to strategically approach a learning task and multiple means of becoming engaged in learning. For this reason, listening can play an essential role in supporting learners with diverse needs, abilities, and styles. Tools such as digital text, text-to-speech and audiobooks offer powerful alternatives to traditional classroom materials that rely almost exclusively on printed text. Twenty-first century learning environments should leverage the advantages of new digital media to provide these options—thereby expanding the potential circle of successful learners in today's classrooms.

Plato Revisited: Learning Through Listening in the Digital World

Long ago, Plato raised a concern in his *Phaedrus* that is familiar in our era: new technology will undermine traditional literacy. Plato (quoting Socrates) expressed the fear that the emerging technology of writing would destroy the rich oral literacy that was central to his culture. Writing would reduce the need for memory and attentive listening. It would give learners the appearance of wisdom by aiding rapid recall of information and facts without requiring internalization of such wisdom. This sort of "superficial" learner would inevitably be less literate. It turned out Plato was right only in part; although writing did change the meaning of literacy it enabled incredible advancements in knowledge.

In our era, new technologies are again challenging traditional literacy. Many fear that these new technologies will weaken the literacies—reading and writing—that have been central to our culture. We now live in a media-saturated age where these traditional forms of literacy are being blended, redefined and replaced by dynamically evolving media and communication technologies that seem to emerge daily. Whereas reading and writing used to take priority, these new communication technologies increasingly dominate our culture, especially for young learners who grew up using personal digital technologies.

In this paper, we argue that the proliferation of new technologies will not diminish literacy but rather expand it. In particular, we shall argue that new technologies—from functional magnetic resonance imaging (fMRI) and positron emission tomography (PET) to iPods, sound blogs and text-to-speech—have revived the importance of listening and "re-balanced" literacy such that printed text remains an important facet of literacy but is not itself synonymous with literacy. The new literacy, in which listening and oral literacy regain an important role, will be a literacy that even Plato would have admired.

In the sections that follow, we will address how new technologies are affecting our perspectives on listening and literacy by examining how new technologies are:

• changing our view of what listening is,

• changing our view of the relationship between listening and literacy, and

• changing our view of what a literacy program should be.

We will conclude with recommendations for enhancing the role and practice of listening in today's classrooms.

How New Technologies Are Changing Our View of What Listening Is

During the last decade, new imaging technologies have radically altered our understanding of how the brain works and learns. The new digital imaging techniques allow neuroscientists to study the living, working brain in ways that earlier imaging technologies, like X-rays and CAT scans, could not. Where these technologies provided primarily static, fixed images of the brain, new imaging techniques like PET, fMRI, and magnetoencephalography (MEG) can generate dynamic, interactive images. These kinds of images allow viewing of not only the anatomy of the brain but also the way it functions in the course of different cognitions and behaviors. This provides great insight into the brain's operations, including how listening works.

In this section, we illustrate some of the new understandings about listening and learning to listen that have emerged from this research. We will show that listening is much more complex than most people had imagined. To simplify somewhat, we will distinguish three broad aspects of listening, which correspond to three broad regions of the brain as described by neurologists and neuropsychologists (Luria, 1973; Rose & Meyer, 2002) and also by educational psychologists such as Vygotsky (1978). Collectively, these three networks coordinate how we listen and learn to listen.

Listening in the Brain: Recognizing Sounds and Their Meaning

The digital image in Figure 1 illustrates cortical activity while someone hears words. Several activation areas appear, mainly within the posterior (rear) regions of the cortex. These areas form a network of brain processors that are involved in the task of hearing words. What is happening in this part of the brain? What makes it active? The role of this posterior part of cortex, which we will call recognition cortex, is to categorize the many sound patterns that reach the ears so that we can recognize and understand them.

Most of the posterior half of the brain's cortex is devoted to pattern recognition (Farah, 2000; Mountcastle, 1998), with one region specialized for recognizing the patterns that we call sound (Figure 1). This auditory region makes it possible to identify what an auditory stimulus pattern is—to know that a particular pattern is a dog's bark, the sound of car brakes or a melody from Beethoven. These pattern recognition capabilities are essential for identifying many basic patterns in the ways things sound—their pitch, duration, timbre, location, sequence and so forth. In language, the auditory cortex is responsible for recognizing sound patterns in language—the phonemes, morphemes, syntax and semantics. Within slightly different regions, even higher-level patterns are recognized, patterns that help us identify a specific speaker's voice, style, place or origin, and even intent.
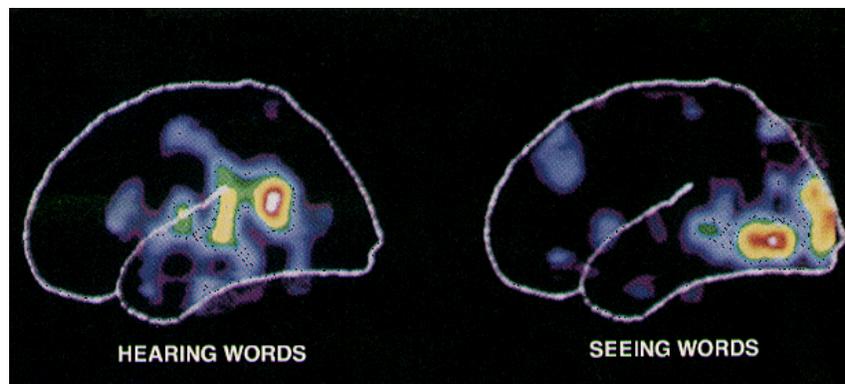

Figure 1. Computer imgae of a brain showing areas of intense activity when words are being heard. (Posner & Raichle, 1994; Used with permisson.)

