Using Technology to Support Academic Achievement for At-Risk Teens During Out-of-School Time

Literature Review

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National Institute on Out-of-School Time (NIOST)
For more than 20 years, NIOST, at the Center for Research on Women at Wellesley College, has successfully brought national attention to the importance of children's out-of-school time, influenced policy, increased standards and professional recognition, and spearheaded community action aimed at improving the availability, quality, and viability of programs serving children and youth. NIOST's varied initiatives have moved the field forward using three paths: Research, Evaluation, and Consultation; Policy Development and Public Awareness; and Training and Curriculum Development.

NIOST's mission is to ensure that all children, youth, and families have access to high-quality programs, activities, and opportunities during non-school hours. NIOST believes that these experiences are essential to the healthy development of children and youth, who can then become effective and capable members of society. Our work bridges the worlds of research and practice.

Education Development Center, Inc. (EDC)
EDC is a nonprofit research and development organization dedicated to improving education and health worldwide. Founded in 1958, EDC manages more than 350 projects around the globe. EDC's work strengthens nearly every facet of society, including early child development, K–12 education, learning technologies, health promotion, workforce preparation, community development, and social justice. The America Connects Consortium project is led by EDC's Education, Employment, and Community Programs with support from EDC's Center for Children and Technology.

America Connects Consortium (ACC)
Established in 2000 under a contract from the Office of Vocational and Adult Education, U.S. Department of Education, ACC serves community technology centers nationwide. ACC is a partnership that includes EDC, NIOST, and the Community Technology Centers' Network. Past collaborators have included the Alliance for Technology Access, Compumentor, ICF Consulting, the Information Technology Association of America, and the Alliance for Nonprofit Management. ACC provides training, technical assistance, evaluation, and research services to the field of Community Technology.

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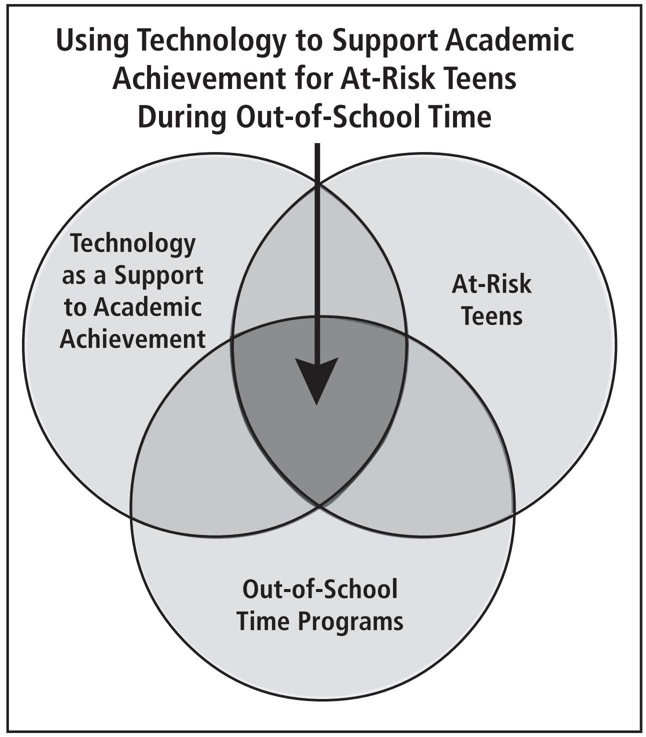
Introduction and Methods

This review conducted by the National Institute on Out-of-School Time (NIOST) explores the use of technology to support academic achievement for at-risk high school-age youth during their out-of-school time.[1] In the last two decades, technology has exploded into the school classroom, home, and other learning settings in far-reaching ways. Some current efforts to support young people to progress in school and to navigate the transition from school to work and higher education have endeavored to harness the potential of technology as a learning tool. Many researchers have tested a wide range of technology applications in different learning settings and situations, creating a growing collection of literature and commentary on the value and usability of technology-based learning strategies. Our task in this literature review was to sort through the many publications, research briefs, and observations in this arena, with a particular focus on at-risk teens and the out-of-school hours, and to summarize the latest thinking on both the theory and practice of using technology to support academic achievement.



It was not surprising that there is little literature that particularly focuses on the junction of the three spheres explored in this paper: out-of-school time programs, at-risk youth, and technology as a support to academic achievement. However, there is substantial literature on two of the individual spheres: at-risk youth and the use of technology to support academic achievement. There is also a growing body of literature on out-of-school time programs that can be considered in exploring the convergence of the three spheres.

This paper begins with a discussion of at-risk teens and a look at the literature related to academic achievement. The second section examines the literature on the use of technology as a support to academic achievement and the use of technology with at-risk youth. The third section explores the literature on out-of-school time programs, looking specifically at (1) the use of technology in such programs, (2) out-of-school time program content as a support to academic

[1] In this paper, the term "out-of-school time programs" is generally understood to mean programs for children and youth that operate during the before-school, after-school, summer, weekend, holiday, and vacation hours. Much of the literature and research in the out-of-school time field is based specifically on after-school experiences but can be generally applied to most out-of-school time settings and programs. In this paper, the term "technology" is used to generally represent computer and telecommunications technology, including the Internet. The authors have specified types of technology where possible; however, its broad use as a general term across the literature at times makes specific definition challenging. The term "at-risk teens" refers to teenagers who are at high risk of failing school and often live in impoverished settings. High school-age teens are the focus of this paper unless otherwise specified.

achievement, and (3) the experiences of at-risk teens in out-of-school time programs. By combining insights from these three domains, this paper will help to inform leaders in the out-of-school time program field, educators, policymakers, technology program designers, and other stakeholders as to what to consider when creating out-of-school time programs that use technology-based learning activities to support academic achievement for at-risk teens.

The first task for this literature review, with advice from several university departments and library reference professionals, was to identify the key resources for information collection. The second task was to conduct extensive database, Web and electronic document searches. We used electronic databases—including ERIC, Dissertation Abstracts, PsycINFO, Infotrac, GenderWatch, Sociological Abstracts, OmniFile, LexisNexis Academic, Education Full Text, and FirstSearch—to search for recent journal articles, reports, and papers. We also employed several additional data collection strategies, including e-mail and phone interviews with youth program leaders and researchers.

The researchers reviewed NIOST's extensive library, including books, articles, research briefs, conference proceedings, and other information related to research on out-of-school time. We also reviewed Web sites and documents from project-related national organizations, such as the United States Department of Education, United States Department of Commerce, Southwest Educational Development Laboratory, North Central Regional Educational Laboratory, National Afterschool Association (formerly NSACA), Forum for Youth Investment, Coalition for Community Schools, Center for Research on the Education of Students Placed at Risk, Institute for Educational Leadership, American Educational Research Association, American Sociological Association, Pew Internet and American Life Project, Urban Institute, National Association of Secondary School Principals, Association for Educational Communications and Technology, Center for Youth Development and Policy Research at the Academy for Educational Development, National Research Council, United States National Science Foundation, and Technology in Education Program at Harvard University Graduate School of Education; Johns Hopkins University, EDC (Education Development Center, Inc.), and SRI International (Stanford Research Institute).

