Chapter 1
Introduction: Technology as a Support for Literacy Achievements for Children at Risk

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Being a well-integrated person in contemporary technologically oriented society requires more than the mastery of traditional reading and writing skills. While essential mainly for acquiring knowledge, occupational success, and improvement in socioeconomic status worldwide, the computer age demands broadening application of these skills and the integration of the accompanying new literacies. In parallel, these same technologies are providing access to new tools that may make basic literacy more readily available to the groups that are widely being known as populations at risk (Marsh 2005; Neuman 2009).

The concept "at risk," originating in the world of medicine, refers here to any group or individual in danger of suffering from difficulties in acquiring literacy. In complex, multicultural societies, these difficulties arise from socioeconomic gaps, bureaucratic categorization, as well as ethnic diversity. Students, of any age and belonging to any risk group, may also lack proper learning and teaching environments at home or in school. Some students may also have special needs that require highly individualized teaching methods and learning curricula.

Educators and researchers throughout the world are therefore increasingly concerned with the growing gaps between the disparate groups found in the same classroom. They are seeking ways to narrow gaps in school performance while focusing on traditionally underserved groups of children, such as low-income students, students with disabilities, and students belonging to major racial and ethnic subgroups.

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A. Shamir and O. Korat (eds.), *Technology as a Support for Literacy Achievements for Children at Risk*, Literacy Studies 7, DOI 10.1007/978-94-007-5119-4_1,

Evidence of the growing priority of these concerns is found in the passage, in the USA, of the No Child Left Behind Act of 2001 (NCLB), which aimed at improving the education of broad groups of children at risk attending public schools. The act requires schools to rely on *scientifically based research* when formulating curricula and teaching methods, specifically "research that involves the application of rigorous, systematic, and objective procedures to obtain reliable and valid knowledge relevant to education activities and programs." Such research is expected to result in "replicable and applicable findings" to generate persuasive, empirical conclusions. The need for research-based intervention was also noted. As a sign of the government's seriousness regarding this program, we need to simply note that the US Congress has since increased federal funding of education from $42.2 billion (2001) to $54.4 billion (2007). Importantly, funding targeted at reading acquisition quadrupled from $286 million in 2001 to $1.2 billion.

Research in the application of new technologies to literacy instruction is also being indirectly encouraged by its beneficiaries – students. Today's children tend to be fascinated by advanced technology rather early. Children as young as kindergarteners are increasingly exposed to and enjoying electronic media in the form of television and DVDs, video games, computer software programs, electronic books, Internet, mobile phone applications, interactive toys, and similar products (Marsh 2005). This exposure has motivated a growing body of research into just how children respond to these technologies beyond the level of entertainment. In a survey conducted by Vandewater et al. (2007) in the USA, they revealed that children aged 5–6 spend about 50 min a day on a computer, 10 min of which were devoted to e-book reading.

In a broader survey among more than 1,000 households with children aged 6 and under, again conducted in the USA, Rideout and Hamel (2006) found that in a typical day, 83% of the children participating used some type of screen media. Twenty-seven percent of the parents surveyed reported that their children used a computer at least several times a week, and 69% indicated that they felt computers helped their children learn.

This reality poses a significant challenge to researchers in the field of education. With the entry of computers into the class and the home, new opportunities are now provided for the improvement of learning skills in different subject areas; the need to ascertain the educational quality of existing computer tools has arisen. Researchers have therefore begun to look to the new technologies that characterize the modern age as opportunities to investigate and improve literacy acquisition for wide-ranging populations around the world.