To take one example, consider the way in which we use our voices to emphasize critical information. We use variance in loudness, pitch, length, and accent to punctuatesentence structure and instill speech with emphasis and nuance. These variables are unique to speech and convey rich information to the listener. For example, pauses can designate grammatical significance (pauses are longer between sentences than between clauses or phrases) or general significance (a pause before a phrase to add emphasis). Changes in pitch and tone also mark the structure of phrases and sentences.

A typical declarative phrase begins with a jump in pitch, and the pitch diminishes in an undulating fashion until the end. Questions are tagged with an ending rise in pitch. Recognizing the shifts in meaning that result from a simple change in emphasis is another essential part of listening.

Damage to the posterior cortex can affect the brain's capacity to recognize sound and language in general or very specific ways. Depending on the degree and kind of damage, an individual may lose the ability to recognize sounds, to recognize words, to recognize a speaker's voice or to recognize verbs but not nouns. Because the varied speech cues seem to be processed in different locations within the recognition cortex, individuals can have deficits affecting very specific aspects of phrase recognition. Normal variation in the ability to recognize the information in sound and language can occur by virtue of differences in the amount of cortex or the extent of neural networks allocated to auditory recognition or a particular facet of auditory recognition. A small minority of people, for example, have a large region of recognition cortex devoted to pitch, resulting in what is called "perfect pitch"; others (including the authors!) have very small regions devoted to pitch, with the result that our pitch recognition is far from perfect.

Obviously, listening critically depends on the recognition cortex. The brain's ability to quickly recognize the auditory pattern of a word, the syntax of a sentence and the pattern of meaning in speech is critical to listening. But it is not enough.

Listening in the Brain: Strategies for Making Meaning

Listening is qualitatively different from hearing. Hearing seems effortless, automatic and nonselective. Our brains recognize and categorize sounds even when we are sleeping, which is why we wake to a faint but unexpected noise in the next room but sleep peacefully through the blast of the regular midnight train. On the other hand, listening feels intentional; it is effortful, focused and selective. We need to be awake to listen. Hearing is reactive, while listening is strategic. The strategic, effortful, selective aspect of listening recruits a different part of the brain than the posterior regions with which we recognize sounds.

Modern imaging technologies show that when we really listen, when we are strategic and effortful in what we hear, we engage areas of the brain that are located at the very front of the brain, in the prefrontal cortex. The prefrontal cortex is specialized for organizing and prioritizing actions and movements into goal-directed activity. Beyond purposeful action, the prefrontal cortex is also important for organizing and prioritizing what we attend to and what we remember. Overall, the prefrontal cortex, often called executive cortex, allows us to be strategic rather than reactive, such that our own goals and plans dominate the way we interact with the environment and with other people (Fuster, 2003; Goldberg, 2001; Jeannerod, 1997; Stuss & Knight, 2002).

Planning and organization are essential features of listening. Effective listening involves setting priorities (e.g. attending to a single woman's voice at a cocktail party), being purposeful and strategic (e.g. listening to find out whether her ideas are conservative or liberal), and sustaining effort and monitoring progress (e.g. continuing to selectively listen until you have understood her politics but switching to something else when you have learned enough). Because speech is ephemeral, listening is particularly dependent on the attention- and memory-related functions of the prefrontal cortex. To extract meaning from speech we must effortfully hold the information in memory, compare it to background knowledge, predict what is ahead and sustain attention. This is what we call active listening, and cognitive neuroscientists have shown that it engages a large portion of the prefrontal cortex (Osaka et al., 2004).

Individuals who have a damaged prefrontal cortex are often poor listeners. They can hear speech but have difficulty following or understanding it, because they cannot organize the strategies and skills necessary for selective listening, attention and maximization of memory resources (Semrud-Clikeman, 2005). On the other hand, individuals with strong strategic listening skills can compensate to an extent for problems with speech recognition by predicting, hypothesizing and filling gaps in what they hear. Thus, strengths and weaknesses in an individual's strategic networks impact how well he or she is able to listen to and understand speech.

Listening in the Brain: Affect and Emotion

An effective listener knows what is important to listen to; he or she cares about what is being said. Identifying what is important to listen to is no simple task. In the cocktail party scenario, a conversation with the man with the yellow hat may seem important, but our brains must also monitor the other sounds in the room in case a more urgent or important event occurs, such as someone mentioning our name, in which case our attention shifts rapidly! What we regard as important to listen to changes over time, depending on our status, history, expectations and the many features of what we call our personality. What is important can shift rapidly with changes in the environment, for example, whether we are in a dangerous place or a romantic one. And it varies with the speakers, not only with what they are saying but with how they are saying it. The speaker's tone and emotion bear directly on the importance of the content to the speaker and to us.

Speech and music carry emotional content that is separable from the words or syntax, and understanding the meaning, the importance, of that emotional content requires its own processing. Affective networks, part of the extended limbic system at the central core of the brain, process this content in order to determine the value, importance and significance of what we listen to. They determine whether information and events matter to us, whether they are important and help us to decide which actions and strategies to pursue, on the basis of their value and significance (Damasio, 1994; Lane & Nadel, 2000; Ledoux, 2003; Ochsner, Bunge, Gross, & Gabrieli, 2002; Panksepp, 1998).

Individuals clearly differ in their abilities to employ and interpret emotional cues when they are listening, just as they differ in their abilities to understand semantic content or to apply strategies for listening and remembering. In particular, many individuals with emotional disabilities have difficulty in social situations because they fail to recognize the emotional cues in what is being said.