In total, we selected approximately 235 documents for initial review. This final paper incorporates 132 of the originally selected documents. During the initial review process, the researchers considered the date of the publication along with its specific content and scope. The researchers primarily focused on literature and research published within the last 10 years. For some of the sub-themes, the publication year was less significant, whether because very few sources of information existed or because the document cited was a seminal publication within its field. Each source was reviewed and either deleted from further consideration or coded according to research themes. The need for further research is addressed in the final section of this literature review.

Literature Review

Section I: At-Risk Teens and Academic Achievement

Teenagers who are at high risk of failing school and often live in impoverished settings are noted in the research literature as "at-risk teens." Conditions associated with being at- risk include coming from poor families with ethnic and linguistic minority backgrounds, having parents who are not high school graduates, and having negative self-perceptions" (Druian & Butler, 1987). At-risk learners are likely to be low achieving, of low socioeconomic status, educationally disadvantaged, academically under-prepared, and English language learners, or to have "behavior problems" or learning disabilities (Land & Legters, 2002; Moore, Laffey, Espinosa, & Lodree, 2002; Page, 2002). A report by Public/Private Ventures (2002) estimates that more than 5 million youth between the ages of 14 and 24 fit this definition. It is not uncommon for at-risk teens to perform below grade level, fail a grade level, or score poorly on proficiency tests (Ohio State Legislative Office of Education Oversight, 1997). Slavin and Madden (1989) reported that such teens are often in danger of failing to complete their education with the skills necessary for being successful adults.

Assessment literature on at-risk teens and academic achievement shows few rigorous impact studies on instructional strategies and program participation. Most of the research is descriptive and non-experimental. There is substantial literature based on research, mostly descriptive, comparative, or correlational, that articulates particular instructional strategies for at-risk teens (National Society for the Study of Education, 2002). Also, literature on dropouts, drop-out prevention programs, and resiliency, which has been widely studied, offers important insights into academic support for at-risk teens. Here again a substantial amount of rigorous research is still needed.

Less current but notable research by Hodgkinson (1985), Green and Baker (1986), Hamilton (1986), McDill, Natriello, and Pallas (1985), and Wehlage (1983) reports on characteristics of effective drop-out prevention programs and potential consequences of school reform for at-risk teens. The more recent book *Educating At-Risk Students* published by the National Society for the Study of Education (2002) takes a comprehensive look at the state of education for students at risk of low academic achievement and of dropping out before completing high school. Resiliency research on high school youth by Reyes and Jason (1993), Gonzalez and Padilla (1997), Waxman, Huang, and Wang (1997), and McClendon, Nettles, and Wigfield (2000) is profiled in the book. The book suggests that a perspective on educational resiliency might improve the education of at-risk students and help educators design more effective educational interventions.

Public/Private Ventures (2002) produced a very thorough summary of findings from the limited number of rigorous studies conducted in key youth organizations that target at-risk youth, including the studies of Career Academies, Job Start, Job Corps, Project Redirection, and New Chance. Such programs tend to focus on diploma or GED completion, employment, enrollment in higher education, and earnings rather than grade improvement or advancement in particular academic subjects. In the summary report, researchers conclude that overall findings from the evaluation of many programs for high-risk youth indicate "no" or "limited" impacts for youth and add that perhaps only the most highly disadvantaged youth are benefiting from such programs.

In regard to instructional strategies, Waxman, Padron, and Arnold (2001) describe five practices that have been shown in field studies to improve the education of at-risk students: (1) cognitively-guided instruction, (2) culturally responsive teaching, (3) technology-enriched instruction, (4) cooperative learning, and (5) instructional conversation. Many of these strategies, along with individualized and self-paced instruction, appear across the literature about at-risk youth (see, for example, H. F. Dalton, 1996; Korgen, Odell, & Schumacher, 2001; Lauer et al., 2004; Page, 2002; M. G. Sanders, Allen-Jones, & Abel, 2002; and U.S. Department of Commerce, 2002).

Norris (1994) proposed similar teaching strategies that have been found to be successful with at-risk students: (1) individualized instruction facilitated by computer-assisted instruction, (2) collaborative learning, including learning that employs computer-based simulations, computer conferencing, and database access, (3) peer tutoring, which can focus on the study of technology itself, and (4) teaching across the curriculum through computer simulations that incorporate topics in math, language arts, and science in the same lesson. Norris also explained how various uses of technology can support these four teaching strategies.

Other researchers have demonstrated that technology, in a variety of forms, can have a positive influence on students at risk of failure (Chavez, 1990; Dunkel, 1990; Means, 1997; Merino, Legarreta, Coughran, & Hoskins, 1990). Means (1997, p. 2) concludes that strategies that use technology to teach "real world applications that support research, design, analysis and communication" will support at-risk students.

Day"(2002) conducted a study of middle school students at risk of failure who were given the opportunity to work in a "technology lab." He found that based on this experience, students felt more motivated to learn, received better grades, and accepted more responsibility for their work in the lab environment. Additionally, Page (2002) found that computer-based instruction can increase the self-esteem of at-risk youth.

The lack of rigorous scientific studies on the impact of particular strategies with at-risk teens limits the ability to design academic support programs with research-supported practices. Yet, there is significant information to inform program providers as to general features of learning environments and strategies that seem to best support the academic achievement of at-risk teens. It would make sense for program providers to consider these strategies when designing program content and structure.

Section II: Technology, Teens, and Academic Achievement

Technology and Teens

There is considerable current research and literature on gender and race differences in teens' computer and Internet use. Rather than recommending best practices, the research and literature point to gender and race differences in technology use and application that may be valuable to consider when creating technology-based programs for diverse teens. The focus of the literature is discerning differences between gender and races, rather than the impact of such technology on academic achievement. At-risk youth are not typically examined exclusively. However, findings about gender and race differences based on the general teen population may still be helpful in understanding differences that are likely to also be relevant for at-risk teens.

Gender Differences Computer and Internet Use Among Teens

Several studies have shown that teen girls tend to view the computer as a tool and a means to an end (American Association of University Women, 2000; American Association of University Women, Educational Foundation, Commission on Technology, Gender, and Teacher Education, 2003; Gunn, 1994; Rabasca, 2000). Males, on the other hand, are more likely to view computers as toys or extensions of the self (American Association of University Women, 2000). Young (2000) reported that males prefer computer instruction that focuses on programming, whereas females prefer computer instruction that focuses on applications.

Teen females are also more practical and instrumental in their approach to computers, compared to male users who tend to use a more exploratory approach (Gunn, French, McLeod, McSporran, & Conole, 2002). When working on computers, teenage girls generally prefer to sit down and accomplish a specific task rather than explore technological possibilities (Koch, 1994). However, teenage girls do report that they learned most of their computer skills from simply "messing around on it" (Miller, Schweingruber, & Brandenburg, 2001).

Teenage males spend more of their out-of-school time each day on computers than their female peers do (Lupart & Cannon, 2002; Mark, 1992). Over the last 15 years, studies have shown that males tend to seek out more extracurricular training in computer technology than females do (Hess & Miura, 1985; Lockheed, 1985; Miura, 1986; Weinman & Cain, 1999). In addition, studies have shown that starting in middle school, and sometimes even earlier, males tend to be more represented in after-school computer clubs (American Association of University Women, 2000; American Association of University Women, Educational Foundation, Commission on Technology, Gender, and Teacher Education, 2003; Kirkpatrick & Cuban, 1998; Sanders, 1995).