Several studies have uncovered some of the main reasons why computerized and multimedia learning environments promise to promote literacy. Van Daal and Reitsma (2000), for instance, suggest that when compared to regular classroom instruction, computer-based learning is more structured and thus easier to absorb. Hutinger et al. (2002) show that in the area of emergent literacy, interactive technologies are particularly effective. These technologies appear to replicate a child's typical learning encounters more naturally than do standard tools (e.g., workbooks) while being sufficiently flexible to incorporate new curricula. Other research

confirms that computer-assisted learning does promote children's language and literacy development (de Jong, and Bus 2003; Marsh et al. 2005; Reinking 1997; Shamir et al. 2012; Snyder 2002; Underwood and Underwood 1998; Valmont 2000; Yelland et al. 2006) in addition to arousing children's motivation to learn. Eshet-Alkalai (2004) reports on the multiple representations (text, voices, pictures, and animations) of similar content that multimedia platforms can provide, an approach that enables alternative means of learning the same material. In research attending to the content of multimedia presentations, Moreno and Duran (2004) cite the mutually referring information that each type of media makes available. Generally speaking, all the findings locate some literacy-promoting benefits in the dynamic multisensory environment available to the technologically attuned contemporary student population.

What remains open to investigation is computer technology's benefits for different types of children at risk, whether resulting from their young age (Lankshear and Knobel 2003), their belonging to low SES, ethnic groups, or the presence of special needs (Shamir and Margalit 2011; Zucker et al. 2009).

Within this body of literature, we consider the theoretical work of two researchers to be especially important for explaining why multimedia technologies can support emergent literacy among children at risk. We begin with Mayer's cognitive theory of multimedia learning (Mayer 2003; Mayer and Chandler 2001). Mayer (2003) has drawn our attention to the impact of design features (e.g., spatial contiguity, temporal contiguity, coherence, modality, and redundancy) on the quantitative as well as qualitative improvement of children's performance. He argues that multimedia platforms make several symbolic systems available simultaneously; this synchronization promotes cognition more effectively than does exposure to monomedia (exclusively visual) platforms. Hence, multimedia tools provide children with multiple opportunities to learn based on the special communicative and logical characteristics of each of the different media. Taken together, they support the cognitive transfer and retention of information. Neuman's (2009) theory of the synergetic effects of multimedia learning builds on these and other insights. She points to the benefits of combining different types of presentation – computers, television, and radio in addition to printed materials – each of which differentially contributes to stimulating and sustaining a specific learning capacity. The core of her argument thus stresses that the very combination of platforms produces improved interpretive and emergent literacy development.

To conclude, additional research is required to empirically support the theories promulgated regarding the effectiveness of multimedia technologies in promoting literacy and enhancing literacy-related outcomes among different groups at risk, working in different settings.

It is in this spirit that we have compiled the studies offered in this collection, which is designed to shed further light on some of the gaps in this important literature. The book focuses on studies investigating whether and how multimedia learning tools can instill and support literacy skills and thus prevent isolation of these children in the classroom, a condition often predicting their later marginality in the twenty-first century society. The book is one outgrowth of the international research

conference held in 2010. The conference, supported by the Israel Science Foundation (ISF), brought together well-known researchers involved in cutting-edge research on technology as a support for the literacy development of students at risk. We believe that the results of the international research reported here can offer much to education systems around the world in their efforts to help these children, whatever their age, become active and contributing members of society.

The chapters in this book are grouped into three parts: (1) Early Childhood, (2) School Children, and (3) Special Education Needs. Part I, Early Childhood, examines the possible contribution of new technologies for the acquisition of language and early literacy skills among preschool-aged children. The majority of the chapters in this part focus on children from low-income families. In Chap. 2, Adriana G. Bus and Cornelia A. T. Kegel question about whether a computer program can stimulate early literacy skills. How is computer tutoring among low SES kindergarteners and does susceptibility to computer programs vary? The study's findings indicated that the effects of the software used (a computer game) were moderately strong only when a built-in tutor was available. Children's susceptibility to the program was found to be associated with a genetic predisposition to dopamine-regulated reward- and attention-related mechanisms, independent of cognitive ability. The authors' conclusion, that a computer intervention's efficacy is stunningly variable across program qualities and across children's characteristics, points to areas in which new research is needed. In Chap. 3, Susan B. Neuman presents a study applying an intervention designed to accelerate 3- to 4-year-old children's vocabulary knowledge and conceptual understandings. Participants included 1,200 children enrolled in Head Start. The intervention used an embedded multimedia curriculum known as the "World of Words" (WOW) developed by the authors. The chapter presents the data on the progress made by the children and shows how this multimedia intervention can influence their learning.

