LITERACY INSTRUCTION, TECHNOLOGY, AND STUDENTS WITH LEARNING DISABILITIES: RESEARCH WE HAVE, RESEARCH WE NEED

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Abstract. Technology, whether assistive (AT) or instructional (IT), has played an uneven role in the field of learning disabilities since its inception more than a half century ago. In addition, technology is in a constant state of flux; hence, researchers have been challenged to conduct appropriate experimental testing of interventions before they are outdated or made irrelevant by advances in hardware and software. As schools seek to improve learning outcomes for all students using tiered instructional models such as response to intervention (RTI), practitioners need assistance in capitalizing on AT, IT, or a combination of the two, to guide and enrich literacy instruction for students with learning disabilities. This article presents a conceptual framework for multimedia instructional design grounded in theory and empirical research. The article concludes with recommendations for how to integrate multimedia literacy instruction within RTI frameworks.

The gap between the level at which students with learning disabilities (LD) perform and the demands of the curriculum that they are expected to meet is often wide. This is especially the case as students move into the secondary grades where curricular expectations accelerate and content demands (e.g., history, science, mathematics) are markedly different.

The long-term consequences of the challenges students with LD face are underscored in data from the National Longitudinal Transition Study II, which found (a) 21% of students with LD are five or more grade levels below in reading; (b) 31% of students with LD drop out of school compared to 9.4% of nondisabled peers; and (c) only 11% of students with LD attend postsecondary institutions (Wagner, Newman, Cameto, & Levine, 2005).

Fortunately, considerable progress has been made in designing and validating interventions and instructional protocols that markedly improve academic outcomes for students with LD. Increasingly, protocols have included technology-based solutions based on the rapid development of technology tools focused on reading. Developments in technology-based supports, especially in the area of literacy instruction for students with LD, have promising implications for instruction and learning (McKenna & Proctor, 2006). Although the evidence base for using technology in the literacy instruction of students with LD is relatively small (Okolo & Bouck, 2007), curriculum designers and educators have the opportunity to integrate validated instructional practices with technology to markedly improve the
design and implementation of instructional protocols and practices (Kamil, 2003).

With the promise of technology to enhance literacy-related outcomes, this article will (a) briefly review current efforts in technology to address literacy instruction for students with LD; (b) present a conceptual framework for designing multimedia instruction intended to augment literacy learning of children with LD; and (c) outline recommendations for integrating multimedia literacy instruction into a tiered instructional frameworks (e.g., response to intervention) and pose questions for future research.

TECHNOLOGY AND LITERACY INSTRUCTION, WHAT WE KNOW

Numerous lines of sustained research have been undertaken in the field of LD to promote the development of strong literacy and overall learning skills for students (cf. Deshler & Schumaker, 2006; Fuchs, Fuchs, & Burish, 2000; Graham & Harris, 2005; Scruggs, Mastropieri, Berkeley, & Graetz, in press). Each line of research shares a common attribute: It focuses on building capacity within children to become proficient learners (across various contextual settings) without the need for ongoing external support. Likewise, technology-based solutions, when designed from theoretically sound pedagogical principles, are often tools that schools can use to augment traditional face-to-face literacy instruction (Boone & Higgins, 2007; McKenna & Walpole, 2007; Torgesen & Barker, 1995).

While sustained lines of research in the area of technology are only beginning to emerge (cf. Anderson-Inman, 2009), this field has the capacity to benefit from existing empirical groundwork as a launching point. Below we attempt to contextualize current technology-based literacy instruction by (a) reviewing a select number of studies that examine technology tools that promote literacy-related skill development, and (b) highlighting an existing framework for integrating technology into literacy instruction (King-Sears & Evmenova, 2007).

Technology and Literacy Instruction

While a review of the literature on technology-based solutions and literacy instruction garners a number of articles (e.g., Edyburn, 2003, 2006, 2007), few offer evidence of the impact of technology on literacy instruction. Nevertheless, research lines do exist. For example, Anderson-Inman and her colleagues from the National Center for Supported eText (NCSeT) have undertaken a sustained line of research in support of the concept of supported electronic text (eText). Supported eText helps students gain access to text through simple changes to font size, color, and availability of other tools that are assistive in nature. However, the intent of this innovation and research is not limited to promoting access (Anderson-Inman, 2009). This research group seeks to improve student decoding, fluency, and reading comprehension through various embedded supports such as electronic dictionaries, links to outside resources, and utilization of cognitive learning strategies (Anderson-Inman & Horney, 2007). Empirical data from the NCSeT group have established a record of positive outcomes among students from various age groups and content areas (see Anderson-Inman, 2009).

