IMPACTS OF TECHNOLOGY ON OUTCOMES FOR YOUTH: A 2005 REVIEW

A COMPANION REPORT TO: MEASURING DIGITAL OPPORTUNITY FOR AMERICA'S CHILDREN: WHERE WE STAND AND WHERE WE GO FROM HERE

INCLUDING THE DIGITAL OPPORTUNITY MEASURING STICK 2005

A PUBLICATION OF

The Children's Partnership

ABOUT THE CHILDREN'S PARTNERSHIP

The Children's Partnership is a national nonprofit, nonpartisan child advocacy organization with offices in Santa Monica, CA and Washington, D.C.

We undertake research, analysis, and advocacy to place the needs of America's over 70 million children and youth, particularly the underserved, at the forefront of emerging policy debates.

The hallmark of The Children's Partnership is to forge agendas for youth in areas where none exist, to help ensure that disadvantaged children have the resources and opportunities they need to succeed, and to involve more Americans in the cause for children.

Since 1993, our work has focused on securing health coverage for uninsured children and working to extend the benefits of technology to all children and their families.

National Advisors

The Children's Partnership relies on experts in a broad range of fields to inform our work for children and families. Below are our National Advisors:

IMPACTS OF TECHNOLOGY ON OUTCOMES FOR YOUTH: A 2005 REVIEW

A Companion Report to Measuring Digital Opportunity for America's Children: Where We Stand and Where We Go From Here

Including the Digital Opportunity Measuring Stick

A Publication of The Children's Partnership

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INTRODUCTION

In 1994, The Children's Partnership (TCP) published *America's Children & The Information Superhighway*, the first-ever analysis of the impact that the information revolution could have on the lives of America's children. We wrote:

"Every one of the 67 million children in America today, along with the approximately 4 million born each year, will be affected by the information revolution. But the needs and interests of America's children have not been comprehensively addressed."

At that time, we, as a nation, were just starting a public debate on the importance of Information and Communications Technology (ICT). There had been virtually no discussion about what was best for the millions of children in the United States facing this new frontier. Furthermore, the body of research to help inform our collective action on behalf of children was practically nonexistent.

Now, more than 10 years later, the information age has advanced to the point where we can begin to assess the difference that computers, the Internet, and emerging information technologies can make in the lives of children. Over this 10-year period:

- Information and Communications Technology—most notably the Internet—has spread faster than any previous communications invention and has begun to affect nearly every aspect of children's lives;
- Commercial and social applications of ICT including online shopping, gaming, e-mailing and instant messaging have taken a firm hold, as have some hazardous uses like gambling and pornography;
- Children have been at the forefront in using these new tools, eager to incorporate them into their day-to-day living; and
- Tens of billions of dollars have been invested by government and the private sector to equip children, "wiring" homes, classrooms, youth centers, children's health facilities, and places where young people are trained for work.

Now it is time to address the question: **How can the Internet help our children succeed?**

Children today need what children have always needed to become healthy and productive adults—caring parents, a safe place to live, a strong education, and health care, among other basics. What we set out to answer is whether Information and Communications Technology could help address these needs in new and sometimes more effective ways.

Focus of This Report

With public attention focused mainly on who does and does not have access to ICT, the questions of whether, and in what ways, technology can improve children's opportunity and well-being have not been answered. The Children's Partnership's *Measuring Digital Opportunity for America's Children: Where We Stand and Where We Go From Here* addresses those questions and others about how best to extend ICT-enabled opportunity to all children. This report provides further information about ICT's impact on youth, supplementing Chapter II of our broader report ("Impacts: How Does Information and Communications Technology (ICT) Affect Opportunity for Children and Young Adults?") with greater detail about available studies and other research. To our knowledge, it is the first attempt to pull together these research findings across the fields of health, education, economic opportunity, and civic participation.

Although available information is still limited, our analysis shows that ICT can impact youth's lives *in real ways, on a daily basis*. Of course technology is not a panacea, and, if not implemented correctly and with care, technology will not have significant effect. The research base on the potential positive impacts of technology for youth is still "young" but growing.

SCOPE AND METHODOLOGY

Our review of existing research on ICT and youth outcomes revealed its potential to produce important and measurable impacts in four areas that matter to children. These four areas are also traditional rungs on the ladder of opportunity that have benefited generations of Americans.