Chapter 4 presents research conducted by Maria de Jong and Marian J. A. J. Verhallen, who tested whether a digital technology can be used to stimulate early literacy skills in kindergarteners at risk. The chapter describes a series of randomized experiments that demonstrated the surplus value of video storybooks for understanding storyline (e.g., the story's actions and the internal responses of the story's main characters) and vocabulary. Another promising finding brought forth is that interactive features such as multiple-choice questions can add to the learning effects of video storybooks. The authors conclude their chapter with remarks related to what they call the "level-up effects" of multimedia.

Cathy Roskos and Karen Burstein present in Chap. 5 a unique four-component model focusing on the e-book instructional environment. The components include e-book quality rating, physical space for e-book browsing/reading, the child's engagement with e-books, and shared e-book reading instruction. Qualitative analytic techniques were used to formatively assess the model's functionality in the preschool learning environment and to gauge its potential usability in early literacy practice. The study's results reveal the model's promise for e-book pedagogy in early childhood settings.

Chapter 6 is devoted to kindergarten children aged 5–6. In the research described, Ora Segal-Drori, Ofra Korat, and Pnina Klein asked what medium can better support low SES kindergarteners' reading. They examined e-book and printed book reading with and without adult mediation. The young participants were assigned to four research groups: (1) independent e-book reading, (2) e-book reading with adult mediation, (3) printed book reading with adult mediation, and (4) receipt of the regular kindergarten program (control). The authors found that the group reading the e-book with adult mediation exhibited the greatest progress in letter name recognition, emergent word reading, concept about print (CAP), and general emergent reading among all the groups.

Part I closes with Chap. 7, contributed by Victor van Daal and Jenny Miglis Sandvik. They present a meta-analysis of 35 studies conducted to review and analyze the effect of multimedia on the early literacy development of children at risk. van Daal and Sandvik note that large effect sizes were found for phonological awareness, concepts of print, vocabulary, and reading. Medium effect sizes were found for comprehension, nonword reading, and alphabet knowledge. However, large effect sizes for vocabulary, reading, and alphabetic knowledge were also found for children at risk who did not participate in a multimedia intervention. The authors suggest that multimedia literacy applications can be beneficial for children at risk of literacy underachievement, especially with respect to phonological awareness, concepts of print, comprehension, and nonword reading.

Part II presents three studies discussing the effects of technology on school children. Carol Connor claims, in Chap. 8, that effective instruction can be supported by linking assessment and instruction. She describes online software that uses algorithms to translate assessment results into specific recommendations for amounts and types of literacy instruction. Her finding shows the greater the amount of time that third-grade teachers spent using the software, the greater were their students' reading comprehension gains. The findings also revealed that software use positively predicted the precision with which teachers provided the recommended amounts to each student in their classroom.

In Chap. 9, William H. Teale, Katie Lyons, Linda Gambrell, Nina Zolt, Rebecca Olien, and Donald J. Leu present a project including an online learning environment, In2Books, and a literacy-based eMentoring program. The program brings together 9- to 12-year-old at-risk students in American elementary schools with adult mentors for the purpose of reading, responding to, and writing about children's books in order to promote thinking and literacy. The series of studies conducted by the authors explores the program's impact on student achievements and engagement, together with the range of factors involved in constructing an online environment designed to be user-friendly and educationally effective. Analysis of the students' book discussions suggested that authentic literacy tasks – reading books, exchanging letters, and engaging in small group discussions – represent viable tools for creating a learning context reflecting student accountability to the community, content, and critical thinking.

