THE ROLE OF TECHNOLOGY IN THE READING CLINIC: IT'S PAST AND POTENTIAL

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In this chapter we examine the use of technology in clinical settings from several perspectives. We begin with historical applications beginning early in the twentieth century and then project possible applications based on trends and developments currently in progress. Finally, we argue that technological transformations not only make possible fundamental changes in the operation of university clinics, but in fact necessitate them since, by altering the nature of literacy, technology correspondingly alters the manner in which literacy must be assessed and teachers trained.

This view may very well place us at odds with those who assume that the proper goal of university clinics is to assess children's proficiencies and needs relative to print alone. This difference in perspective arises from a vision of the future not shared by all, a future some have characterized as a post-typographic age, when literacy and what it demands of readers and writers may bear little resemblance to the notions of the past.

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HISTORY OF TECHNOLOGICAL APPLICATIONS

In the broadest sense of the term, reading clinics have always depended on technology. In fact, literacy itself is in large part shaped and defined by technological changes—from the development of moveable type, to the creation of diverse fonts, to the invention of the pencil. While the word technology has presently come to connote the use of machines, and while that is our focus here, it is important to realize that this connotation is, in reality, a narrow perspective.

During the twentieth century, technology (in the mechanical sense) came to serve two distinct functions in clinical settings. One of these functions was to provide clinicians with physical measurements, typically involving vision and hearing. The other function was that of a medium of instruction, first as filmstrips, audiotapes and the like, and more recently as computer-assisted instruction (CAI). These applications were not unique to clinical settings, but such factors as expense and infrequency of use made some applications more likely to be housed there.

Source: Betts (1954).
Types of Applications

The mission of university reading clinics has historically varied in its scope, sometimes being confined to the production of a diagnostic report and sometimes including remedial work based on the diagnostic recommendations. Using the broader of these two missions (that is, including both assessment and instruction), we suggest four general categories of technological applications in clinical settings.

Perceptual Screening Devices

Perhaps the least controversial application of technology to reading assessment has involved screening for visual and auditory deficits. Visual screening has been associated with a variety of devices that present specific stimuli to one or both eyes. While visual acuity has been the primary focus of such screening, other aspects of vision, such as binocular coordination, have also been screened in this way. Figure 1 shows a student being assessed around mid-century using an early stereoscopic device.

Eye Cameras

Cameras designed to track and record eye movements have been used for nearly a century. By measuring saccades and fixations during reading, eye cameras provide a window on certain reading subprocesses, a capacity which has given them an important role in contemporary research (e.g., Rayner & Pollatsek, 1989). Figure 3 shows an early eye camera used in Miles Tinker's laboratory at the University of Minnesota in the 1930s.

Tachistoscopic Devices

A tachistoscope is any device used to control a reader's exposure to print. The general aim of tachistoscopes has been to train readers in the use of more efficient eye movements. Tachistoscopes have been broadly defined to include even paper apparatus in which a card can be used to reveal words for short periods (Harris & Sipay, 1990). Mechanized tachistoscopes have involved filmstrips such as the Controlled Reader (Educational Developmental Laboratories), as well as a variety of moving parts designed to reveal text at various speeds. More recently, microcomputers have been programmed to serve a tachistoscopic function by displaying text at various rates (e.g., Davidson's Speed Reader). Some tachistoscopic devices provided children with auditory input while the visual stimulus was being presented. In the case of the Language Master, a card contained both a printed sentence and a mylar strip with an audio recording of the sentence. As the card passed along a groove, the tape was played, allowing the child to hear the sentence read while (hopefully) attending to its printed form.

Tape Recorders

At least three clinical uses of audiotape have evolved. One use has involved data gathering, as when students are interviewed or taped while orally reading passages from, for example, an informal reading inventory. Another is as a means of standardizing what is presented during the assessment process. For example, the Goldman-Fristoe-Woodcock Test of Auditory Discrimination uses an audiotape to present pairs of words involving minimal phoneme variations in order to ensure that all children are exposed to the same stimuli. Instructionally, tape recorders have also been used to support readers in clinical settings by making...
available audio recordings of books to be listened to while reading or by providing taped guidance and instruction.