Much research has reported that since males typically have more out-of-school time experiences with computers, they exhibit higher self-confidence and more positive attitudes about such technology than girls do (Gunn et al., 2002; Mark, 1992; Weinman & Cain, 1999; Young, 2000). Margolis and Fisher (2002) found that this increased confidence had more to do with males' self-assurance than with actual skill level. Even the most highly skilled females with significant experience in technology generally exhibited less confidence than their equivalently or less than equivalently skilled male peers did (Margolis & Fisher, 2002).

While teen females tend to have more computer experience in word-processing, males tend to use computers more for programming and game purposes (American Association of University Women, 2000; Coley, Cradler, & Engel, 1998; Lockheed, 1985; Miura, 1986; Weinman & Cain, 1999). Lupart (2002) and Rabasca (2000) both reported that teen girls generally use computers for communication activities, such as e-mail or visiting chat rooms. They tend to dislike the narrow focus of programming courses and instead are more likely to master applications, such as databases, page layout programs, and graphics, rather than technology skills, such as programming and technological problem solving (American Association of University Women, 2000).

Some research has shown that although there is no longer a gender gap in online access between males and females, there are still differences regarding frequency of Internet use between both genders (Debell & Chapman, 2003; Ono & Zavodny, 2003; Young, 2000). Females tend to access the Internet less frequently, and when they are online they generally remain there for a shorter duration (Young, 2000). However, Miller et al. (2001) found that teen girls do not doubt their online abilities, rating themselves toward the positive side of "expert" in terms of their Internet skills. Teen males are more likely than their female peers to use the Internet for "surfing" purposes (Lupart & Cannon, 2002).

Research by Pinkard (in press) examined the possibility of males and females being attracted to games that they perceived to be geared more toward their gender-specific interests. Pinkard's research questioned whether adolescent males would be more interested in computer games that were packaged and designed with their interests in mind. Her findings showed that both males and females tend to view software programs as specifically designed for males or females, but not both. Pinkard also found that both males and females are more likely to select software that they believe has been designed specifically for their gender, limiting their use and exploration of other forms of technology.

The Internet, computer programs, and software all tend to feature male characters and male activities, which tend to be less engaging for females (Nelson & Watson, 1991; Rabasca, 2000). Gender-neutral software may help females overcome their reservations about exploring technology (Lynn, Raphael, Olefsky, & Bachen, 2003).

Computers are not inherently gender-biased. It is primarily the attitudinal, social, and environmental factors that play a role in the gender differences that contribute to differences in computer use

(Mark, 1992). Lack of role models for females in the field of computer science, as well as the differences in learning styles of males and females (Brown, 2001; L. M. Miller et al., 2001), contribute to gender differences in technology use. Recent research has shown that there is still a difference in the amount of access males and females have to all types of technology, which affects their differences in use of and interest in computers and technology (Brown, 2001; Miller et al., 2001). As a result of these differences, there may be differences in the types of computer activities that are most appropriate to support academic achievement for males and females (Solomon, 2002). Such information can be useful in planning program content and delivery.

Race Differences in Technology Use Among Teens

It has become increasingly clear over the last decade that race intertwines in complex ways with technological access and use. The term "digital divide" has been used to express the difference in technology access and use based on ethnicity or socioeconomic status. The digital divide has been a well-researched topic and of great national interest, prompting reports from the U.S. Department of Commerce"(2000, 2002) based on household and individual surveys. Two other recent reports, *Toward Digital Equity* (Solomon, 2003) and *Losing Ground Bit by Bit* (Goslee, 1998), substantively examine the challenges of and strategies for closing the digital divide in schools and communities and bringing all Americans into the digital age. However, similar to the research on gender and technology, most studies on race and technology do not necessarily specify at-risk teens as a unique study group. However, given that at-risk teens are overrepresented in low-income families with ethnic and linguistic minority backgrounds, the general findings about race and technology use seem valuable.

Technological fluency is not a skill arena in which all teens are participating equally (Kominski & Newburger, 1999). Research has shown that access to technology is influenced by a user's[2] assets, such as education and family background (Ba, Culp, Green, Henriquez, & Honey, 2001). Teens that are considered at risk are also more likely to fall into the category of "technology have-nots." Cooper (2000) found that youth that do not have access to these forms of technology miss out on many meaningful, high-quality, and interactive educational experiences.

Studies looking specifically at students from various racial backgrounds and their use of technology showed substantial differences in technology access and ownership. In a survey of students by Hoffman and Novak (1998), 73% of the white students owned a computer while only 32% of African American students did. Asians were found to use the Internet most out of all racial groups (Korgen et al., 2001; U.S. Department of Commerce & National Telecommunications and Information Administration, 2000). Surveys show that students who live or attend schools in low-income areas are least likely to receive full benefits from the use of educational technology (Solomon, 2003). Coley et al. (1998) reported that students who attend poor schools and those highly populated by minority youth have less access to most types of technology.

A study by Swain and Pearson (2003) documents research on technology integration in school classrooms, the differences in students' educational experiences, and teacher influence on access and instructional opportunities. The researchers suggest that implementation of technology standards can help close the gap in the digital divide. Ross, McGraw, and Burdette (2001) provide a brief summary of research that has been conducted on access and reducing the digital divide.

An examination of college-bound high school seniors by Coley et al. (1998) showed that students from minority groups were less likely to have taken word-processing or computer literacy courses. These minority students were also less likely to have used a computer for English classes or for solving problems in math courses. Minority students were more likely to have taken courses in data processing and computer programming (Coley et al., 1998). Korgen, Odell, & Schumacher (2001) also studied college students and found that differences by race/ethnicity in use of the Internet exist despite students' significant access and computer ownership. Using data from 1996 and 1997, Hoffman and Novak (1998) showed that the most dramatic difference between whites' and African Americans' home computer ownership occurs for high school and college students and that household income does not explain race differences.

There are two important implications for program and instructional design from these findings on race and gender differences in technology use. The first implication is that lack of technology access influences engagement and participation choices. Teens who are already at risk of failing school due to economic, social, and educational barriers may also be marginalized from the full use of technology because of gender or race. Teens with little experience in using technology may be less likely to engage in learning tasks that rely on technological skills and experience. They may also be less attracted to programs highlighting technology experience, expecting that such would be a mismatch to their interests or background.

A second implication is that the disparity in technological skills and experiences warrants strong consideration of after-school programs as a desirable venue for technology experiences, since the

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[2] This reference is to all users and not specifically teens.

youth that have fewer technology opportunities are the same youth most often served by out-of-school time programs. Also, budget cuts and time constraints coupled with an intensive emphasis in schools on improving English Language Arts and Mathematics have relegated other subjects and skills, including technology skills, to the margins. After-school hours may be a critical time for young people to access and engage in technology-focused experiences (California Department of Education, 2000).

The following section presents a series of research results on specific technology applications and their relationship to academic improvement. Although such research is in its infancy, there is a steady stream of investigation aimed at uncovering the possibilities, potential, and risks of technology-based learning strategies and tools. To what extent providing access to and engaging at-risk teens in experiences involving technology during the after-school hours can support their academic achievement is the principal question the following section of this paper will address.