In summary, the affective cortex plays a key role in effective listening. Without it, we are impaired in our ability to recognize what is important in what is being said, but also we are impaired in our ability to establish a priority for listening, to focus attention appropriately, to select what is of value and to remember what is important.

How New Technologies Are Changing the Relationship Between Literacy and Listening

The previous section on listening and the brain illustrated one important thing: skillful listening involves a very complex and varied set of activities. The fact that many areas of the brain are involved in listening (and remember that we have simplified somewhat) is one of the dramatic findings of modern neuroscience. Not surprisingly, when listening is understood in its full complexity, it is clear that becoming a skillful listener requires a lot of learning. Using the same framework as in the preceding section, we would like to highlight, partly as a review, the kinds of learning that successful listeners must undertake.

Learning to Listen

First, successful listeners must learn to recognize the sounds of their environment. As one example, they must learn to recognize the sounds from which their local language is constructed. It is now clear that very young infants are already learning to distinguish the particular phonemes that constitute their language. Later they will learn to recognize the words and syntax, the forms of emphasis and the narrative schemas from which meaning can be derived. This kind of learning, based in the posterior recognition cortex, will continue throughout their lives.

Second, individuals must learn how to listen actively rather than passively hear. They must learn the tactics and strategies needed to comprehend, review, and remember a variety of sounds, from simple language streams to complex soundtracks with sound effects, music, and human speech. These active listening skills require practice and effort: they need to be learned.

Third, to be successful, learners must learn what is important to listen to. From among the many things that they will hear at any moment, successful listeners must learn what to select for further attention and what to ignore. Moreover, a listener must learn the

signs and symbols of significance in language—the ways in which sound and language convey value and importance, highlight critical features, manipulate mood and affect, and generate appeal or excitement.

There are at least these three kinds of learning that are important to becoming a good listener. It is now clear that during the early developmental years we are learning to listen in all these ways, and there is much to learn. Learning to listen is critical, since it is by listening that we are able to learn and to communicate with one another.

Listening to Learn: Multimedia

It is notable that we have eyelids but not ear flaps. Our ears are always open. This difference reflects the importance of hearing to our survival. Our ancestors survived because hearing and listening were critical early warning signals of danger. Listening proved to be much more valuable than vision in that regard. With the onset of language, a new aspect of the value of listening became apparent. Language amplified opportunities for learning by providing a foundation for culture and the social transmissions that could complement and extend direct experience. Within linguistic cultures, humans listened to learn.

Over time, written language emerged and overcame the primary weakness of oral language, its impermanence. With writing, language became permanent, transportable, viewable and recordable. As a result, print literacies came to dominate many cultures, relegating oral literacies and listening to secondary status. In the new media age, new ways of making speech (and other sounds) permanent, transportable, viewable and recordable have emerged. In fact, they have flourished.

As a result of new media and technologies, a much broader palette for literacy is now available, one that extends beyond reading and writing to include aural (and oral) literacy as well as visual literacies. While some scholars still assume that text retains its privileged status over more dynamic visual and aural media for intellectual discourse, the overall culture has already migrated to a broader palette for communication, persuasion, inquiry and entertainment.

This is especially true for young people. Today's students have never known a world without computers, digital media or the Internet. Described as digital natives, they view the world of information and communication technology (ICT) differently from most of the adults in their lives, who in contrast, are considered digital immigrants (Prensky, 2000). Students spend six hours per day on average using some form of technology-based media (Lenhart, Madden, & Hitlin, 2005), much of it geared more toward listening and viewing than reading and writing. Teens and tweens (ages 9-12) talk to each other, exchange pictures, send text messages and watch movie trailers on their cellphones. They listen to music that they have selected, downloaded and organized on their

iPods. They spend hours as active participants on the Internet, where they shop for clothes, "chat" with friends, contribute to blogs, create personal web pages to express themselves, and get information about almost anything that interests them, including school assignments. They are usually far more savvy then their teachers about how these new digital literacies can work to their advantage. Technology has raised the importance of listening, as students live now in a sea of oral language and sound. Digital natives listen to learn.

While some schools have moved to employ new media in the classroom, most continue to emphasize learning almost exclusively from printed text. This creates a tremendous gap between the learning technologies students use and the way in which academic content is delivered. It also has the effect of relegating listening to a rather minor role, with the major instructional effort reserved for reading and writing. The irony is obvious: while new media are making listening even more important in students' everyday interactions, listening does <u>not</u> receive the sort of emphasis it should in school, especially in the development of literacy skills.

This is a missed opportunity. Technology now allows us to store and manipulate language in ways previously not possible. Once speech is captured in digital format, it can be transformed in multiple ways to support students' learning, without loss of the original representation. In doing so, listening experiences can be designed to productively engage diverse learners by providing alternative learning opportunities for reaching common academic standards.

Listening to Learn: Reading

New technologies are repositioning listening as an important "new" literacy, an important way to learn in the digital age (as well as communicate, entertain, etc.). But it is important to recognize that listening is foundational for other, more traditional, literacies as well. In this section we will explore how learning to listen is fundamental in learning to read. Not surprisingly, in view of the neuroscience framework reviewed earlier, we shall see that learning to listen is critical to learning to read in at least four important ways.

First, successful reading depends on phonemic awareness, the ability to recognize the elements of oral language on which reading depends (Nation & Snowling, 2004). Decades of research summarized by the National Reading Panel (2000) demonstrates that young children need to be able to hear and recognize the sounds of language, and its vocabulary, in order to learn to read. Beginning readers develop a foundation for reading by listening to the sounds of language and manipulating them and by listening to the vocabulary and syntax through which meaning is constructed. The current emphasis on phonemic awareness and oral vocabulary and oral discourse for comprehension recognize the critical role that listening to language plays in early reading.