FIRST, IMPROVED HEALTH: We found some of the strongest evidence of positive impacts as well as some of the most exciting untapped potential of ICT in the area of improving the health of children. ICT is proving to be an effective way to keep parents, patients, and doctors in closer communication; a cost-effective means to manage chronic health problems common among children, such as asthma; and a resource offering teenagers and young adults a safe way to learn about sensitive subjects like birth control, pregnancy, and AIDS that has been shown to lead young people to make better choices about healthy behavior.

SECOND, EDUCATIONAL ACHIEVEMENT: Various studies have documented that appropriate use of technology in an educational context can help students achieve better grades, increase scores on standardized tests, increase school attendance, and improve school behavior. However, often these results are achieved in conjunction with other educational elements, such as highly trained teachers, and therefore it is difficult to measure the specific impact of just technology. There is early evidence that technology can have a particularly significant impact on improved academic performance among students with lower grades or from low-income or rural backgrounds.

THIRD, ECONOMIC OPPORTUNITY: Young people with well-developed technology skills can benefit from their skills in two ways: (1) they are prepared for better jobs, and (2) they can more easily use their skills to search, apply for, and obtain jobs. As greater numbers of workplaces incorporate computers and the Internet in their everyday work, young people's ability to use these tools means they have better job opportunities. Early evidence suggests that teaching at-risk youth marketable ICT skills (such as word processing, Web design, desktop publishing or video production) helps them resume their education, obtain jobs, and embark upon a productive path to adulthood. Similarly, use of the Web to post and find jobs means that youth proficient in searching for jobs online will be more competitive in the job market.

FOURTH, COMMUNITY AND CIVIC PARTICIPATION: There is a growing "youth civic culture" on the Web with thousands of sites offering a variety of ways for young people to become involved in their local communities or communicate with others who share their interests. Although there is very little empirical research about impacts on children, ICT appears to hold considerable promise to increase community involvement by offering young people a new forum in which to state their views on community issues; get connected to local youth organizations; or transact business with government—whether obtaining a work permit, or applying for a driver's license or college financial aid.

Methodology

In assessing the state-of-the-art information about the impacts of ICT on children, we reviewed scientific journals, technology program evaluations, national survey results, and anecdotal information. In some cases, the evidence is relatively rigorous, such as when a technology practice relating to children or youth has been evaluated based on measurable outcomes. Even with more rigorous studies, there is wide variation in approach—some were short-term studies using a small number of participants, while others were carried out over a longer period of time and with a substantial number of children. In still other cases, the available information comes from surveys of what parents, children, or other adults believe about how the Internet and ICT impact their lives. We include this wide range of studies in our analysis because, despite their limitations and variation, they are the base that exists today and on which future research must build.

In each of our four sections, we begin by citing some of the more relevant survey results on how ICT has impacted youth. The survey section is followed by the best examples of evaluated research studies that measure the impact of technology on youth in more direct ways. In certain cases, we have included technology programs that only offer self-reported data because we believe, given the scarcity of relevant research, less rigorous research can provide useful insights.

Our project benefited from the input of a group of digital opportunity experts from academia, government, and the private sector. During the research and drafting of *Impacts of Technology on Outcomes for Youth: A 2005 Review*, our advisors provided advice about what questions to ask, where to seek answers and how to structure this report so that it is most relevant to those who can use it most. Advisors are listed at the back of the report.

The report outlines our findings on ICT's potential to improve outcomes for children and young adults in ways that can make them healthier, better educated, career-ready, and engaged in their local community.

I. IMPROVED HEALTH: POTENTIAL IMPACTS OF INFORMATION AND COMMUNICATIONS TECHNOLOGY

- *About one of five (19%) young adults ages 18–25 has conducted an online search for health information.*[1]
- *Four out of 10 (39%) 15–24-year-olds who have sought health information online say they have changed their personal behavior because of the information they obtained on the Internet.*[2]

The early research related to ICT's impacts on children's health, while probably less familiar to the public than the education research, offers some of the most promising areas of untapped potential: improving health behavior of young people, enhancing communication between parents and health practitioners, and improving the quality and effectiveness of health care for children. Because most of the studies are small in scale, their findings suggest important *potential* applications rather than definitive conclusions. This section reviews a wide-ranging set of ways in which ICT may improve health status and health care for children and young adults.