Technology and Academic Achievement

Conducting research on the effectiveness of educational technology use is challenging, in part, because technological change is swift. Also, the range of applications of technology is broad, from drill-and-practice computer-assisted instruction[3] to technology-enabled project-based learning. As technology changes, the multimedia capacity, interactive characteristics, and design components change, too. In addition, contextual factors surrounding implementation have made generalizing findings difficult (Valdez et al., 2000). Most studies investigate technology as it is used in school classrooms and labs, rather than out-of-school time programs. However, out-of-school time program settings can sometimes resemble, both in environment and content, the in-school setting, suggesting that findings from traditional school studies can offer important insights into the potential role of technology use in out-of-school time to support academic achievement.

While many studies offer compelling examples of the ways that technology-based learning strategies may support academic achievement, not all studies yield positive results. Substantial literature also proposes that the use of technology as a learning tool may have drawbacks (Akin, 1998; Barley, 1999; Cuban, 1993; Gordon-Calvert, 1999; Hansen, n.d.; Hartman, 2003; Milken Family Foundation, 1999; Peterson & Orde, 1995; Roschelle, Pea, Hoadley, Gordin, & Means, 2000; Wang & Chan, 1995). The mere existence of technology-based tools in the learning environment does not guarantee that learning will transpire; the tools must be part of a "coherent education approach" (National Research Council, 2000). Goldenberg (2000, pg. 2) concluded that the "single most important thing that research shows is that what really matters is not the use of technology, but how it is used." Research by Yegelski and Powley (1996) demonstrated that even the most basic incorporation of technology into an educational setting can encounter technological, institutional, and theoretical boundaries. However, based on the volume of positive findings about the possible impacts of technology on academic achievement, there is sufficient reason to highlight many of those studies in this review and to consider their findings, as well as gender and race differences, when structuring academic support programs.[4]

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[3] Technology-enabled learning appears by different names in the section Technology and Academic Achievement, for example, computer-assisted instruction, computer-based instruction, computer-supported instruction, and technology-based learning. The names used may differ if they refer to different pedagogical approaches or to the different roles that technology plays in teaching and learning situations.

[4] See Appendix B for further details on most of the research studies cited in this section.

Technology as a Support to Academic Achievement

Atkinson (1968) and Suppes and Morningstar (1968) were among the first researchers to attempt incorporating computer technologies into educational environments with the hopes of enhancing learning. There is extensive literature outlining the possible benefits of using technology to support academic achievement. Some studies suggest that by incorporating exploration, creativity, and individualized learning experiences, technology-based tools can take the learner beyond the memorization of facts to exploring the how and why (Burns, Heath, & Dimock, 1998). Other researchers indicate that technology can enhance how youth learn by supporting four fundamental characteristics of active learning: (1) active engagement, (2) participation in groups, (3) frequent interaction and feedback, and (4) connections to real-world contexts (Roschelle et al., 2000).

Studies show that computers can be used to promote collaborative activities, move instruction and facilitation away from the whole group to smaller clusters of youth working cooperatively, and offer a variety of real-world and interactive learning experiences that cannot be replicated by other learning tools (Roschelle et al., 2000). The combination of computation, connectivity, and multimedia has radically changed the potential for technology in learning environments (Honey, Culp, & Carrigg, 2000).

There have been few large-scale studies (Roschelle et al., 2000) on the effectiveness of technology, and those that have been conducted often yield mixed results. However, results from a number of studies on the relationship between computer use and academic achievement indicate that technology can bolster student outcomes (Hedges, Konstantopoulos, & Thoreson, 2003). The evidence suggests that computer-based applications that encourage deep reasoning increase learning, while those that promote repetitive skill practice can actually hinder learning (Cuban, 1993). Ross, McGraw, and Burdette (2001) point to four kinds of potential improvements from the integration of technology into learning experiences: (1) increased learner motivation, (2) mastery of advanced topics, (3) students acting as experts, and (4) better results on standardized tests.

Researchers for the U.S. Department of Education categorize learning technology into four basic categories:

- **Tutorial:** Technology does the teaching, lecture/workbook style. Includes computer-assisted instruction and integrated learning systems.
- **Exploratory:** Learners are free to roam around the software, which promotes discovery. Includes electronic databases and computer-based exploratory applications, such as Logo.
- **Application:** Uses such applications as word processors, databases, spreadsheets, and tools to facilitate writing tasks, analysis of data, and other uses. Includes publishing, music applications, and video production.
- **Communication:** Allows students and teachers to send and receive messages, including distance learning and using networks and other interactive technologies. Includes WebBoards, electronic mailing lists, chat rooms, and Web conferencing (Means et al., 1993).

Research conducted in the 1980s (Kulik, Kulik, & Bangert-Drowns, 1985; Kulik, Kulik, & Schwalb, 1986; Schmidt, Weinstein, Niemic, & Walberg, 1985) concluded that computer-assisted instruction is more effective than conventional instruction for increasing students' academic achievement. However, these studies were conducted with populations other than teens, and their findings may be outdated.

Kulik and Kulik'(1991) conducted a comprehensive meta-analysis from 254 controlled evaluation studies on the effectiveness of using computers to increase student achievement. In their findings, students receiving computer-based instruction had higher exam scores than those taught by conventional methods. Students who received computer tutoring had the largest effects. Based on their own research and others, Kulik and Kulik came to the following conclusions:

- Students learn more in computer-based instruction.
- Students learn lessons in less time with computer-based instruction.
- Students like their classes more when they receive computer help in them.
- Students develop more positive attitudes toward computers when they use them regularly and receive help from them.

Two studies by Funkhouser illuminated the effects of computer-augmented[5] instruction on mathematics achievement and attitudes toward mathematics of secondary school students. In 1993, Funkhouser conducted research on computer-augmented instruction for high school students in their second or third year of high school math. An analysis of the results of an attitude assessment suggests that students involved in such instruction develop more positive attitudes about themselves as learners of math. In addition, Funkhouser's analysis of performance on a test of problem-solving ability and on standardized tests of mathematics content demonstrated significant gains in problem-solving ability and knowledge of mathematics content.

Later research by Funkhouser (2002) centered on 10th and 11th grade students enrolled in geometry courses. Funkhouser found that students who were taught with a constructivist approach to geometry using computer-augmented methods tended to make significantly stronger gains in acquiring geometry concepts and to perform better on a standardized geometry test.

Looking at a specific series of computer programs for use in high school geometry courses, McCoy (1991) compared the geometry achievement of a group that used the software to a similar group that did not use the software. Results revealed that the software participation group scored significantly higher on the final examination in geometry than the control group did.

Pump Algebra Tutor field studies conducted with Project Explore in Union City, New Jersey, showed significant achievement of 16-18 year old students participating in a school-wide reengineering program on standardized tests and assessments of problem solving compared to students not involved in the program. A four-year study demonstrated significant gains on the SAT-1 of students who participated in an integrated technology curriculum; these students scored 54 points higher and 34 points higher in the verbal and the math sections of the SATs, respectively (Bain & Ross, 1999).