Second, well beyond the early stages of reading, indeed, at every stage of reading development, successful reading is intimately connected with what one has learned from listening. Reading comprehension critically depends on the recognition of words and ideas in the context of what has already been learned. That is, comprehension relies on connecting to general background knowledge, previously learned vocabulary, the concepts and principles that tie words together, the oral discourse structures for telling stories, participating in conversation, giving directions, etc. These can all be learned through listening, for some students only through listening, especially in the early grades.

Third, successful reading requires not only recognizing the elements of language but also implementing effective strategies and tactics for constructing meaning from those elements. Reading comprehension is strongly related to oral language comprehension. Recent brain research has revealed an important finding: when individuals are engaged in active, strategic listening, they use the same executive functions in prefrontal cortex that are engaged during active, strategic reading (Osaka et al., 2004; Schumacher et al., 1996). This finding from the neurosciences confirms an important relationship: the same strategies and skills that allow a listener to make sense of oral language—predicting, monitoring, connecting to background knowledge and summarizing—allow a reader to make sense of written language. Listening comprehension is critical to reading comprehension because listening and reading require the same strategies. Students who do not know how to listen carefully and strategically also will not know how to read carefully and strategically.

Fourth, for continued development of literacy, lifelong engagement in literate activity is essential. In order to love reading, it is essential that students love stories and narratives, as well as the language and rhetoric in which they are told. Engagement in multiple literacies is hugely important.

The importance of these connections between listening and reading are further demonstrated by the National Research Council report, Preventing Reading Failure in Children, in which the authors describe "three potential stumbling blocks" to learning to read (Snow, Burns, & Griffin, 1998):

> *The first obstacle, which arises at the outset of reading acquisition, is difficulty understanding and using the alphabetic principle—the idea that written spellings systematically represent spoken words. It is hard to comprehend connected text if word recognition is inaccurate or laborious. The second obstacle is a failure to transfer the comprehension skills of spoken language to reading and to acquire new strategies that may be specifically needed for reading. The third obstacle to reading will magnify the first two: the absence or loss of an initial motivation to read or failure to develop a mature appreciation of the rewards of reading (p.4).*

Importantly, these three stumbling blocks directly correspond to the neurological divisions described earlier. Even more important here is the fact that two of these are directly dependent on listening: students must be able to hear the relationship between spoken words (and sounds) and the alphabetic representation in reading, and they must be able to apply the skills of spoken language comprehension to reading. It must be said, moreover, that the third "obstacle" is probably also heavily connected to good listening: students who don't love language and the stories composed in that language will not see the importance of reading either.

Listening and Literacy in the Modern Era

Both learning to listen and listening to learn are critical to literacy in the 21st century as new technologies rebalance what it means to be literate and to learn. Listening is not merely a "folk" literacy that has been superseded by the modern technologies of print, media, and multimedia, but rather it is a powerful and essential means of developing and mastering both old and new literacies.

Listening is a vital alternative to the limits of print for some students, especially those with disabilities that interfere with the fluent use of printed text (e.g., students who are blind, dyslexic, have visual processing disorders, and so forth). For these students, the skills of listening are critical as an alternative literacy that can allow them to keep pace with their peers in building knowledge. In addition, in the modern era, every student needs to learn to listen in order to be literate—literate in traditional print media (knowing how to read) and literate in the new media of iPods and the web.

How New Technologies Are Changing What a Literacy Program Should Be

The same kinds of digital technologies that are repositioning listening among the literacies of the 21st century are changing the classrooms in which literacy is learned. While many of the early promises of computers in the classroom have not been achieved, it is apparent that new technologies for the classroom have at least two agreed upon advantages.

First, new technologies are an important component of any pedagogy that prepares students for living in the 21st century. New technologies are obviously essential in teaching students how to be literate with the tools that they will need for their futures. Computers are not very good at teaching students how to use blackboards, but blackboards are essentially useless at teaching students how to use the multimedia digital tools of reading, writing, listening, viewing, composing and communicating that are essential for their future.

Second, new technologies are an important ingredient in meeting the challenge of individual differences. Where print technologies present many barriers to students because of their essential "one size fits all" quality, digital media can have just the opposite effect. Their malleability and customizability allow digital media to provide a flexible platform that can meet the challenge of different kinds of learners.

In particular, the flexibility of digital media is an essential component in Universal Design for Learning (UDL; Rose & Meyer, 2002), an approach to curriculum design that seeks to maximize learning across a wide spectrum of students with and without disabilities. By designing to support the needs of students with disabilities, the curriculum is strengthened in a way that supports all students. Within UDL, the flexibility of new technologies is an ssential foundation for meeting the challenge of individual differences:

• To support individual differences in learning to recognize the world, provide multiple, flexible methods of presentation

• To support individual differences in learning strategies for action, provide multiple, flexible methods of expression and apprenticeship

• To support individual differences in what is motivating and engaging, provide multiple, flexible options for engagement (Rose & Meyer, 2002)

By helping us to recognize obstacles in the curriculum, technology can enrich the curriculum for all students. As Meyer and Rose (2005) write, by helping us "… to appreciate the full extent of learners' diversity and the variety of ways in which they can be unique, it will become apparent that the curriculum itself can be improved to the benefit of all students" (p.30).

It should be noted that increasing the opportunities for listening to learn in the classroom is an essential component of a UDL approach to literacy. Through that approach we increase the likelihood that diverse learners will have access to standardsbased literacy and the learning strategies needed to master that literacy. Further, we increase the probability that many students will remain engaged in literacy learning, especially those for whom text presents a barrier.