It is important to note that the role played by technology in each of these categories has also been addressed by nontechnical applications. Visual and auditory screening, for example, can be accomplished through structured observation. Eye movements have been observed using a "peephole" technique in which the clinician looked at the reader's eyes through a small hole, making it easy to count fixations (Miles & Shen, 1925). Tachistoscopic presentations can be made manually. And oral reading samples can be garnered using miscue analysis, running records, and similar techniques. Technology in each case adds an element of precision and convenience not possible without it.

Historical Trends

The limited availability of both research and records into the clinical application of technology prevents any precise description of twentieth-century trends. On the other hand, certain broad trends seem apparent from the available evidence.

One such trend, of course, involved the introduction of technology into clinical settings early in the century. This process was gradual and its origin is difficult to pinpoint. Some idea of its pervasiveness can be gained by inspection of methods texts dating from the period. In his classic 1928 book, The Improvement of Reading, Arthur Gates made no mention of technological applications. In 1936, however,

Emmett Betts described and recommended the use of eye cameras and tachistoscopes. The frontispiece of his book, which appears in Figure 4, provides a rare glimpse at the early contents of university clinics, and the presence of technology is strikingly clear. Thus, technology seems to have secured a foothold long before mid-century.

A second trend involves the movement from the initial appearance of a technological application as a research tool to its eventual clinical use. One example of this movement is that of eye cameras, which were used early in the twentieth century by Tinker and others (see Betts, 1936) and which later found extensive clinical applications (e.g., Spache, 1976). Another example is the use of computers, which began with university-based research, such as that conducted at Stanford (Atkinson & Hansen, 1966), and evolved into the use of microcomputers at many present-day university clinics (Allen, Swearingen, & Kostelnik, 1993). The trend from research to clinical application is perhaps a natural result of both clinics and researchers being housed within university settings. Indeed, clinics are frequently managed by researchers, who can be expected to keep clinical practice in line with available evidence. This relationship may account for the public's perception, accurate or not, that cutting-edge techniques can be expected at a research-driven university clinic.

A third major twentieth-century trend concerns the assessment and training of eye movements. The advent of eye cameras allowed researchers to focus on the operation of the eyes as a source of pathology in reading diagnosis. Tachistoscopes soon followed as a means of remediating faulty and inefficient eye movements. Advertisements for various tachistoscopic devices, many of which were housed in university clinics, were common around mid-century. Figures 5 and 6 display two such ads, both appearing in the December, 1963, issue of The Reading Teacher. But research into the effects of eye movement training on reading achievement, while somewhat mixed, was generally unimpressive. Tinker (1958) had come to believe that faulty eye movements were a symptom and not a cause of reading difficulties, a view generally held today (Rayner & Pollatsek, 1989). Such a view tends to explain the fact that eye movement training by means of tachistoscopic devices tended to have little impact on the underlying problem. For these reasons, tachistoscopes are rarely seen in university clinics or in public schools today. Their abandonment, however, should not be seen as evidence that eye cameras have no utility in clinics. On the contrary, Spache (1976) argued that the information produced by eye tracking can effectively complement other data sources available to clinicians. We agree, though our notion of the clinical role of eye cameras differs from that of Spache. We will return to that notion later.

A fourth major trend concerns the advent of microcomputers in clinical settings. Computers make possible a wide range of applications by virtue of their capacity to combine instruction with data collection, to target both reading and writing, and to better reflect the realities of literacy in an increasingly digital world. Our belief is that the potential for clinical applications of microcomputers
What are the three cows doing?

From kindergarten through college, the Keystone Tachistoscope and Teaching Materials have proven, in service, to be economical, convenient, and reliable in developing visual perception and reading skills. Using the Keystone Overhead Projector and Flasher, which make up the Tachistoscope unit, visual problems from Keystone's extensive subject library can be flashed on a screen in an darkened room at any exposure rate from 1 second to 1/100 second.