Other examples of empirically validated uses of technology to promote literacy instruction target areas of vocabulary instruction and reading comprehension instruction. Xin and Rieth (2001) used a series of videos in part to provide vocabulary and comprehension instruction using the construct of anchored instruction (Cognition and Technology Group at Vanderbilt, 1990). Students who were taught using the technology-based materials made significant gains in number of vocabulary words learned vs. control condition students. Likewise, Kim and her colleagues (Kim et al., 2006) used the essential principles of the Collaborative Strategic Reading program (Klingner & Vaughn, 1996) and built upon them to create a technology-based program (Computer-Assisted Collaborative Strategic Reading; CACSR). The CACSR was used during an experimental study to teach reading comprehension and other literacy skills to students with disabilities; findings from this research favored students who had exposure to the technology-based program.

In these experimental studies with a focus on literacy outcomes for students with LD, researchers began with theoretically based instructional principles and introduced logical uses of technology to deliver literacy instruction. As a result, the combination of the effective practice with a technology-based solution proved to be an effective intervention. We argue that further research that follows this model is needed in the area of technology-based solutions specific to literacy instruction. Building sustained lines of research takes time and resources; yet, the research we have clearly shows that (a) technology can be useful in promoting literacy learning for students with LD, and (b) existing evidence-based practices for literacy instruction may be of benefit to teachers and students if repacked and delivered using technology.

Technology Integration Framework

Regardless of the growing research, if we are to see technology integration within literacy instruction, educators need guidelines or explicit instructions for how various uses of technology fit within their existing repertoires of practice (McKenna & Proctor, 2006). An
example of a practitioner-friendly framework for technology integration into literacy instruction is King-Sears and Evmenova's (2007) TECH framework: "Target the students' needs and the learning outcomes; Examine the technology choices, then decide what to use; Create opportunities to integrate technology with other instructional activities; and Handle the implementation, and monitor the impact on the students' learning" (p. 10).

Recent research has confirmed that many practitioners working with students with LD do not use evidence-based strategies found to help raise literacy achievement (Klingner, Urbach, Golos, Brownell, & Menon, 2010). As researchers and practitioners consider technology-based solutions that are available (given limited district and school resources) for various learning scenarios, the TECH framework should be viewed as a straightforward and logical approach to individualizing instruction to meet the needs of students, while not using technology simply because it happens to be available. A limitation of this framework is the burden left to practitioners in terms of recognizing the cognitive demands of various learning activities and sorting through available technology options to deliver efficient and effective literacy instruction.

Maccini, Gagnon, and Hughes (2002) conducted a significant review of technology-based practices for secondary students with LD and noted several recommendations to the field. Two of these recommendations are as follows: (a) use technology systematically and strategically in instruction; and (b) incorporate effective instructional design principles within technology-based instruction (Kelly, Carnine, Gersten, & Grossen, 1986; Kelly, Gersten, & Carnine, 1990).

We use these two key recommendations in offering a conceptual framework that seeks to bridge theory and practice with respect to technology-based solutions and effective literacy instruction for students with LD. It is our belief that practitioners need more explicit guidance in terms of selecting or designing technology-supported (e.g., multimedia) materials to support the literacy learning needs of students with LD. This need for explicit guidance provides the rationale for the conceptual framework presented here.

CONCEPTUAL FRAMEWORK

Clearly, the literacy of yesterday is not the literacy of today, and it will not be the literacy of tomorrow. (Leu, 2000, p. 744)

While the empirical base for using IT to improve literacy skills and outcomes for students with LD is still solidifying, existing data provide ample rationale to warrant future inquiries (Maccini et al., 2002; Okolo & Bouck, 2007). The purpose of this conceptual framework is to ground future research and implementation of technology-based solutions within tiered instructional models (e.g., RTI) to improve literacy skills for students with LD. The conceptual framework is organized around four major theoretical principles that individually and collectively influence design and delivery of literacy instruction for students with LD: (a) the deictic relationship between technology and literacy (Leu, 2000); (b) technological pedagogical content knowledge (Koehler & Mishra, 2005); (c) multimedia instructional design principles (Mayer, 2005); and (d) the enzymatic theory of education (Fox, 1983; Larsen, 1995).