In the following sections, we describe two scenarios that illustrate some of the many ways in which new technologies and the universal designs that they allow can support learning through listening in an overall literacy program.

Listening to Learn: A Digital Scenario

In Plato's time, speeches were ephemeral; words and diction could be lost almost immediately and entirely. With the development of writing, the logic of a speech could be recorded and remembered, but not the rhetoric, power or voice. With analog recording, the full power of speech could be recorded and saved, but in highly vulnerable and limited media. In the digital era, the full power of speech can be recorded (along with visuals) and stored in media that offer many kinds of display and allow the kinds of power and flexibility needed for teaching and learning.

For example, consider children of today listening to a digital audio recording of Martin Luther King Jr.'s "I Have a Dream" speech. With digital playback they may slow down or speed up the rate of narration, pause to reflect or replay a segment or skip to various sections of the speech. The user rather than the speaker is now in control and may play back the speech in flexible ways to suit his or her goals for listening, preferences and needs. Consider three students, each listening to the same digital audio recording:

• Elena, a Spanish-speaking student, is listening to the speech for the first time. She slows down the narration rate so that she can more easily understand the language.

• Desmond, who is preparing for a test on the civil rights era and is familiar with the speech, speeds up the narration, stopping and pausing to take notes on critical points.

• Tanya, who is designing a multimedia presentation about King, skips directly to phrases of the speech that she has previously bookmarked, selecting the items that she will include in her multimedia report.

While this ease of navigation, ability to vary narration rate and option to place audiobookmarks are obvious advantages of digital versus analog audio, digital audio that is integrated with text, media and interactivity options offers additional affordances to the learner. To consider these affordances, and how they change the nature of the listening experience, let's consider some other options for learning with the "I Have a Dream Speech," using the UDL principles as a guide.

Provide multiple means of representation

For some listeners, access to the meaning and the spirit of the speech is impeded by underlying difficulties with language. Some students may lack the vocabulary to comprehend, while others may be unfamiliar with King's syntactic style and rhetorical structures, such as the use of repetition and refrains. The speech also assumes a certain level of background knowledge. Today's students may have limited or no knowledge of the civil rights movement. For English language learners, issues of language, history and culture may be compounded, making the speech even more challenging for them as listeners.

However, in a digital context, the speech can be transformed so that students have multiple entry points into meaning-making. Many audiobooks now offer both text and audio narration so that students may listen to and view a print version of the text. In some cases, synchronized highlighting is offered to encourage students to attend to the text while listening. Vocabulary and background knowledge can be supported via hyperlinks to glossaries and other informational resources, including access to experts and online communities with a special interest in this topic.

Further, English language learners may be provided with access to audio and print translations of the speech in their first language. For Elena, Desmond and Tanya, the learning options have been expanded. Elena listens to the speech in Spanish first, then in English. Then, as she studies the printed text more closely, she reads the text in English, clicking on multimedia glossary hyperlinks in Spanish and English to help her understand key terms and concepts. She also views a hyperlinked news video of the march on Washington to understand the larger context. Desmond reviews key points he has marked in the audio and text versions in preparation for his test. Confused by a reference made in class to Mahatma Gandhi's influence on King, he follows a link to a website that provides multimedia coverage of King's meeting with Gandhi in India. Tanya reads and listens to the speech again, this time focusing on the accompanying photos and eyewitness accounts of the march on Washington to help her develop a deeper understanding of this seminal event that she can bring to her multimedia presentation. Layering additional information and media onto the speech has multiplied options for understanding and learning the "content" of this speech and event. In other words, each of the students is benefiting from multiple representations.

Provide multiple means of expression

In addition to offering students multiple means of representation, digital texts offer options to support strategic learning and expression. This is often the more challenging task, since it requires a more detailed and comprehensive view of the learner, the text, and the goals and activity. Listening to a speech, reading a text, viewing a graphic, animation, or video, or carrying out a combination of these activities, requires both knowledge and strategies. To support strategic learning, prompts to apply relevant strategies, such as stopping to summarize key points or to note a question or confusion, can be embedded in the learning environment. Pedagogical agents can provide models and thinkalouds, as well as feedback to the learner. Online experts can mentor students in ways of thinking and knowing within their discipline. The flexibility of digital environments makes it feasible to vary the level and type of support in relation to the task demands and the learner's needs and strengths.

Consider again our three students, Elena, Desmond and Tanya. Imagine a digital environment that supplements the speech, text, and other representational supports for learning about the man, the speech, and the larger historical context, with embedded supports for strategic learning and expression.

For example, before listening to the text, Elena clicks on a "Listening Coach" who points out that King will increase the volume and intensity of his voice to draw attention to key points. As Elena is listening to the speech, she periodically encounters an audio prompt that asks her to stop and think about what she is hearing and to apply strategies, such as summarizing key points, visualizing or making a prediction about what will be addressed next in the speech. She types a response into her online notepad. Because she is still learning to express herself fluently in English, she stops and audiorecords a note in Spanish to expand what she has written.

Meanwhile, Desmond is focused on studying for his test. He listens to the highlighted main points that he bookmarked in a previous section, then clicks on a selfcheck quiz to monitor his understanding. When Desmond misses an item, he is prompted to listen again to a particular section of the speech by clicking on a link. The link takes him to the relevant section so that he can listen at a slower pace. It also highlights the corresponding segment in the printed speech to further focus his attention on the salient information. Desmond continues through this guided review until he is satisfied that he understands the core information needed for the class test.