Above is a sample problem and question used to test the student's perceptive accuracy. Of course, there are only two cows—and they are jumping. Write Keystone today for complete information or a demonstration of the Tachistoscopic Service.

KEYSTONE VIEW COMPANY*
Dept. RT123 • MEADVILLE, PENNSYLVANIA
*A Subsidiary of MAST DEVELOPMENT COMPANY


Figure 5. 1963 Advertisement for a Tachistoscopic Device Involving Controlled Exposure of Text

PROVED EFFECTIVE in helping students read faster

For the past ten years, the AVR RATEOMETER has been used daily in thousands of classrooms to improve reading skills and comprehension. Write for further details and prices!

AUDIO-VISUAL RESEARCH
523 So. Plymouth Ct., Chicago, Illinois 60605, Dept. RT 312

Source: The Reading Teacher (1963)

Figure 6. 1963 Advertisement for a Tachistoscopic Device Involving a Moving Part to Encourage Higher Reading Rates
is largely untapped, and we will explore some of the possibilities in subsequent sections of this chapter.

**TECHNOLOGY IN THE CLINIC OF THE FUTURE**

Computers make possible a number of transformations in the nature and operation of university clinics. At the risk of offering speculative projections on our part, we suggest the following possibilities but, in doing so, have attempted to constrain them to applications now fully within the scope of technology.

Merger of the Two Historical Functions of Technology in Clinics

The characteristic functions of technology as tool and as instructional medium may become increasingly fused as computers react in more sophisticated ways to child input. Tracking systems associated with instructional materials have long been a part of computerized diagnostic-prescriptive instruction (e.g., Reinking & Bridwell-Bowles, 1991) but have recently been associated with more sophisticated applications, such as monitoring children’s use of hypermedia resources (Anderson-Inman & Horney, 1998), integrating performance-based tasks to assess knowledge of content (Leu & Hillinger, 1994), recording student decisions during word processing, and interpreting a child’s voiced responses (McKenna, 1998). While student input does not always perfectly reflect what they know or do not know (Horney & Anderson-Inman, 1996), it nevertheless has the potential to be a reliable means of monitoring student performance. We now examine these systems in more detail.

Resource Use

One of the most provocative ways in which electronic texts have the potential to differ from their print counterparts is in the availability of resources to assist readers in accomplishing their purposes. Such resources can be categorized broadly into those designed to support the reading of students whose proficiency is not commensurate with the demands of the text and those intended to enrich and extend the reading experience. (Anderson-Inman & Horney, 1998) have further delineated these resources.) The growing availability of electronic texts equipped with such resources, through authoring systems or commercial production, strongly suggests that clinical assessment could usefully include a reader’s ability to use such resources, particularly those designed to assist readers at risk.

**Embedded Tasks**

Conventional diagnostic-prescriptive software, such as that now found in an integrated learning system (ILS), presents students with postreading questions, records their accuracy, and implements appropriate prescriptions. Advances in software design have made possible sophisticated tasks situated within the reading activity. For example, Reinking and Pickle (1993) presented students with periodic questions which, if answered unsuccessfully, compelled rereading of the material covered by the question followed by a different question. Leu and Hillinger (1994) have presented students with manipulative tasks such as dragging geographic place names from a list to appropriate locations on a map. Incorrect matches led to the labels’ jumping back to their place in the list. These examples suggest the ingenuity with which embedded tasks can be designed. Clinical data gathering based on a child’s performance when confronted with embedded tasks of various kinds appears to possess extraordinary potential for meaningful assessment, particularly given the increasing expectation that children will be able to negotiate electronic text effectively.

**Word Processing**

Tracking systems, such as Camera Man, record individual keystrokes made by students during word processing. Clinicians or teachers can then “play back,” in QuickTime, precisely what a child did from start to finish of a word processing episode. Word processing tracking software of this kind is designed to capture data about the process of composition and makes available information concerning the drafting, revising, and editing stages of composition. A tacit assumption underlying such software, of course, is that students in the near future will do their writing by means of word processors in preference to a conventional paper-and-pencil approach. Unless, however, word processing has become so familiar to a given child that its nuances no longer require much conscious thought, tracking data may not convey an adequate notion of how the child approaches writing.