The science laboratory is one of the high-potential areas for incorporating computer-supported instruction. Experiments on diffusion, osmosis, mitotic division, and population problems can be easily simulated by microcomputers. Hounshell and Hill (1989) examined the impact of a computer-supported biology course on student achievement and student attitudes toward science. They found that the participants in the computer-supported group scored significantly higher on the comprehensive test and on the science attitude inventory than the participants in the comparison group. Computer-based applications using visualization, modeling, and simulation have been proven to be powerful tools for teaching scientific concepts. Such programs

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[5] Computer-augmented is defined in this study as instruction aided by the use of computers.

as “ThinkerTools,” “Stella,” versions of “Logo,” and “Global Exchange” help high school youth master advanced scientific concepts (Roschelle et al., 2000).

A report conducted by Interactive Educational Systems Design Inc. summarizes educational technology research from the late 1980s through 2000 (Software Information Industry Association, 2000). From an original set of more than 3,500 studies of technology as a tool for learning, 311 studies were chosen for the analysis. Specific findings include the following:

- In studies focusing on reading and language arts, technology has been shown to provide a learning advantage in the areas of phonological awareness, vocabulary development, reading comprehension, and spelling.
- Technology has been used effectively to support mathematics curricula that focus on problem solving and hands-on, constructivist, experiential activities. Students participating in such technology-supported learning experiences have demonstrated superior conceptual understanding of targeted math topics than have students receiving traditional instruction.
- Studies focusing on science education suggest the benefits of simulations, microcomputer-based laboratories, videos that anchor instruction to real-world problems, and software that targets students’ misconceptions about science.
- A learning advantage has been found when students have developed multimedia presentations on social studies topics.
- Educational technology has significant positive effects on achievement for populations with special needs. Speech recognition is an especially valuable compensatory tool for those with learning disabilities.

Technology studies showing the strongest evidence of positive effects on academic achievement have primarily focused on applications in science and math (Roschelle et al., 2000). However, researchers Anderson, Inman, and Horney (1998), Kamil, Intrator, and Kim (2000), McKenna (1998), and Reinking and Lobo (1999) have contributed to a growing body of research demonstrating the value of computer-supported reading and studying environments (as cited in Dalton, Pisha, Eagleton, Coyne, & Deysher, 2002).

Boyd (2000) found that self-paced, computer-based reading instruction helped to increase seventh- and eighth-grade students’ independent reading levels. Researchers at CAST Inc. carried out a three-year study involving 102 middle school students that looked at the effect of computer-supported instruction versus traditional instruction on reading comprehension. Overall, students using computer-supported strategies gained approximately .53 grade equivalents, while students in the traditional group gained approximately .2 grade equivalents. Several features of the computer-supported instruction may account for the differences in achievement:

- The text-to-speech feature allowed students to read age-appropriate text that was well above their decoding level but was at their interest level.
- Students were able to write their thoughts and feelings throughout their reading of the novel.
- The opportunities to exercise choice and control were greater in the computer-supported environment.
- The electronic work log was visible evidence of accomplishment and a means of self-evaluation (Dalton et al., 2002).

Beach and Lundell (1998), in studies conducted with middle school students working on computers, observed that students who engaged in computer-mediated communication,[6] such as e-mail, posting messages, and online chats, learned literacy skills through these social exchanges. Participants are expected to respond in written format, conveying meaning accurately and effectively. The computerized communication format can encourage participation from youth who normally shy away from participating in face-to-face communication (Kamil, 2003). Additionally, other research supports the finding that computer-based applications, such as desktop publishing and desktop video, can be used to involve students more actively in presentations on subjects of interest to them (Roschelle et al., 2000).

Innovative educators have shown that learning impacts in other areas of study and for special populations are also possible. The popular computer game "SimCity," for example, has been used to teach youth about urban planning. Computer-based tools have been designed to allow students to choreograph a scene in a Shakespeare play or to explore classic movies from multiple points of view, increasing their ability to consider alternative literary interpretations. Through the "Perseus Project," students use a multimedia learning environment for exploring hyperlinked documents and cultural artifacts from ancient civilizations (Roschelle et al., 2000). In a four-year study of students with special needs, which included an 8th grade cohort, who were engaged in an integrated, technology-rich curriculum, researchers found that students gained 89 points in combined verbal and math SAT 1 scores (Wenglinsky, 1998).

Infrastructure Supports

Many studies show that effective use of technology as a support to academic achievement is dependent on many other factors or infrastructure. Technology is more likely to be an effective learning tool when it is supported by other things, such as professional development of staff and relevant assessment processes and tools (Roschelle et al., 2000). Teachers and facilitators need training to use technology—training in using it to support higher-order skill building in tandem with fundamental basic computer skills, computation, etc. (Roschelle et al., 2000). Researchers from ETS found that students whose teachers used computers primarily for simulations and applications that support higher-order thinking performed better than youth whose teachers used computers primarily for learning games. In addition, students whose teachers had professional development in technology outperformed those whose teachers did not (Norman, 2000).

Much research has been conducted indicating the importance of computer literacy capabilities both in students and in instructors in order for computer-assisted instruction to be productive (Yagelski & Powley, 1996). If one or both parties lack previous knowledge and experience with technology, then the learning process may suffer (Carter, 1999; Yagelski & Powley, 1996).

Technology can improve learning, but technology use does not automatically translate into better outcomes for youth. The impact of technology depends on the software chosen, what students actually do, and how facilitators structure and support the learning activities (Funkhouser, 2002). Technology is likely to be most successful when the software and learning objectives match the facilitator's understanding of the learners' needs (Valdez et al., 2000). The specific youth population, the software design, the educator's role, how the youth are grouped, the preparedness of the educator, and the level of youth access to the technology—all of these factors influence the effectiveness of educational technology (Sivin-Kachala & Bialo, 2000).

[6] Computer-mediated communication in this study occurs in two formats: synchronous and asynchronous. In synchronous communication, participants chat simultaneously with one another, mimicking oral communication. In asynchronous communication, participants read and respond to one another at their leisure.

While there is mixed opinion about the benefits and suitability of technology-based learning tools, there is substantial evidence that educational technology changes the process of teaching and learning. Technology can transform the learning environment to be student-centered, problem- and project-centered, collaborative, communicative, and customized (Wenglinsky, 1998). Educational technology expert Chris Dede suggests that if technology is used to automate traditional methods of teaching and learning, then we can expect limited impact on academic progress. If it is used to enable new ways that can't be implemented without technology, or to enable learning beyond the walls of the program, then we may expect a major impact (O'Neil, 1995).

Technology and Academic Achievement for Learners with Special Needs

Many youth come into learning experiences with a variety of challenges. In exploring the potential impact of technology-based learning on academic achievement, it is important to probe into the ways that technology can respond to or, in fact, precipitate these challenges.

Technology-based learning tools can present multiple barriers to individuals with special needs: (1) lack of audio output for visually impaired or non-reading students, (2) mouse and keyboard difficulties for individuals with physical disabilities, and (3) written text that is difficult to comprehend by students with learning disabilities (Bayha & Doe, 1998). However, as a learning tool, technology can also compensate and substitute for some of these disadvantages and disabilities (Benton Foundation, 2003).

Research has shown that technology has the potential to assist individuals with hearing, physical, visual, and communication difficulties. The Individuals with Disabilities Education Act of 1997 refers to this type of technology as adaptive or assistive technology, which includes any device, piece of equipment, or product system, whether acquired commercially, modified, or customized, that is used to increase, maintain, or improve the functional capabilities of an individual with a disability.