Tanya becomes increasingly interested in the topic of civil rights as a result of her exploration of Internet resources. She chooses to complete a multimedia slide show that illustrates the audio recording of "I Have a Dream" with still and moving images of protest marches, examples of discrimination and other visual aids that enhance the experience of listening to the speech. With multimedia options for expression, Tanya blends text, video and audio media to reinforce the important points and emotion of King's speech as it unfolds on that momentous day.

Provide multiple means of engagement

At the heart of learning is engagement—engagement with the process, with the content, with ourselves as learners, designers and communicators. Centered in the affective networks of the brain described earlier, engagement is individually based and, for the most part, socially constructed. Recent studies on how human beings become experts in fields as diverse as sports, business, science and the arts suggest that while talent is important, even more essential to developing expertise is a high level of interest and commitment (Feltovich, P.J., Prietula, P.J., & Ericsson, K.A., 2006). Goal-setting and practice, guided by feedback, are essential to the development of expertise. And, not surprisingly, they conclude that the level and amount of practice that is required to excel is more likely to happen if one is interested in whatever it is that he or she needs to practice.

Yet all too often in school, students have little freedom to set their own goals and pursue interests. In fact, many stumble at defining an interest that is academically related. Further, despite the acknowledged need to differentiate instruction and provide guided practice, it is quite difficult to achieve in today's diverse classrooms without additional teaching support and, we would argue, without flexible multimedia, such as audiobooks and digital texts, which can open up the learning process in ways that inspire more interest and instill a sense of ownership.

Let's revisit Elena, Desmond and Tanya as they finish learning about, with, and through "I Have a Dream," and accompanying digital learning supports and resources. The students set learning goals and made choices about how they were going to accomplish them. They took advantage of all that the digital literacy tools afforded, including audio options. For example, Elena—who might have become discouraged by a language barrier if learning about "I Have a Dream" was restricted to print alone— now finds it easier to persist in studying the topic. The topic is still challenging, but the multiple means of tackling the subject hold her interest, especially since she can use her Spanish knowledge to support her English comprehension. Desmond also increases his investment and interest since he is able to control the pace of his review of the audio recording and access crucial background knowledge that he knows will help him accomplish his goal of performing well on his test. Tanya, too, thrives in a learning environment where she can make choices and be creative in fulfilling the assignment.

Listening to Learn: Digital Text for Learning to Read

Consider a second example of digital capacity in the classroom. Interactive storybook reading has long been a cornerstone of beginning literacy instruction in pre-K and primary classrooms. Teachers model how to read with expression, while drawing attention to how to read. Read-alouds continue to play an important role with older students, where expressive reading of an excerpt, or on occasion a whole text, entices students into book worlds that might be otherwise unexplored. In the digital classroom, audiobooks and digital texts with read-aloud functionality are expanding opportunities to listen to, and learn from, text.

While there has long been a place for audiobooks in the classroom, in recent years they have become increasingly popular in the home and school, as evidenced by a 350 percent increase in the number of books transformed into audio format in the last 15 years (Wysocki, 2005). This is attributable, in part at least, to the vast improvements in audio technology and the creation and distribution of audio products. Audiobooks can be downloaded on the Internet, checked out of the local library, purchased at the supermarket, or borrowed from an educational library. Organizations such as Recording for the Blind & Dyslexic (RFB&D, http://www.rfbd.org) are a primary source of audiobooks for individuals with print disabilities. RFB&D's library includes approximately 109,000 titles recorded with human voice.

Education policy has also had an impact. U.S. federal law (IDEA 1997) mandates that all children have access to the general education curriculum, including their textbooks and other core texts, and audiobooks are one means to improve access.Recorded speech can serve a compensatory function for students with decoding or fluency problems, much as wearing glasses compensates for weak vision (Edyburn, 2002; Strangman & Dalton, 2005). As such, it indirectly supports students' learning of the content. Once students have access, learning is dependent on other factors, such as background knowledge and vocabulary, reading strategies, engagement and instruction. For the fourth-grade child reading on a second grade level, or the 12th grade student reading on a sixth-grade level, listening to text is essential if they are to learn from (and enjoy) the same content as their peers. The passage of IDEA in 1997 increased the use of audiobooks by students who have print-related disabilities, such as students with visual impairments, limited physical mobility or dyslexia.

Digital texts with read-aloud functionality also meet the critical need for improved access to the curriculum and are playing an increasingly important role in the classroom. Digital texts can be read-aloud using human voice or synthetic speech (or a combination). Human voice requires audio recording of the specific text, while synthetic speech is not linked to a particular text, but rather is produced word by word via a text-to-speech (TTS) engine that typically relies on strings of phonetic and prosodic symbols. Each form has its own advantages and limitations. Human voice is superior in its ability to convey emotion and tone, to pronounce words correctly, and to use appropriate phrasing and pausing. It not only provides a richly expressive listening environment that may hook even the most reluctant reader, it also offers a strong model of oral language usage, something of particular relevance to young children and children who are English language learners. However, from a practical standpoint, human voice has important limitations, including the demands of recording, production, distribution and file storage. Further, with recorded narration it is not possible to provide audio access to the enormous volume of text encountered on the Internet, much of which changes from day to day. The vast majority of digital content on the Internet is not supported by human voice narration.