As illustrated in Figure 1, the center of the proposed conceptual framework is the proactive student-centered learning theory, the enzymatic theory of education (ETE; Fox, 1983). Our philosophy regarding the purpose of special education for students with LD is to help students remediate areas of academic struggle through individualized interventions comprised of a menu of evidence-based practices. Therefore, our graphic shows the ETE surrounded by instructional design theories and practices intended to promote active learning in specific areas of need.

The Deictic Relationship Between Technology and Literacy

We have entered a period of rapid and continuous change in the forms and functions of literacy. Today, changing technologies for information and communication and changing envisionments for their use rapidly and continuously redefine the nature of literacy. (Leu, 2000, pp. 744-745)

The concept of deixis within the field of literacy and technology means that the overall nature and essence of literacy and technology are changing so rapidly and thoroughly that it is difficult to define and describe either, let alone both in tandem (Leu, 2000). In a sense, the seemingly obvious questions "what is literacy?" and "what is instructional technology?" (and their respective answers) have become moving targets. For researchers and practitioners seeking to understand the interrelated and dynamic relationships between literacy and technology, the deictic nature of this relationship makes experimental rigor demanded in today's research climate a complex proposition (Leu, 2000).

Across the field of education, rapid and often unpredictable advances in technology are well documented. However, the concept of literacy is also an evolving construct (Leu, 2000). Hence, tying down a satisfactory definition and description of literacy is problematic (Moje, 2007). A significant line of research has been undertaken in the "new literacies" (Coiro, Knobel, Lankshear,
& Leu, 2008) to learn more about the cognitive and practical differences promoted by changing constructions of what it means to be literate.

**Systemic problems of deixis.** With regard to technology-based literacy interventions with limited rigorous field and experimental testing, educators may be cautious about the practices they select for classroom use. An important consideration in this respect is whether the technology-based interventions have an underlying theoretical basis. Therefore, it is critical that sustained programs of research in this area be undertaken (Anderson-Inman, 2009; Edyburn, 2007; Maccini et al., 2002; Okolo & Bouck, 2007). This research will guide practitioners attempting to provide individualized services to students with LD across tiers of instruction. With that said, Klingner et al.'s (2010) recent findings remind us that not all educators implement evidence-based practices with the fidelity necessary for success. Therefore, researchers must ensure new practices are powerful, but also usable by the intended audience.

**Technological Pedagogical Content Knowledge (TPACK)**

**TPACK and the deictic interplay of literacy and technology.** Practitioners, teacher educators, and researchers can do little to alter the rapidly changing landscape of how technology influences literacy instruction, except trying to keep up (Leu, 2000). Therefore, as educators consider technology as a strategy to augment literacy instruction, a major consideration will be the capacity to rapidly integrate technology-based solutions into existing teaching repertoires. Educators at all levels of the profession have a long history of resisting or rejecting new interventions that are not a logical fit with their existing approaches to teaching. Technology can play a role in helping teachers structure individualized literacy instruction; however, the use of technology must be augmentative and logical in terms of its impact on the overall instructional plan (Larsen, 1995; Maccini et al., 2002).

Researchers have developed an instructional design framework that seamlessly integrates technology, content, and pedagogy for design and delivery of various types of content, known as technological pedagogical content knowledge, or TPACK for short (Koehler & Mishra, 2005). Koehler and Mishra describe TPACK as an extension of Shulman's (1987) classic construct of pedagogical content knowledge. We see TPACK as a helpful construct for conceptualizing and organizing the role of IT for delivering literacy instruction when teaching students with LD across all tiers of an RTI model.
TPACK and tiered instructional models (RTI). For practitioners providing services to students within an RTI framework, the question of how TPACK can guide instructional design across increasingly intensive settings is a significant issue to be addressed by researchers. First, it is critical that evidence-based practices that address literacy skills be in place across all tiers of a school's instructional settings and that practitioners are armed with a menu of appropriate IT options to augment existing strategies. Second, researchers, teacher educators, and practitioners must reflect on the specific demands related to literacy native to the various content areas and curriculum standards. And finally, typical elements of RTI frameworks such as universal screenings and progress monitoring must guide practitioners in terms of matching the individual needs of students with evidence-based and IT-driven practices that address the demands of the various content areas and learning tasks.