**Voice Input**

The growing sophistication of voice recognition software suggests the feasibility of voice input as a method of gathering data about a student’s performance while reading. This development might well lead, for example, to electronic miscue analysis performed as children read passages that appear on screen. Electronic informal reading inventories may eventually supplant the print versions now administered as a matter of established practice in virtually all university clinics (Laster, 1996).
Greater Precision and Sophistication of Physical Measurements

The utility of conventional screening instruments such as the audiometer is undeniable, but computer technology may link these functions to text representations and extend what they tell us by incorporating eye tracking cameras that enable clinicians to consider eye movements in relation to the text a child sees. As we noted earlier, this approach is now an established research paradigm (e.g., Rayner & Pollatsek, 1989), but McConkie and Zola (1987) envisioned its extension to the clinic:

These eye movement techniques make it possible to obtain specific information about particular aspects of perceptual or language processing from a person who is in the act of reading. It is our hope that as further knowledge is acquired, these techniques will be found useful for diagnostic purposes. Children suspected of having reading problems will be able to read a series of passages as their eye movements are being recorded. These passages will be carefully designed to contain specific types of complexities that have diagnostic potential. In addition, during the reading certain types of display manipulations will take place. The computer will immediately analyze the data to see which manipulations did and did not have effects on the reader, and to examine the reader's response to the various complexities present in the text. The computer will then print out the reading specialist a report that describes specific characteristics of the reader's perceptual and language processing, and how these are similar to and deviate from those of successful readers. Such information may be useful in identifying particular disorders and suggesting lines of remediation that are needed. Ideally, it would be possible to adjust deviations in the nature of the processing taking place early enough to allow for correction before a student's reading progress has been seriously retarded (pp. 103-104).

The creation of diagnostic software to realize this vision would be challenging, to be sure, but is well within the range of applications now possible. The hardware configuration to support it is well established.

More Comprehensive and Convenient Expert Systems

Expert systems, artificial intelligence (AI) programs designed to analyze an array of data and then offer conclusions that a human expert might reach, have already been pioneered in reading (McEneaney, 1992; McKenna, 1986, 1987). Several factors have limited their success, however. These include prohibitive memory requirements for a truly comprehensive expert system, the time needed to input student data, and the difficulty of encoding qualitative, process-oriented measures (though these too could be considered by the system as a means-triangulating). Such developments would do a great deal to circumvent two of the factors that have limited the usefulness of expert systems to date: input time and scope of the assessment. The remaining factor, RAM requirements, may be alleviated by two developments. One of these is the advent of cheaper, faster, more powerful stand-alone computers. The other, remote access, is a factor that will discuss separately because of its broad implications for university clinics.

Remote Clinical Access

The traditional practice of bringing children on campus for in-depth reading diagnosis has been fraught with difficulties ranging from logistical and scheduling concerns, to the limited number of clientele who can be served in this way, the possible traumatizing effects of the experience. Distance technology has already led to the distribution of remote expertise in medicine as physicians have used video links to examine patients at remote sites or have demonstrated surgical techniques to practitioners located elsewhere. Such applications of technology hold great promise for the prudent use of limited resources by increasing the accessibility of expertise to children who are geographically distributed and might find it difficult to visit the clinic.

We envision several applications of distance technology, all of which are within the scope of current technology.

E-Mail Linkages

A practicum experience for clinicians in training could easily include e-mail linkages to practicing teachers faced with students experiencing difficulties. Information about the children could be summarized, with work samples or other documents scanned and forwarded as attachments. Ongoing correspondence between clinicians and teachers might include analysis and commentary concerning the overall profile, requests for additional information that might further illuminate the case, and, finally, researching and suggesting alternative instruction methods. Continuing correspondence would be apt to acquire greater focus with each exchange.