National surveys indicate the Internet is an important source of health information for teens and young adults. It's clear that adolescents in particular find the Internet to be a valuable tool for accessing health information they might not feel comfortable or secure finding elsewhere. More than four in 10 (44%) online teens and young adults have used the Internet to find information on issues such as pregnancy, birth control, and AIDS.[3]

Perhaps even more importantly, 39% of those 15–24-year-olds who have sought health information online say they have changed their personal behavior because of the information they encountered.[4] Internet health searches also cause teens and young adults to consult with a doctor, parent, or friend. More than half (53%) of 15–17-year-old health information seekers have talked with a parent or other adult about health information they saw online.[5] The Internet also serves as a resource for parents seeking health information for their children. Parents are more likely than nonparents (65% versus 50% respectively) to have dedicated their last online health search to someone else's health needs.[6]

One emerging and promising function of the Internet in health care is using e-mail to correspond between patients and doctors. While the research has found that only 7% of respondents said they exchanged e-mail with doctors, almost all of these e-mailers said their electronic correspondence with their physicians was useful to them.[7] Respondents said e-mail communication between patients and doctors can overcome geographic distance, facilitate ongoing, nonurgent communication, and remove the adversarial nature of some medical discussions.

As we will see in the case study and empirical research below, using ICT in health care for children, youth, and their families involves employing computers and the Internet to target specialized health information online, manage chronic health conditions, and positively alter youth health behavior.

Case Study:

MANAGING CHRONIC HEALTH CONDITIONS IN CHILDREN

New ICT tools are emerging that hold the potential to greatly improve the quality of life for children living with a chronic illness such as asthma. Asthma and other chronic illnesses in children are some of the most frequent causes of school absenteeism.

The findings from one experiment found that using the Internet to enable children to monitor their asthma symptoms and send the information to health care providers resulted in a 48% reduction in limitations in activity compared to a control group that monitored their condition using a written diary.[8]

In this demonstration program, inner-city children used an electronic asthma self-management and education program designed to enable children to assess and monitor their asthma symptoms and transmit the information to health care providers through a secure Web site. After adjusting for other variables, this group of about 70 children were less likely to have limitations in activity due to their asthma and less likely to experience a battery of asthma-related difficulties. Compared with the written asthma diary, monitoring asthma symptoms using electronic means increased self-management skills and improved asthma outcomes significantly among the children tested.

The electronic device tested in this research project is connected to a home telephone and can be programmed to present questions and information on a screen and to record responses. Using a standard Internet browser, the nurse coordinator sends a set of queries each day that the patient answers by pressing one of four buttons. The questions are tailored for children and designed for a third-grade reading level.

Although this was a small and short-term randomized trial involving 134 children monitored over three months, the outcome points to an important role for Internet communication in terms of improving the quality of life for children with chronic diseases. Other ICT tools to manage different chronic illnesses are now entering the market, and research in the near future should also be able to assess their effectiveness in ensuring the well-being of children with limiting health conditions. These tools also have the potential to positively impact health care utilization and cost.

Examples of ICT's Potential to Improve Health

POTENTIAL OF "INFORMATION PRESCRIPTIONS" TO GUIDE PARENTS TO RELIABLE HEALTH INFORMATION

Given that serving as an information source is one of the key functions of computers and the Internet in health, making Internet health searches more efficient and effective will have broad impact for parents and children. One way in which this is being done is through "information prescriptions." Information prescriptions (IPs) are "prescriptions of specific, evidence-based information to manage health problems."[9] Typically, they are given by physicians in order to direct patients to reliable information about health care conditions and issues.

A study led by doctors and researchers from Iowa sought to determine whether a pediatrician-provided IP would change parents' attitudes and behaviors about using Internet health information. The research team conducted a randomized controlled trial of 200 parents who were visiting an academic general pediatric practice. The intervention group in the trial was offered computer training and received an IP for specific Internet sites that contained reliable and specific pediatric information.

The study findings indicate that 66% of the Internet information resources sought by the intervention group of parents were prescribed by pediatricians. Thus, IPs were associated with health information seeking that was targeted to reliable information on the Internet. Having parents' Internet health searches guided by physicians enhanced the effectiveness of the Web as a source for pediatric health information. Since parents of children in pediatric practices frequently use the Internet for general and children's health information, the use of IPs by physicians can give parents more relevant and reliable information that may also lead to better patient outcomes.