Assistive technology comes in a variety of formats that help individuals with learning disabilities capitalize on their strengths and bypass or compensate for their weaknesses. Assistive technology not only incorporates technologies designed specifically to assist learners with special needs, but also often contains generic features that can be used by the general public (such as captioned programming, touch-screen computers, and voice commands for computers and phones) (Lewis, 1998). Advances in technology, such as single-switch, speed recognition, and laser devices, have made learning experiences more accessible to populations with special needs (Hehir, 2003). Other applications have also been successful at reaching children with teaching strategies that are different from those found in a classic instructor-learner model.

Assistive technology can be as simple as a magnifying glass used to assist an individual in reading small text or as complex as a computer workstation that allows individuals with learning disabilities to scan textbooks that will be read aloud while the text is simultaneously displayed on a computer screen (Goddard, 2004). Other common types of assistive technology used in educational settings are speech digitizers and synthesizers; reading machines that allow auditory access to any printed material; voice input for computers to be used by individuals with physical disabilities; books available on computer disks, which allow the reader to change the appearance of the font; and handheld spelling, thesaurus, and dictionary devices used during the writing process (Garrick-Duhaney & Duhaney, 2000; Lewis, 1998). Garrick-Duhaney and Duhaney (2000) point out the necessity of instructors receiving proper training and support with the use of assistive technologies in order for students to receive maximum benefits.

Studies by MacAuthur (1996) and others indicate how technology can assist learners with special needs in the process of writing. MacAuthur (1996) points out that students with learning disabilities can benefit from working with word processors because of the flexibility they provide writers throughout the process of writing, editing, and rewriting. Fennema-Jansen (2001) reports that technology can support learners in the process of composing and with text production. Assistive technology can provide writers with a variety of supports to assist them during composition, including such tools as spelling checks, grammar checks, word prediction software, multimedia programs that incorporate drawings and text, and word processors with speech synthesis (Fennema-Jansen, 2001; Garrick-Duhaney & Duhaney, 2000; MacArthur, 1996).

Section III: Out-of-School Time Programs

Out-of-School Time Programs and Academic Achievement

Many youth-serving organizations through their out-of-school time programs have particularly focused attention on and historically served youth who have grown up economically and educationally disadvantaged. The current emphasis on high-stakes testing and raising student academic achievement has put pressure on out-of-school time programs and providers to demonstrate the role they can play in filling the gaps and supporting classroom learning and academic improvement, particularly for middle and high school-age youth.

Youth-serving organizations and researchers have shown that trying to support the academic achievement of high school-age youth, including at-risk teens, through participation in out-of-school time programs is a challenging endeavor. There is a growing amount of research showing that participation in after-school programs is positively associated with better school attendance, more positive attitudes toward schoolwork, higher aspirations for college, better work habits, better interpersonal skills, reduced drop-out rates, higher-quality homework completion, less time spent in unhealthy behaviors, and improved grades (Clark, 1988; Huang, Gribbons, Kim, Lee, & Baker, 2000; Posner & Vandell, 1994, 1999; Schinke, 1999). In contrast to most of the published findings, the first-year findings from the National Evaluation of the 21st-Century Learning Centers Program concluded that after-school programs had limited influence on academic performance (U.S. Department of Education, 2003).

Research has also suggested that out-of-school time programs can promote the youth assets that are crucial to laying the foundation for academic achievement and healthy development (Hall, Yohalem, Tolman, & Wilson, 2003). Miller (2003, p. 9) explains that after-school programs can offer intangible benefits, such as the "opportunity to engage in activities that help young people realize they have something to contribute to the group; the opportunity to work with diverse peers and adults to create projects, performances and presentations that receive accolades from their families and the larger community; and the opportunity to develop a vision of life's possibilities that, with commitment and persistence, are attainable." However, the focus of much of the academic and asset research is on youth in grades K–8 and is limited in program scope.

There is an extensive collection of evaluation research published by the Harvard Family Research Project as the Out-of-School Time Program Evaluation Database (available at www.gse.harvard.edu/hfrp). The database provides information about evaluation work on more than 200 out-of-school time programs and initiatives. However, as is generally true in the research literature on after-school programs, the evaluations are more focused on programs serving younger youth than on high school-age youth.

Researchers at the National Institute on Out-of-School Time–(Hall, Israel, & Shortt, 2004) recently compiled a summary report on key issues and challenges facing program leaders in creating and sustaining after-school program opportunities that engage the interest and participation of high school-age youth. Programs appear to be most successful in reaching high school-age youth and sustaining their interest when the following is true:

- Older youth feel a sense of independence as part of their participation in the program, particularly financial independence through earning wages or a stipend.
- Youth voices are listened to and incorporated into the decision making.
- Programs offer employable skills, such as office work skills, and include preparation for or direct connection to job training and employment.
- Youth have an opportunity to interact with community and business leaders.
- Schools and principals are active partners.
- Participation includes receiving assistance in navigating the post-high school experience.
- Youth are introduced to the world outside their local neighborhoods.

Out-of-School Time Programs and Use of Technology

Research on the use of technology in after-school programs to support academic achievement is thin. However, researchers at the Urban Institute offer good insight into the possible contributions of after-school programs in this arena (Liu et al., 2002). The study describes the implementation of computer technology supports in Washington, D.C.'s 21st-Century Community Learning Centers summer program. Participants in the study included students in 10th grade. The report is based on data collected through monitoring reports submitted by program staff, observations of technology activities, interviews with facilitators and instructors, and focus groups with participating youth. Researchers could not directly measure student outcomes from the data collected, but did observe that the quality and quantity of equipment were high, as was the overall level of exposure to technology, and that students were generally engaged (Liu et al., 2002).

Most of the literature on out-of-school time programs and technology explores strategies for using technology to support learning and offers approaches for integrating technology into teen programs. Pololski (as cited in Benton Foundation, 2003) contends that if program providers are to succeed with technology-based programs directed to teens, then content and program design must be integrated, authentic, inclusive, and self-generated. According to other researchers, programs that successfully integrate technology must be organic, drawing from and responding to the real lives, histories, and experiences of the youth and communities they serve (Benton Foundation, 2003). In setting learning goals, planners should consider the needs, interests, and resources of all the diverse youth populations (Southwest Educational Development Laboratory, n.d.).

It would seem that one of the most critical roles technology can play in supporting academic achievement is to offer an attractive entry into after-school activities. Kugler (2001) notes that the after-school computer club is often one of the most popular after-school activities and can serve as an entry point to other academic learning experiences. He further explains the flexibility of technology applications, suggesting that programs can use technology for remedial purposes, or can design experiences that combine the development of basic skills with problem-solving exercises and opportunities for creativity. Researchers suggest that applications focused on multimedia projects, which are often highly attractive to teens, can lead to success in higher-order thinking, problem solving, multi-step problem solving, and synthesizing different points of view (Valdez et al., 2000).

Youth tend to be more engaged in technology-oriented programs when they are given choices in activities, when program staff provide technological support, and when the youth are given opportunities for reflection, discussion, and interaction (Alexander & Wade, 2000). In general, teens seem more attracted to approaches that attempt to infuse technology into all program activities rather than having a "technology component" that focuses primarily on teaching technology skills (California Community Technology Policy Group, 2002).