The TPACK framework is potentially useful for selecting and embedding technology that complements literacy instructional practices given different instructional settings and the unique learning needs of students. However, the recognition that technology should complement existing approaches to instruction, not supplant them, leaves a significant piece of the puzzle unsolved, especially for the typical educator responsible for the education of students with LD. The piece frequently overlooked or taken for granted by practitioners is the actual “looks and sounds” of specific technology-based program or intervention. In the next section we describe an important instructional design principle that can be used to guide construction of multimedia materials.

Multimedia Instructional Design Principles

Educators must give thought to the impact technology has on the cognitive processes of the intended audience (Boone & Higgins, 2007; Mayer, 2009). This is one reason why researchers from all sides of the technology discussion agree that technology must not be gratuitously during instruction (King-Sears & Ervenova, 2007). Literacy instruction should reflect multimedia design principles that are a match for the cognitive learning needs of the intended population of learners, as much as being a logical addition to the overall plan for teaching.

Cognitive theory of multimedia learning. The cognitive theory of multimedia learning (CTML) is a learner-oriented instructional theory and empirically validated design process (Mayer, 2009). The CTML is grounded in the cognitive load theory (CLT; Chandler & Sweller, 1991) and the dual processing theory (DPT; Paivio, 1986). The CLT holds that humans have a limited working memory; therefore, when incoming stimuli overwhelm the limited cognitive resources in working memory, new learning cannot take place (Chandler & Sweller, 1991). The DPT, in turn, reflects the belief that humans have capacity to internalize information through visual and auditory channels in working memory (Paivio, 1986). The combination of these two theories and associated research findings underwrite Mayer's CTML and its three assumptions about human cognition. The three assumptions of the CTML are as follows:

(a) Humans possess two separate channels for processing visual and auditory information; (b) Humans are limited in the amount of information that they can process in each channel at one time; and (c) Humans engage in active learning by attending to relevant incoming information, organizing selected information into coherent mental representations, and integrating mental representations with other knowledge. (Mayer, 2009, p. 63)

A key component of the CTML is an understanding that learners’ cognitive capacity is influenced by three kinds of cognitive load during learning, termed the triarchic model of cognitive load (DeLeeuw & Mayer, 2008). When designing instructional materials to address Mayer's three assumptions, it is necessary to use research-based design principles that address each specific element of the triarchic model of cognitive load by (a) limiting extraneous processing, (b) managing essential processing, and (c) fostering generative processing (Mayer, 2009).

Grounded in CLT and DPT, Mayer has outlined 10 interdependent, research-validated design principles that, when brought together, constitute a “construction checklist” for designing instructional materials that are effective for fostering learning (see Mayer, 2009). The steps and brief description are listed in Table 1.

The CTML and literacy learning of students with LD. Students with LD need instruction that actively reflects on and addresses limitations with respect to processing speed, working memory, and overall reading performance (Johnson, Humphrey, Mellard, Woods, & Swanson, 2010; Swanson, 2001). The core of any literacy instruction should include evidence-based practices (EBPs); therefore, embedding EBPs within a TPACK framework for multimedia instruction is a logical design strategy (Harris, Mishra, & Kohler, 2009). However, simply using TPACK does not necessarily address Mayer's assumptions of how humans utilize limited cognitive resources to process information, and thereby meet the individualized cognitive needs of students with LD.

In reality, many uses of technology to deliver or augment literacy instruction can be distracting, disruptive,
### Table 1
*Mayer's Design Principles as Aligned with the Triarchic Model of Cognitive Load*

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<tr>
<td><strong>Limit Extraneous Processing</strong></td>
<td>Coherence Principle</td>
<td>Instructional materials are enhanced when irrelevant or extraneous information is excluded</td>
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<tr>
<td></td>
<td>Signaling Principle</td>
<td>Learning is enhanced when explicit cues are provided that signal the beginning of major headings or elements of the material being covered</td>
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<td>Redundancy Principle</td>
<td>Inclusion of extensive text (transcription) on screen along with spoken words and pictures hinders learning. Carefully selected words or short phrases, however, augment retention (Mayer &amp; Johnson, 2008)</td>
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<td></td>
<td>Spatial Contiguity Principle</td>
<td>On-screen text and pictures should be presented in close proximity to one another to limit eye shifting during instructional presentations</td>
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<tr>
<td></td>
<td>Temporal Contiguity Principle</td>
<td>Pictures and text shown on screen should correspond to the audio presentation</td>
</tr>
<tr>
<td><strong>Manage Essential Processing</strong></td>
<td>Modality Principle</td>
<td>People learn better from spoken words and pictures than they do from pictures and text alone</td>
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<tr>
<td></td>
<td>Segmenting Principle</td>
<td>People learn better when multimedia presentations are divided into short bursts (5-7 minutes) as opposed to longer modules</td>
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<td></td>
<td>Pretraining Principle</td>
<td>Instructional messages should contain some sort of orienting message to introduce the forthcoming content</td>
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<tr>
<td><strong>Foster Generative Processing</strong></td>
<td>Multimedia Principle</td>
<td>People learn better from pictures and spoken words than from words alone</td>
</tr>
<tr>
<td></td>
<td>Personalization, Voice, and Image Principles</td>
<td>Narration presented in a conversational style results in better engagement and learning than more formal audio presentations</td>
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</table>