POTENTIAL OF WEB SITES TO LINK FAMILIES AND PHYSICIANS IN PEDIATRIC INTENSIVE CARE UNITS

Information sharing and searching involving parents and physicians is particularly relevant when children are in intensive care. Our review of the research shows that the use of interactive Web sites in pediatric intensive care units (PICU) can help family members share information and facilitate physicians' communication with other doctors and family members who might not be able to remain bedside with children admitted for long stays in hospitals.[10]

The research cited here, which involved 78 patients admitted to a PICU at a children's hospital in Portland, Oregon, found that 77% of surveyed family members and friends thought that Web-based communication helped them share information. Furthermore, 73% of physicians thought that Web-based communication was easier than conventional methods of conveying patient information.

More than half (54%) of physicians involved in the research said they were more likely to refer patients to that particular PICU because of the Web-based communication. Researchers noted that Web-based communication in PICUs is particularly relevant because of the absence of PICUs in most communities. The hospital featured in this study was the only tertiary care academic children's hospital in the state. Therefore, more than half of the patients in the hospital are transferred from outside Portland, some from distances of up to 500 miles away. As the researchers note, the impact of such great distances separating the child from family and friends is "substantial."

This Web-based link for PICU patients was established in 1999 and was the only one in the nation to serve both patients' families and their physicians. The findings prompted the research team to suggest further research on Web-based PICU communications in other hospitals in order to more rigorously assess their medical and economic impact on patients and physicians.

POTENTIAL OF COMPUTER-BASED CONTRACEPTIVE DECISION AID TO HELP ADOLESCENTS

Medical and health care researchers have found that computer decision aid programs have the potential to impact contraception decisions and reduce pregnancies among adolescents. One study involved a year-long evaluation of computer-based contraceptive decision aids among 949 teenage young women in Chicago, Illinois and Madison, Wisconsin.[11]

The Aid for Contraceptive Decision-Making Program (ACD) employed in this study is intended to help patients become more informed about their medical choices, treatment alternatives, and the risks and benefits of each. The program allows patients to learn about as many methods of contraception as they wish in a session. The program demonstrates how the contraceptive method is used and how it works. It also graphically presents the method's effectiveness and helps patients assess their personal characteristics and situation, among other services related to learning about contraception. A print-out of all the information is provided to the patient at the end of the session.

Use of this interactive program by young women resulted in improved short-term knowledge and confidence in oral contraceptives. Furthermore, the Madison group had higher oral contraceptive knowledge one year after the initial visit with researchers and a trend for fewer pregnancies. The research team concluded that the findings "suggest the usefulness of informatics tools as a supplement to patient-provider interactions."

Researchers stated that computer-based interventions conduct routine assessments and basic education, freeing clinicians for unique problem-solving and support needed by the patient. They also found that the interactive information program is particularly helpful with health issues such as contraceptive education because adolescents are more comfortable receiving sex education from computers where they can keep the issue private. Studies show that adolescent girls admitted engaging in specific sexual behavior 75% more often to a computer than in face-to-face or written interviews. Furthermore, computer graphics allow patients to view a contraceptive method and how it works, and sophisticated computer software allows the program to tailor its interaction to each user based on his/her previous responses.

POTENTIAL OF ONLINE GAMES TO IMPROVE CHILDREN'S DIETARY HABITS

Technology also has the potential to motivate young people to have healthier lifestyles. Current research shows that multimedia computer programs have the potential to substantially change dietary behavior, now a critical health problem in American life. Research reveals that the use of a particular computer nutrition-education game among 1578 elementary school students in Houston, Texas led to increased consumption of fruit, 100% juice, and vegetables (FJV) compared to a control group of students not receiving the program.[12] The consumption of FJV has been shown to lead to a variety of positive health outcomes including: "greater longevity, some level of protection from several cancers, [and] heart disease."

The interactive nutrition program uses a storyline to teach children about good dietary habits and how to implement them in their lives. The intervention group of children was exposed to 10, 25-minute sessions of the program over five weeks in which they were encouraged to set goals to eat more FJV servings at a meal or as a snack, and to ask for his/her favorite FJV to be more available at home.

After five weeks, the group using the program ate more fruit, juice, and vegetables than children not in the program. The change in FJV consumption in this study is the second-largest in the literature. Researchers state "it appears that the fun aspect kept the attention of the students and may have facilitated the change."

The strengths of this research include a large sample of schools and students, a mixed ethnic and socio-economic background of students, and minimal differences in FJV consumption at baseline measurement. While the study did not ascertain if the intervention group of children maintained their improved eating habits after the end of the experiment, the researchers concluded that the measurable positive impact at least merits further research on the effectiveness of such computer-based multimedia games.