Out-of-School Time Programs and At-Risk Teens

Researchers at McREL (Lauer et al., 2004) recently completed a comprehensive research synthesis of the effectiveness of out-of school time strategies in assisting low-achieving or at-risk students in reading and mathematics. Their work included an extensive literature search to identify published and unpublished research and evaluation studies conducted after 1984 that addressed the effectiveness of a program, practice, or strategy delivered outside the regular school day for low-achieving or at-risk K–12 students. Fifty-three studies were reviewed for the final analysis. The results for reading and mathematics suggest that out-of-school time programs can significantly increase the achievement of low-achieving and at-risk students by an average of one-tenth of a standard deviation, compared to students who do not participate in out-of-school time programs. The largest positive effect size in mathematics was for students in high school (grades 9–12). The timeframe for delivery of out-of-school time strategies (i.e., before school, after school, summer) did not have a statistically significant influence.

Morley and Rossman (1998) from the Urban Institute published a thorough report on the experiences of community-based initiatives, both federal and foundation funded, serving at-risk youth. The topics addressed include (1) services integration and case management, (2) parental involvement, (3) volunteers for tutoring and mentoring, (4) fund-raising and marketing, and (5) program outcomes. The authors explain that at-risk youth and their families have multiple needs and interrelated problem behaviors that are not likely to be successfully addressed by single-response, stand-alone initiatives. The programs in the report focus on services integration that addresses clients' multiple needs by linking youth and families to a variety of services.

Some researchers caution that attracting and sustaining the participation of at-risk teens in after-school programs can be extremely challenging (Herrera & Arbreton, 2003). However, studies have shown that certain components of after-school programming attract the interest of at-risk teens. Program activities should promote positive developmental experiences through interest-based exercises that not only attract these hard-to-reach teens, but also address their specific needs. It is also important that program participants are provided with intense exposure to a variety of activities from which to choose (Public/Private Ventures, 2002). Public/Private Ventures (2002) reported that it might be helpful if programs were able to continue to provide services to teens as needed after the programs end. Finally, Slavin and Madden (1989) reported that it is important to constantly assess the progress of at-risk teens in programs so that instruction can be altered to fit individual students' needs.

Section IV: Conclusions and Recommendations for Future Research

The intersection of at-risk teens, technology, and out-of-school time hours brings together a rich set of research findings and active debate. There is overwhelming consensus that youth will benefit in multiple ways from having positive supports and opportunities available to them during the out-of-school time hours. Increasingly, out-of-school time programs are being considered an additional arena for supporting student academic achievement. Program providers have had to consider in what ways after-school programs can incorporate activities that reflect local and national academic standards, as well as the knowledge and skills needed for the 21st century. There are many convincing accounts of the positive influence of participation in after-school programs, although these focus primarily on younger youth. The question as to how the infusion of technology learning strategies into out-of-school time programming for older youth can impact academic achievement depends in large measure on the applicability of technology as a learning tool for teens, and the viability of attracting and retaining at-risk teens in out-of-school time programs.

Youth development experts agree that the latter question poses many challenges. Infusing technology-based learning strategies into programs opens up additional challenges, such as accommodating young people's learning differences, addressing young people's variations in technology approaches and experiences, providing appropriate professional development and support for instructors and activity facilitators, clarifying and connecting learning objectives and assessments, and transforming the nature of the learning environment. There is sufficient evidence in the research literature that appropriate use of technology-based learning strategies can enhance the learning experience and lead to measurable academic improvements. Yet, using technology as a support to academic achievement also raises implementation and utilization concerns, which require careful consideration when creating technology-based learning activities.

Since learning technologies change so rapidly, it is difficult for research studies to keep pace. Educational technology includes an ever-increasing array of hardware, software, and network configurations that may make up just one component of a learning intervention (Haertel & Means, 2003). The field may well benefit by turning emphasis away from the question of "whether new instructional tools are more efficient at accomplishing goals than conventional methods, but instead how emerging media can provide an effective means of reaching essential educational objectives in the technology-driven, knowledge-based economy of this new century"(Dede, 2000, p. 174).

There is a great need for research about after-school programs that use technology-based activities as a central program component. While technology-based learning strategies have been studied in the traditional classroom, there is little information to suggest how applicable these findings are to out-of-school time programs. When using technology-based learning strategies in out-of-school time programs, could we expect to find similar improvements in academic progress and similar drawbacks to the traditional classroom experiences? Out-of-school time programs can function in ways very different from traditional classroom activities and learning, such as mixed-age groups, small-group learning, flexible schedules, and real-world connections. Future research should consider the unique components and characteristics of after-school programs and how these programs relate to the implementation of technology-based learning strategies. Promising practice and case study research about the experiences of at-risk youth in technology-based learning activities would help inform policymakers and program providers in creating and funding effective programs.

We (the authors) hope that the information included in this literature review will provide guidance to learning researchers, educators, after-school leaders, policymakers, and youth program providers on the issues related to using technology to support academic achievement for at-risk teens during the out-of-school time hours. Technology is an extremely powerful tool that will surely continue to reshape our vision and experience of learning.

Appendices

Appendix A: Program Development and Other Resources

YouthLearn Guide
Morino Institute, EDC
To obtain copies of the guide, contact EDC at 800-449-5525 or www.youthlearn.org.

The *YouthLearn Guide* is a resource for planning and implementing creative, active learning centers and programs for children and youth using technology and the Internet. The guide offers practical advice to get your center or program up and running—everything from step-by-step lessons in establishing the program, sustaining the quality of the program, and teaching and learning materials, including practical, age-appropriate projects and classroom ideas.

Seven Principles for Using Technology to Teach Science and Math
To obtain copies, contact Educational Leadership at 800-933-ASCD (2723).

These seven principles were adapted from a report submitted to the National Science Foundation.

Technology as a Teaching Tool
New York City Department of Education
Available at www.nycenet.edu/oit/mgmt/techteach.

This publication provides examples of teacher-prepared materials using word processing, desktop publishing, spreadsheets, databases, multimedia software, and drawing programs, and discusses teacher and student uses of the Internet.

Older Struggling Readers: What Works
K. Feldman
To obtain copies, contact K. Feldman at kfeldman@scoe.org.

This bibliography of resources for middle and high school struggling readers includes listings of instructional technology programs.

Using Technology to Improve Instruction and Raise Student Achievement: Outstanding Practices
Southern Regional Education Board (SREB)
To obtain copies of the guide, contact SREB at 404-875-9211 or www.sreb.org.

This publication contains 21 examples of how educators are using technology to improve instruction and raise student achievement in academic and career/technical courses.

Using Technology to Support Learning in After-School Programs
EDC
To obtain copies of the guide, contact EDC at 800-449-5525 or www.edc.org.

This is an illustrative and analytical overview of how technology is used for learning in after-school programs in Boston.

Technology Teaching and Learning Tools

Don Zundel (Apple Computers)
To obtain copies, contact the Hawaii Department of Education at www.k12.hi.us/~tethree/01-02/foundations/techtool.pdf.