or altogether ineffective if they are not produced with the individualized cognitive needs of the target learner in mind (Mayer, 2009). As professionals design multimedia instructional materials that explicitly address learning demands presented by text or content, Mayer's CTML and accompanying instructional design principles may be a pathway to ensure the look and sound of materials adhere to the theoretical principles of multimedia learning and the cognitive learning needs of students with LD.

**Enzymatic Theory of Education**

Fox's (1983) enzymatic theory of education (ETE) completes our conceptual framework and vision for use of multimedia instruction to promote literacy skills among students with LD. A student-centered learning theory (Larsen, 1995), the ETE is a logical match given the other elements of our conceptual framework (e.g., deictic nature of literacy, TPACK, and the CTML). The ETE holds that students with LD need instruction that facilitates, enhances, and accelerates cognitive processes and overall motivation (Fox, 1983; Larsen, 1995). In this model, students are encouraged and expected to be catalysts in their own learning, as opposed to being passive recipients of information.

To provide instruction in line with the ETE, practitioners must select or design instructional materials that are grounded in theory and are a logical match for the demands of the intended audience. To create instruction with technology that is of use for students with LD, therefore, it is necessary to consider all aspects of a computer program, including dimensions of graphics, text, feedback types, motivation, and learner control (Larsen, 1995).

Mayer's CTML and accompanying instructional design principles are a logical method for authoring multimedia instruction that facilitates learning among students with LD. Educators who develop their teaching repertoire within a TPACK framework and consistently create multimedia instructional materials that adhere to theory-based instructional design and learning principles will find students who are more engaged and successful in their literacy and overall learning. The ETE is an essential piece of instruction occurring within RTI frameworks, especially for struggling and frustrated students at tiers 2 and 3.

**Summary of Conceptual Framework**

Teaching students with LD – at any level or in any content area – is a complex task for any educator. This complexity is sustained and perpetuated, at least in part, by the deictic nature of technology and literacy (Leu, 2000). Fortunately, educators have the capacity to be guided by theoretical principles for instructional design and can look to empirical research to bolster existing teaching repertoires that work for literacy learning. Evidence-based practices for literacy instruction (e.g., Torgesen et al., 2007) and instructional design frameworks (e.g., TPACK, UDL; Mayer's CTML) can guide construction of homegrown technology-based practices and interventions that empower the hands-on learning of students with LD.

**RECOMMENDATIONS**

Based on our review of the theoretical and empirical literature germane to teaching literacy skills to students with LD in a tiered instructional system, we propose three recommendations for practitioners. Following the recommendations is an analysis of how practitioners can embed each of the recommendations within an RTI framework.

**Recommendation 1**

Select or design multimedia materials for use in literacy instruction that (a) logically extend existing pedagogy; and (b) explicitly help students build skills necessary for literacy-related success, including meeting individual needs, along with demands of local and state standards (Koehler & Mishra, 2005).

**Recommendation 2**

Design or select multimedia materials that limit extraneous processing, manage essential processing, and foster active learning through micromanagement of literally every image and sound that is presented to students during multimedia instruction (DeLeeuw & Mayer, 2006; Mayer, 2009).

**Recommendation 3**

Incorporate validated theories of learning into multimedia-based literacy instruction (Kelly et al., 1986; Kelly et al., 1990). However, (a) shape instruction to reflect the discipline- or task-specific literacy demands of the subject matter being learned, and (b) ensure multimedia instruction adheres to the instructional design principles of Mayer's CTML.