POTENTIAL OF COMPUTERIZED PHYSICIAN ORDER ENTRY TO REDUCE MEDICAL ERROR

Research in a pediatric critical care unit (PCCU) concluded that the use of computerized physician order entry (CPOE) reduced medication errors and adverse drug events for children when compared to traditional means of prescribing and administering medication.[13] Among these traditional medication orders, an average of 2.2 adverse drug events (ADEs) occurred for every 100 orders. Medication prescribing errors (MPEs) occurred at a rate of 30.1 per 100 orders and rule violations (RVs) at a rate of 6.8 per 100 orders. Researchers note that the process of prescribing medications for critically ill children is complex and lacks standardization, which can increase the risk of medication errors and adverse effects.

A trial use of CPOE was implemented with 514 pediatric patients who were admitted to a 20-bed PCCU in a tertiary-care children's hospital. A total of 13,828 medication orders were reviewed both before and after CPOE was implemented. After CPOE was implemented, errors were reduced by 96%. Specifically, adverse drug events were reduced by 41%, medication prescribing errors were reduced 99% and rule violations were reduced by 98%.

The research directors of this study concluded that the implementation of CPOE "resulted in almost a complete elimination of MPEs and RVs and a significant but less dramatic effect on potential ADEs."

POTENTIAL OF TELEMEDICINE TO IMPROVE THE QUALITY OF SPECIALTY CARE FOR CHILDREN IN RURAL COMMUNITIES

Researchers analyzing the impacts of a telemedicine program in a rural, underserved community in Northern California found that all the families of 55 children with special health care needs rated the program as either "excellent" or "very good." The rural providers rated the program in similar terms.[14] The telemedicine connection uses live, interactive video and audio and a peripheral patient examination camera. For each telemedicine consultation, the child, the child's parent, the referring health care provider and the sub-specialist participate in the entire encounter.

Prior to the implementation of the telemedicine program, research identified several barriers in access to sub-specialty care for families in this community. The barriers include: traveling for appointments, missing work for appointments, and relying on emergency department services for their child's medications. Although this study did not measure how the telemedicine program actually reduced these barriers, patient and physician satisfaction measures point to the program having an impact on improving care for children with special health care needs in rural communities. The research study concludes that, based on the positive results from families, "telemedicine should be considered as a means of facilitating care to [children] … that relative to the customary delivery of health care is more accessible, family-centered and coordinated among patients and their health care providers."

POTENTIAL OF ELECTRONIC MEDICAL RECORDS TO IMPROVE THE QUALITY OF PEDIATRIC CARE

Researchers in Boston found that electronic medical records (EMRs) improved the quality of care in an urban pediatric primary-care center.[15] A post-intervention analysis was used in the study that compared an intervention of pediatric EMRs with paper-based records. Routine health care maintenance visits for children under five years old were reviewed, and documentation during pre-intervention (paper-based) and post-intervention (computer-based) was compared.

A total of 235 paper-based visits and 986 computer-based visits met the study criteria. Researchers found that computer-based clinicians were significantly more likely to address a variety of routine health care maintenance topics including: diet, sleep, psycho-social issues, smoking in the home, and a variety of other topics.

Users of the EMR system reported that it had improved the overall quality of care delivered, was well accepted by families, and improved guidance quality. However, five of seven users reported that eye-to-eye contact with patients was reduced, and four of seven reported that use of the system increased the duration of visits by an average of 9.3 minutes. All users recommended continued use of the electronic system. Researchers concluded that the use of EMRs was associated with improved quality of care.

II. EDUCATIONAL ACHIEVEMENT: POTENTIAL IMPACTS OF INFORMATION AND COMMUNICATIONS TECHNOLOGY

- *78% of online youth ages 12–17 say they believe the Internet helps them with school work.*[16]
- *79% of college students agree that Internet use has had a positive impact on their college academic experience.*[17]

The impact of technology on children's educational achievement is the most researched of all our areas of analysis. There are several large-scale, longitudinal studies on the impacts of technology interventions with students at different grade levels. More studies are currently in progress and should be available in the near future. While there is still significant debate, the consensus is that, if implemented correctly, computers and the Internet can improve children's learning as measured by a variety of academic achievement measurements. While it is challenging to isolate and measure the impact of technology in education, increasingly researchers are employing sound and sophisticated methodology to determine the role technology plays in children's learning.