This publication offer suggestions on using databases, spreadsheets, printers, scanners, digital camcorders, digital cameras, CD-ROMs, networks, and word-processing and presentation software as teaching and learning tools.

Commentary: Ingredients of Successful After-School Programs—The Experience of Klick

Yong Zhao and Mark Gillingham
Available in *Hanging Out: Community-Based After-School Program for Children*. Edited by Ruth Garner. Greenwood Publishing Group, 2002.

Children Learning with Technology Beyond the School Bell and Building: What Do We Know Now?

Amy Kuhlmann and Lawrence Friedman, North Central Regional Educational Laboratory
Available at www.ncrel.org/tech/child.

PEW Research Center for Internet and the American Life

Available at www.pewinternet.org.

Center for Research on Education, Diversity & Excellence

Available at www.crede.ucsc.edu.

Appendix B: Research Studies

Authors	Year	Study Cited	Sample population	Method	Statistical/Major Findings
Dalton, Pisha, Eagleton, Coyne, and Deysher	2002	*Engaging the Text: Strategy Instruction in a Computer-Supported Reading Environment for Struggling Readers*	102 middle school students; 64 students were computer-supported and 39 were traditionally supported	All students read three age-appropriate novels. Students in the experimental group read digitized versions of the novels with embedded strategy prompts on their computers. The control group students read the novels in paper form and were guided only by their teachers and their peers. Both groups were given the Gates-MacGinitie Reading Test as pre- and post-tests to assess reading growth.	Students in the treatment group gained approximately .53 grade equivalents while students in the control group only gained .2 grade equivalents.
Bain and Ross	1999	*School Reengineering and SAT-1 Performance: A Case Study*	160 secondary school students between the ages of 16 and 18; 89 students were in the pre-model group, and 71 were in the model group.	All students were currently attending a school that has participated in a school-wide reengineering program known as the School Design Model (SDM), which is targeted at accelerating the growth of students academically and socially. The mission of this school was to better prepare students for higher education. Students in both a model and pre-model group were compared using teacher recommendations and SAT scores. A post-test-only cohort design was used to compare SAT scores. Teacher recommendations were used to compare differences that exist between students who were in model and pre-model groups.	No significant differences were found in the model and pre-model groups when teacher recommendation scores were compared. Students who participated in the SDM program scored significantly higher on the Combined SAT-1 than did students in the pre-model group.

Beach and Lundell	1998	*Early Adolescents' Use of Computer-Mediated Communication in Writing and Reading*	12 7th grade students in a largely white, middle class, suburban junior high	Students participated in computer-mediated communication (CMC) and then were interviewed on their beliefs, attitude, interests, and perceptions around oral and computer group discussions.	Through participation in CMC exchanges, students note changes in their ability to contextualize or "read" social agendas implied by messages in order to formulate responses to those agendas. Students also note changes in style of social interaction and their use of language. They also learn how to mutually construct knowledge. Students participating in this study learned literacy skills through social exchanges, such as e-mail, posting messages, and online chats.
Funkhouser	1993	*The Influence of Problem-Solving Software on Student Attitudes About Mathematics*	40 students enrolled in a geometry or second-year algebra course in a public high school	The NEAP attitude inventory "Mathematics and Oneself" was used to determine students" attitudes about mathematics.	Students who used problem-solving software enjoyed math and were willing to work hard to do well in it. The majority of students did not feel that math was more suited to either males or females. Students who received instruction infused with problem solving scored significantly better on tests of mathematical problem solving and academic performance in geometry and algebra than students who did not receive such instruction.
Funkhouser	2002	*The Effects of Computer-Augmented Geometry Instruction on Student Performance and Attitudes*	49 11th and 12th grade students currently enrolled in a high school geometry course in the western United States	Twenty-two students in the treatment group received geometry instruction using a constructivist approach to computer-augmented activities; 27 members of the control group were involved in more traditional geometry instruction. Both groups were given standardized tests in geometry following the treatment group"s intervention.	Students who received geometry instruction using a constructivist approach by means of computer-augmented activities achieved stronger knowledge of geometry concepts than did students who received more traditional geometry instruction.

Hounshell and Hill	1989	*The Microcomputer and Achievement and Attitudes in High School Biology*	76 high school students formed the treatment group; 126 high school students formed the control group	Students in the treatment group were enrolled in biology courses that used computers for classroom activities. The control group used a more traditional biology curriculum. Both groups were tested at the end of 27 weeks using a self-appraisal inventory, Moore's Science Attitude Inventory, and the Comprehensive Test of Basic Skills.	Computer utilization for selected laboratory, demonstration, and other classroom activities can make a difference in improving both attitudes and achievement of students enrolled in biology. A computer-loaded biology curriculum appears to offer promise in secondary education in regard to achievement and attitudes, and it has the added benefits of ease of management and the utilization of modern technology.
Kulik and Kulik	1991	*Effectiveness of Computer-Based Instruction: An Updated Analysis*	Learners of all ages—kindergarten pupils through adult students	Researchers conducted a meta-analysis of findings from 254 controlled evaluation studies.	The analysis showed that computer-based instruction (CBI) usually produces positive effects on students. CBI programs raised student examination scores by .30 standard deviations in the average study. CBI also produced small but positive changes in student attitudes toward teaching and computers. CBI substantially reduced the amount of time needed for instruction.
McCoy	1991	*The Effect of Geometry Tool Software on High School Geometry Achievement*	58 high school geometry students. characterized as college-bound, predominately white, middle class, and above average	Students in the experimental group were given microcomputers and Supposer software, and participated in Supposer activities. The control group was taught using traditional teaching activities and had no exposure to Supposer activities. Both groups took the Houghton-Mifflin Modern Geometry Test at the end of the school year.	Using Supposer resulted in higher geometry achievement for the treatment group. Further analysis indicated that the difference in post-test achievement was limited to application questions and higher-order questions rather than actual levels of knowledge and comprehension.

Software Information Industry Association	2000	*2000 Research Report on the Effectiveness of Technology in Schools*	N/A	Reseachers conducted a meta-analysis of 311 research review and reports.	In studies focusing on reading and language arts, technology has been shown to provide a learning advantage in the area of phonological awareness. Technology has been used effectively to support math curricula that focus on problem-solving and hands-on, constructivist activities. Studies focused on science curricula show benefits of simulations, microcomputer-based laboratories, and videos to anchor instruction to real-world problems. Students have a learning advantage when they develop multimedia presentations on social studies topics. Educational technology can have significant, positive effects for learners with special needs. Educational technology can have positive effects on student attitudes toward learning and on student self-concept.
Weglinsky	1998	*Does It Compute? The Relationship Between Educational Technology and Student Achievement in Mathematics*	National samples of 6,227 fourth-graders and 7,146 eighth- graders	Examination of data from the 1996 National Assessment of Educational Progress (NAEP) in mathematics.	For both grades, urban and rural students were less likely to have math teachers who had received professional development in technology over the last five years than their suburban peers. Black students, in both grades, were less likely to have access to home computers than their white peers. For 8th graders, teachers' professional development in technology and their use of computers was positively related to academic achievement in math. For 8th graders, the frequency of home computer use was positively related to academic achievement. For 8th graders, the use of computers to teach lower-order skills was negatively related to academic achievement. For 4th graders, using learning games was positively related to academic achievement.

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