In this regard, the advantage of TTS tools that can read any content in digital format "on the fly" is obvious. There are many TTS tools available commercially and as freeware. Once acquired, there is no additional cost for audio support, whether the student reads 10 words, 100 words, or 10,000 words. TTS can also read words that the student is producing in a Word document, on a web page, or in an e-mail message. There are no audio files to store, and synchronized highlighting of the text is more easily accomplished than with human voice narration. Finally, since there are speech engines in various languages, it is possible to read Spanish text with a Spanish speech engine, French Canadian text with a French Canadian speech engine, and so forth. However, the flexibility of TTS is also its major weakness. Synthetic voice, despite technical improvements, is still a poor model of oral language. There is minimal oral expression;

words are produced in a stream, with frequent mispronunciations and awkward phrasing. Still, TTS is generally intelligible, and, for individuals with visual impairments who have high levels of listening comprehension, the TTS narration rate can be substantially increased without loss of intelligibility. Ideally, students should have access to both types of listening experience: core texts with human speech to realize the benefits of accurate, rich expressive reading, and use of a TTS tool that gives them the freedom to read any text that is in digital format.

Research suggests that in addition to providing basic access to content, audiobooks and TTS may also support the development of basic literacy skills. While TTS research is complicated by tremendous variation in research design, technology application, duration of intervention and student reading achievement, there is promising evidence for its effectiveness, particularly for older students in the middle grades and above. In an earlier review of the literature on TTS for students with disabilities we identified several studies that investigated the impact of read-aloud support (TTS or human speech) on literacy skills that found a positive effect on comprehension and two demonstrating transfer to reading contexts that did not involve TTS (Dalton & Strangman, 2006). There is reason to believe that audiobooks can also improve literacy skills. A study investigating the effectiveness of RFB&D's AudioPlus books as a component of language arts instruction for students in inclusive settings in grades 4-8 demonstrated significant gains in student reading rate and accuracy (Recording for the Blind & Dyslexic, 2006b). Students using the audiobooks moved from the frustrational reading level (94.4%) to the instructional reading level (96.3%). Moreover, teachers felt that use of the audiobooks increased students' motivation and confidence. Thus, speech support may be an important means to not only support individual differences in recognition, providing access to the curriculum and strengthening literacy skills, but also support affect by boosting confidence and motivation.

The potential to integrate listening activities with effective instructional frameworks is great. The RAVE-O (Retrieval, Automaticity, Vocabulary, Engagement and Orthography; Wolf, Miller, & Donnelly, 2000) reading program is a research-based literacy program for children in grades K-4 who have difficulty reading. The program includes daily direct phonological instruction, reading comprehension strategies, writing and library visits. Two studies have investigated the effectiveness of using RFB&D's AudioPlus text with the RAVE-O reading program. Following a four-week program, students showed significant increases in standard scores for listening comprehension, phonological analysis and blending, rapid naming and reading comprehension (Recording for the Blind & Dyslexic, 2006a). In a subsequent study, children listened to RAVE-O stories using RFB&D's AudioPlus text at a slightly faster rate than their normal reading rate and followed along with the text. Students with poor phonological and naming skills showed significant gains in phonological skills, listening comprehension and reading comprehension (Recording for the Blind & Dyslexic, 2006a).

There is emerging evidence that listening to core curriculum texts can complement strategy instruction, addressing differences in strategic networks. Research shows that comprehension strategy instruction in a listening context improves strategic listening and reading (Aarnoutse, van den Bos, & Brand-Gruwel, 1998; Brand-Gruwel, Aarnoutse, & Van Den Bos, 1998; Thompson & Rubin, 1996). In addition, research suggests that strategy instruction in the context of audio-supported reading can improve comprehension. For example, Boyle and colleagues designed an intervention where high school students with disabilities read a printed version of their social studies textbook with digital audiobook support, guided by the SLiCK learning strategy (Boyle et al., 2003). The SLiCK strategy leveraged the navigation features of the audiobook together with research-supported reading strategies such as previewing a text, noting key ideas, rereading text and summary writing1. Students using the audiobooks (with and without the SLiCK strategy) outperformed the control group on social studies content assessments. In this case, the audiobook provided access to core curriculum content, supported the application of research-validated comprehension strategies, and served as the basis for social interaction and collaboration as students discussed the text and co-constructed a summary. Dalton and colleagues (2002) showed that struggling readers reading universally designed versions of novels with TTS support and prompts for the application of reading strategies outperformed peers using printed versions of the novels and participating in offline reading strategies instruction. While both studies involved complex interventions, they share instructional design and implementation features such as using speech support to provide access to core curriculum, integrating reading/listening with well-validated print-based reading comprehension strategies (Palincsar & Brown, 1984; Pressley et al., 1995), and situating reading/listening in the larger social context of the class. These may be important to consider when implementing digital texts with read-aloud support in the classroom. More fundamentally, these studies demonstrate the potential of active listening activities using audiobooks and TTS to help students connect with and learn core curricular material.

Footnotes for this section

[1] Students in the intervention used an audiobook player to read their digital social studies text, with some students following a graphic organizer outlining the steps of the SLiCK learning strategy:

 S – Set up your player.

 L – Look ahead to preview the text by using the player feature that navigates from title to header.

 C – Comprehend what you are reading by using the bookmark capability of the player to note important points, slowing down the text to focus attention on a particular segment and/or resolve text confusions, re-listening to text to aid comprehension and taking notes on key words to use in drafting an initial summary of the text.

K – Keep it all together by using your individual summary as a basis for discussion and collaborative construction of a group summary.

Recommendations

Having considered some of the research on listening and literacy—as well as scenarios in which modern listening tools might be incorporated into a universally designed classroom setting—we offer the following recommendations and conclusions to enhance listening in the classroom and beyond.

1. Promote wide reading of audiobooks and digital texts for learning and enjoyment.

At a minimum, struggling readers should be able to access digital versions of their textbooks and literature that constitute their educational curriculum. However, becoming an expert reader requires a high volume of reading, with much of it selfselected and taking place outside of the classroom. It is extensive reading that encourages the development of deep interests that is the hallmark of successful learners. Therefore, supplement the core texts with a wide variety of titles, authors and genres that are appealing and appropriate for the targeted age group. Audiobooks engage readers of all ages and abilities.