**RTI Implications: Recommendation 1**

Recommendation 1 is intended to build on the theoretical construct of TPACK (Koehler & Mishra, 2005) to guide practitioners away from conceptualizing the various tiers as places, and instead select evidence-based interventions necessary for helping students augment overall literacy capacity. The core of this recommendation is that practitioners must take time to reflect on (a) the demands of the curriculum, (b) existing EBPs for providing instruction, (c) the needs of individual students, and (d) opportunities to incorporate a logical and powerful form of instructional technology into instruction.

A critical element of TPACK is that technology integration is not an afterthought in the process, but is
embedded in planning and reflection across all instructional planning and design. For students with LD who need explicit instruction that may occur in tiers 2 or 3, technology can influence or augment existing approaches to skill remediation (McKenna & Walpole, 2007). Numerous technology-based stand-alone programs or individual interventions provide targeted literacy instruction to students who need sound- or word-level instruction (e.g., Read 180, supported eText). However, matching individualized student needs with technology-based interventions is not an automatic process.

In summary, educators should provide explicit literacy instruction to students who need it; however, simply plugging children into a computer terminal installed with a stand-alone reading program without explicit consideration of how the technology-based solutions logically fits within the overall scope of the child's development is not advised.

**RTI Implications: Recommendation 2**

A common misconception regarding use of technology is that it is effective regardless of the theoretical and pedagogical principles that went into (or did not go into) authoring the software or intervention (Boone & Higgins, 2007). Recommendation 2, based on the cognitive theory of multimedia learning (CTML; Mayer, 2009), is intended to guide practitioners in their design of multimedia instructional materials for use in any instructional setting with students. When it comes to instructional design, with or without the use of technology, educators at every level should carefully consider the ease with which students’ working memories and capacity for cognitive load can be overwhelmed (Chandler & Sweller, 1991; Mayer, 2009). Careful consideration of limited cognitive capacity and propensity for overload is even more critical when planning literacy instruction for students with LD.

Mayer's instructional design principles (see Table 1) do not constitute a step-by-step roadmap for instructional design, but may be thought of as a “construction checklist” of essential features that the construction site foreman checks off as he or she oversees the combinations of materials (e.g., steel, wood, pipes, wires) being assembled within a new structure. Mayer's framework is content-neutral, in that it is useful for guiding instructional design of content or practices from a wide variety of disciplines. With that in mind, the CTML and accompanying design features help practitioners ensure that the look and sound of the instruction are appropriate in terms of limiting extraneous processing, fostering the processes in working memory, and managing active learning. These guidelines are applicable to the design of instruction at tiers 1, 2, or 3.

**RTI Implications: Recommendation 3**

The purpose of the enzymatic theory of education is to promote an active learning environment for students. In many schools, instruction at tiers 2 and 3 is very repetitive and dull. While, by nature, remedial reading instruction is not an exciting activity, for students with LD, it is one of the most important activities they will participate in during school (Torgesen & Barker, 1995). Therefore, practitioners must find ways to make instruction relevant to students regardless of the topics or skills being taught. Technology is one strategy that can assist in this critical endeavor.

Using Mayer's design principles only accomplishes half of the goal with respect to effective design of multimedia instructional literacy materials. The best technology in the world cannot compensate for a poorly designed and executed lesson. For students with LD in intensive literacy learning situations, the practitioner must be knowledgeable, skilled, and ready with a menu of evidence-based practices to support learning. As noted, technology-based solutions created with specific design properties and that fit logically within the scope of a curriculum can be recommended for use (Kelly et al., 1990). However, instruction should still be engaging and relevant to learners to the extent practical given the type of instruction.

Finally, educators should examine existing evidence-based practices and programs for improving literacy outcomes for students with LD in search of opportunities to infuse technology into existing practice. We do not recommend that practitioners make haphazard changes to existing practices or curricula. Instead, numerous opportunities exist to conduct action research projects where careful data are taken regarding student performance and response to technology-infused instruction.

**The Research We Need**

In conclusion, we pose three lingering questions to be addressed by researchers and teacher educators in the field of technology-based literacy learning for students with LD:

1. What are the barriers and professional development considerations regarding providing effective multimedia literacy instruction at tiers 1, 2, and 3 to students with LD?
2. What are the implications for teacher education in terms of preparing teacher candidates to build teaching frameworks that include TPACK and other IT practices?
3. Under which learning scenarios (grade level, content area, instructional setting) is multimedia literacy instruction most effective? What theoretical
grounding and evidence-based instructional practices were used in the most effective experiments?
As noted by numerous other researchers, more empirical research is needed related to multimedia literacy learning for students with LD.

REFERENCES


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