Online Observations

Classroom-based video cameras have been used successfully to allow pre-service teachers to observe unobtrusively in distant classrooms (Kinzer & Risko, 1998). Extending this application to the diagnosis of individual students would not be difficult. Contextualized classroom observation could be complemented with one-on-one teacher-student interactions (situated at a learning center perhaps), also observed by remote clinicians. Such an arrangement would i
effect use distance technology to achieve the same end envisioned by Reading
Recovery’s™ “behind-the-glass” approach to training. Digitized video could be
used whenever real-time observations were problematic due to scheduling. In
these ways, clinicians would have the unprecedented advantage of a noninvasive
bird’s-eye view of a student’s performance in a naturalistic setting. Such an applica-
tion of technology might do much to counter the longstanding argument chal-
gening the ecological validity of clinical assessment. It would in fact permit
clinicians to evaluate the context of instruction together with the student, and to
arrive at conclusions and recommendations that better reflect the classroom real-
ities of their clients (see Lipson & Wixson, 1997). Observations arranged in this
manner could, of course, be combined with the e-mail dialogue mentioned previ-
ously, and e-mail might be used to suggest video episodes for subsequent obser-
vations. For example, a clinician might ask the teacher to attempt a particular
instructional strategy in order to observe its effectiveness.

Centralized Online Assessment

One way of satisfying the memory requirements of truly useful expert systems
would be to maintain such systems at remote sites where access to mainframe com-
puters is available. (These remote sites would of course be the university clinics.)
Information acquired by the tracking software associated with a child’s word pro-
cessing or reading of electronic text could be transmitted to a university for analysis
and response. In this way, a potentially extensive array of information could be
gathered by, and made available through, the local area network of the school and
could then be accessed as needed by the expert system. Such an arrangement may
be an especially feasible approach to the trend toward cheaper computers, the
reduced computing power of which is justified by Internet links to distant main-
frames (Gates, 1994). The arrangement would certainly possess the potential to
meet the needs of a sizeable number of students within a university’s traditional
service area and even beyond. Such an application would be an easy first step to
take in addressing the needs of students experiencing difficulties. It might well
serve as the starting point for the traditional staffing process and might even serve
a monitoring function by alerting teachers that difficulties are emerging.

Electronic Storage of Cases

Traditionally, university clinics have provided clinicians with valuable experi-
ence in the application of diagnostic principles and procedures to real cases.
While we acknowledge that there is no substitute for a clinician’s interaction with
children, we contend that an examination of virtual case studies can be extremely
profitable. Commercial electronic instruments, such as the Grady Portfolio and
others, or more sophisticated databases using authoring software (Kieffer, Hale,
& Templeton, 1998; McKenna & Clark, 1993) can be used to house data related
to a wide variety of actual children. Such a database could grow with the addition
of new cases and could be used not only for the examination of individual cases
but also to compare and contrast related cases and even to test hypotheses across
many cases. An extensive database of this nature would have the potential to
merge case-based and concept-based learning (Spiro, 1991) and to allow cases to
anchor instruction for clinicians (Kinzer & Risko, 1998). Perhaps a fuller appreci-
ation of the power of such a database comes from considering it not from the
perspective of the relatively limited commercial portfolios currently available, but
from that of the extensive process-oriented tracking systems previously
described. The groundwork for such a system has already been laid through a
federally funded project for preservice teacher training at Vanderbilt University
(Kinzer & Risko, 1998).

CHANGING TECHNOLOGICAL CONTEXTS

We have argued elsewhere that the digital revolution in text representation has
profound implications for educators (McKenna, 1996; Reinkling, 1995). This rev-
olution entails a series of transformations. At the most basic level, representation
of text transforms the nature of literacy in fundamental ways. It allows true reader
interaction, it permits embedded reader guidance, it may have significantly differ-
ent structures than print text, and it incorporates different symbol systems (Reink-
ing, 1994). Readers and writers of electronic text are transformed as a conse-
quence so that the nature of electronic literacy differs in fundamental ways from
the traditional notion of print literacy. Classrooms are being transformed as well,
wherever computers are meaningfully integrated with day-to-day instruction.