2. Provide easy technical access to audiobooks and digital texts.

Today's students are used to having technology at their fingertips. Audiobooks and digital texts can be accessed and read on a specialized e-book player, on the computer, over the Internet, via an iPod or over a cell phone. Schools should plan for multiple distribution channels so that students can easily access their digital texts anytime, anywhere, including outside of school. Not only will this support the struggling reader, it will help the busy student who will take advantage of reading books on his iPod while riding in the car to his soccer game.

Policymakers are already addressing the need for more digital text for students with print disabilities. In 2004, the Office of Special Education Programs, U.S. Department of Education, established two national centers at CAST to lead the development and support of the National Instructional Materials Accessibility Standard (NIMAS; U.S. Department of Education, 2006). NIMAS was also incorporated in the reauthorization of the Individuals with Disabilities Education Improvement Act in 2004. While the legislation (Table 1) currently addresses the needs of individuals with print-related disabilities, publishers and software developers are already moving forward, thinking about the needs and preferences for students with and without disabilities. This will hopefully include discussions about the role of digital audio texts in learning as evidence mounts regarding the powerful role listening can play in supporting other literacies such as reading.

3. Teach students how to use read-aloud support strategically.

Although students are generally tech-savvy, they may not have the specialized knowledge or strategies for using audiobooks and digital texts with read-aloud functionality. Introduce the various tools to students, demonstrating how to open or download the text and use the various features, such as read-aloud options, navigation, bookmarking, note taking and so forth. Provide guided practice and encourage students to share tips and strategies as they become more proficient. In addition, students will need to be taught strategies for effective listening in these environments, in accordance with their purpose for reading and the characteristics of the text. Are they reading a challenging text on an unfamiliar topic, or an easier text written by a favorite adventure r fantasy author? And, are they reading to learn about a new topic, to review for a test or presentation or to prepare a multimedia book report? The listening and reading process and use of features would vary in each of these contexts.

Some of the strategies are unique to listening to human speech, such as paying attention to the speaker's pauses and volume, and some are unique to digital environments, such as pausing and replaying the audio track, marking passages and so forth. Providing listening strategy supports can help students become "thinking listeners" and therefore more successful learners.

4. Connect listening strategies and reading strategies.

Good readers are strategic readers. Take advantage of the strong research and practice base on reading strategy instruction by connecting students' online reading process with their reading of print materials. Just as students predict, question, summarize, clarify, visualize and monitor their understanding with print text, they should be applying these strategies when reading and listening to digital text. Although digital text offers some unique affordances, understanding is the overall goal in both digital and print contexts. The proficient reader and learner will be one who can traverse these boundaries smoothly and flexibly.

5. Research and implement instructional approaches for teaching students how to effectively read, listen, view and communicate with multimedia.

As noted at the beginning of this paper, a shift is underway in the larger literacy space—especially online—to a greater emphasis on voice, sounds, graphics and movement. The Internet is the new literacy space, characterized by multimedia, hypertext structures that allow for nonlinear navigation, and multiple options for user interaction and customization of both the environment and the content. Although the Internet is widely used in and out of school, especially for student research purposes, the instructional emphasis has been on preparing students to conduct effective web searches and to be critical consumers of web content. For example, students might learn about a news event on the Internet by reading and listening via TTS to an Associated Press

news report in text, viewing and listening to a narrated photo slideshow with captions, watching and listening to streaming video of a reporter on the scene and reading/listening to an audio blog report. How do students learn to manage, sort, comprehend and even reconcile this stream of multimedia information, which is not always consonant? How much time should they spend viewing the images, versus listening and reading? How do they evaluate the ways in which media and text are being used (and manipulated) to communicate a particular view of the event, the world? How does good, active listening help the whole process of absorbing information and knowledge? Moreover, how can we help students to learn to communicate with multimedia?

Some of these questions are in the course of being addressed. Media educators bring a critical literacy perspective, literacy specialists often focus on the text demands, and information communication and library science professionals pay particular attention to searching and evaluating information on the Internet. There is a need to develop more effective models of comprehension that reflect the increased complexity of input and output modes that potentially occur in numerous combinations and permutations. Development of these models must be accompanied by development of companion instructional approaches.

Conclusion

In his day, Plato worried that the new technology of writing would irrevocably change the what, where, why and how of learning. Today, new media pose similar challenges and opportunities. We believe these changes will not only broaden learning but deepen it for a great number of people. Learning through listening is just one example but a potentially powerful one for many individuals who would otherwise have diminished opportunities to become successful and lifelong learners.

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The National Instructional Materials Accessibility Standard (NIMAS) is a technical specification that guides the production and electronic distribution of digital versions of textbooks and other print instructional materials so they can be more easily converted to accessible formats, including Braille and text-to-speech. The standard is based on the international DAISY standard, which provides guidance for marking up content in XML for digital talking books. The underlying purpose is to implement a format that will result in the timely production and delivery of specialized formats to qualified students with print disabilities.

Textbook adoption states and local school districts will require publishers to submit NIMAS file sets to the National Instructional Materials Access Center (NIMAC) where they will be validated, cataloged and stored in a database. Reaching beyond the technical specifications are policies and procedures for protection of intellectual property rights, secure distribution of NIMAS source file sets and access to those files by authorized users qualified to convert them into student ready versions. The basic requirements for NIMAS are included in IDEA 2004 and related regulation.

Table 1. What is the National Instructional Materials Accessibility Standard?