Chapter 10 presents Bracha Kramarski's study comparing 80 seventh-grade students (low and high achievers) who were exposed to either forum discussion

supported by self-regulated learning (SRL) with self-guided questions (the SRL group) or to no direct SRL support (the no SRL group). In her study, she investigated mathematical literacy by means of (a) authentic problem-solving performance and (b) forum discussion (mathematics and metacognition). The research findings indicated that the SRL students showed greater gains in mathematical literacy than the no SRL group students. They used mathematical language more frequently and were more flexible in their strategy use.

The book's Part III focuses on children with special education needs and how the new technology can enhance their language and literacy. In Chap. 11, Adina Shamir, Ofra Korat, and Renat Fellah present two recent studies initiated to test the potential of Hebrew educational e-books for enhancing emergent literacy among Israeli preschool children at risk for learning disabilities (ALD). Their findings show that despite the initial disadvantages exhibited by ALD children in vocabulary, phonological awareness, and CAP when compared to typically developing (TD) children, ALD children are clearly capable of making strides in these emergent literacy skills following exposure to an educational e-book of the type employed.

Eliane Segers, in the research described in Chap. 12, examined the use of mnemonics in learning grapheme-phoneme connections among children with specific language impairment (SLI). She asked if these children could benefit from mnemonics use within a computer-supported environment especially when the mnemonic picture is used in a fading condition, similar to the way that typically developing children learn language. Three conditions were tested: (a) a fading condition (letters are taught using a picture-supported first-sound mnemonics procedure in combination with a fading procedure), (b) an embedded condition (no fading), and (c) a pictureless condition. SLI children exhibited higher learning gains in the two mnemonic conditions but – contrary to typically developing children – showed no differences in the fading versus the embedded condition. Segers thus concluded that an integrated-picture mnemonics procedure is beneficial for children with SLI.

Chapter 13 reports research conducted by Sigal Eden, Adina Shamir, and Maayan Fershtman on the effect of laptop use on the spelling capabilities of teenaged pupils (aged 13–16) with learning disabilities. Ninety-three Hebrew-speaking pupils with LD, studying in ten special education classes, participated in this study. The participants were randomly assigned to two groups: the experimental group, which used laptops ($N=54$), and the control group, which did not use laptops ($N=39$). The findings indicated that participants in the experimental group significantly improved their spelling capabilities as opposed to the control group. It appears that the use of laptops in special education classes can enhance the targeted capability.

In Chap. 14, Orit Hetzroni describes research that investigated the effect of using an augmentative and alternative communication (AAC) program that includes a graphic and orthographic symbol processor for enhancing language, communication, and literacy skills. The program is meant to be used by teachers and students in schools for children with communication difficulties. Eighty children studying in six such schools participated in this study. The results demonstrated significant increases in language and communication skills measured across all schools, with the most significant gains in vocabulary. Teachers reported that they increased their use of the assistive technology (AT) for teaching literacy and communication skills.

In the closing Chap. 15, Nira Mashal reports the results of a study focusing on the use of an advanced brain imaging technique (functional magnetic resonance imaging (fMRI)) to improve understanding of metaphor-comprehension deficits in children with learning disabilities. Children with learning disabilities manifest considerable difficulties in understanding nonliteral language, expressed by 3-year delays in metaphor comprehension. The chapter shows how fMRI techniques can enlighten brain functioning in addition to the cognitive mechanisms underlying nonliteral language processing. Mashal also shows how fMRI contributes to our understanding of the specific language impairments observed in children with learning disabilities.

We would like to thank to all the contributors to this book for their scholarship and hard work. We hope that the studies presented here will stimulate thinking and research in this important area and contribute to the integration of technology with pedagogy for the purpose of benefiting all those at risk with respect to literacy development.

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