This instructional transformation is not optional if schools are to provide ade-
quate preparation for a society which is itself being irreversibly transformed.
Because these transformations are ongoing, it is important for university cli-
nicians to recognize the changing technological contexts of their clientele. Because
the students they serve will increasingly be expected to develop electronic literacy
where such applications are the rule rather than the exception, clinics will be
obliged to make their methods of assessment conform to the realities of a world
for which students are being prepared to live and function productively. Within a
society characterized by virtual documents and hypermedia, clinics that continue
to be based exclusively on print literacy will find themselves misaligned with
these contexts. The transformation of what it means, and will mean, to be literate
necessitates transforming how literacy is assessed. Computers housed in
university clinics might well be used for performance-based assessment geared to
answer questions quite irrelevant to print literacy:

- Can the student use electronic resources in a strategic manner?
- Is navigation in hypertext a problem?
• Can the student acquire information from text and other media in concert?
• Can electronic references (encyclopedias, dictionaries, etc.) be used effectively?
• Can the student employ skills that lack print-based counterparts, such as conducting a topic search across encyclopedia entries or managing a graphical interface effectively?
• Can the student write in hypermedia environments, successfully blending pictures, video, and audio with text?

At issue is the alignment of assessment, teacher preparation, and societal expectations. When, like three planets, these factors come into conjunction, a beneficial unity is achieved—and not until.

PROSPECTS FOR A VIRTUAL CLINIC

We have described both the potential for, and the desirability of, a variety of computer applications in university-based clinics. Some, such as voice recognition software, will probably occur because of school markets. But the more sophisticated applications, involving remote clinical access, are far more problematic. What is the likelihood that these applications will be realized? Their implementation appears far from certain given the formidable barriers that may operate to preserve the status quo. One such barrier is the logistical labyrinth of creating remote linkages from school to clinic. Increased Internet access may help, but the orchestration of the process has yet to be developed. What is needed is the emergence of a model program suitable for adaptation elsewhere. A second barrier is the present limitations inherent in expert systems. The resources required to build a truly useful system are enormous and would require a long-term commitment from an insightful group of literacy and technology experts. A third barrier lies in the widespread distrust of information systems in which large amounts of information about individuals, particularly children, are centrally housed in remote repositories. The virtual clinic of the future would require adequate safeguards to protect privacy and secure parental permission. A fourth barrier lies in the resistance by many, professors and practitioners alike, to the notion that expertise resides in the clinic, as a resource to be tapped by less knowledgeable teachers. Unless the distance relationship established between the university clinic and the schools is one of collegiality and mutual respect, the arrangement will not be likely to succeed. But if teachers come to feel that their own expertise is valued in the development of clinicians in training, they may be more willing to establish the long-term lines of two-way communication needed to make the notion of a virtual clinic viable.

NOTES

1. See Spache (1976) for a discussion of some of these studies and their implications.
2. We have referred to these supportive resources elsewhere as "electronic scaffolds" (McKenna, 1998).

REFERENCES


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**READING CLINIC: PAST, PRESENT AND ...FUTURE?**

**Pamela A. Michel and Craig Dougherty**

**INTRODUCTION**

While having lunch with a friend and former educator/clinic director, I happened to mention that I had been asked to write a chapter on university reading clinics and their role in education for the twenty-first century. He immediately replied, "Oh, you're going to tell how your clinic fixes kids." It was apparent that he had not kept up with the reading literature, and I vehemently stated, "We don't fix kids; that would imply they are broken." I explained to him that the field does not think or talk about children or literacy in that way any longer and that much had changed since he had left Reading Education. My former colleague was somewhat taken aback and replied, "So, children no longer have reading problems? What about all that I read in the paper about literacy and so many of our students having difficulty learning to read? You can't tune into the popular press without hearing about the failures of the educational system." He then described a scenario that took place while watching a little league game. A concerned father asked this known reading specialist for advice about his seven-year-old who