The key for educational technology to make a difference is not just providing students with access to ICT, but integrating it properly into the classroom by using the appropriate applications at different grade levels, training teachers, and blending technology into teaching traditional academic subjects. If technology programs are not endowed with these characteristics, educational technology can have a negligible or even negative effect on education outcomes.[18]

When educational technology programs are designed with this in mind, research suggests that ICT skills and access have the potential to help students achieve better grades, increase scores on standardized tests, and increase school attendance. National survey findings from the Pew Internet & American Life Project support this view, with both students and parents lauding the role of computers and the Internet in education. A 2001 Pew survey found that parents and online young people believe that Internet use helps them at school.[19] More specifically, 87% of parents of online young people believe the Internet helps their children in school, and 94% of youth ages 12–17 who have Internet access say they use it for school research. Following, we review evaluated research on the impacts of educational technology on children and young adults.

Case Study:

THE WEST VIRGINIA BASIC SKILLS/COMPUTER EDUCATION TECHNOLOGY IMPLEMENTATION PROGRAM

The West Virginia Basic Skills/Computer Education (BS/CE) research project is one of the early seminal pieces of research on successfully using technology in education.[20] Although the project is somewhat out of date (it ended in the late 1990s), its large sample size and rigorous research methodology are rare in the field. This study is also significant because it demonstrated that the use of computers in the classroom generated significant gains in reading, writing, and math; was particularly successful with low-income, rural, and female students; and was highly cost-effective when compared to other popular education interventions.

The eight-year project started during the 1990–91 school year. Researchers collected data from 950 elementary school students in 18 West Virginia schools who were given enough computer equipment so that classrooms serving the targeted grade cohort would have three or four computers, a printer and a school-wide networked file server. As the 1990–91 kindergarten class advanced in grades, so did the successive waves of new computer installations combined with professional development for teachers.

Starting in the kindergarten class of 1990–1991, the BS/CE program provided:

- Software that focuses on basic skills in reading, language arts, and mathematics;
- Computers so all students can have easy access to the basic skills software; and
- Teacher training on the use of computers and the basic skills software.

The researchers' emphasis was on measuring "basic skills" as determined by performance on the Stanford-9 achievement test. Using regression analysis, researchers found that the technology intervention described above accounted for 11% of the total gain in basic skills achievement scores. This increase is particularly relevant considering that education research experts claim that only 30% of the variation in test score performance can be influenced by schools (the other 70% related to family and other background factors). Seen from this perspective, the impact of the technology intervention accounts for one-third of the total variance possible through school interventions.

Perhaps the most promising aspect of the project is that it had the greatest impact on scores for previously lower-performing students. While BS/CE helped all children perform better, it helped students with lower grades the most. Furthermore, since current ICT is much more powerful than the technology implemented in this study, researchers stated that a similar intervention using today's technology is likely to yield even larger achievement gains.

Examples of ICT's Potential to Improve Educational Achievement

POTENTIAL OF MULTIMEDIA TECHNOLOGY TO IMPROVE STUDENT PERFORMANCE

Missouri's Instructional Networked Teaching Strategies (eMINTS) program integrates multimedia technology into student-centered, interdisciplinary, collaborative teaching practices. The program was started in 1999 using a combination of local, state and federal funds. The core goal of eMINTS is to "create learning experiences that engage young learners in new ways." There are approximately 800 eMINTS classrooms in grades 3–6 in rural, suburban, and urban settings throughout the state. More than 20,000 teachers and children are involved in eMINTS in 218 districts (out of a total 524).

eMINTS classrooms include a wide array of multimedia technologies including one Internet-connected computer for every two students, teacher laptop and workstation computers, scanners, printers, digital cameras, and other ICT tools. The instructional model is inquiry-based, collaborative and multidisciplinary. eMINTS teachers also receive more than 250 hours of professional development over a two-year period. Professional development sessions are followed by in-classroom visits and support from instructional specialists.

An external evaluation of the eMINTS program demonstrated positive changes in teaching practices, student attitudes and performance on statewide tests. In 2004, an annual evaluation of the eMINTS program demonstrated that 35% of second-year program students scored at the proficient level of the state's Communication Arts test compared to 31% of non-eMINTS students. Analyses also showed small, but significant positive impacts on statewide mathematics scores for eMINTS students.[21] Analysis of the Communication Arts state test scores shows that students that spend more time in eMINTS classes outperformed other students.

POTENTIAL OF IMPROVED COGNITION AMONG PRESCHOOL-AGE CHILDREN

Research suggests that ICT can impact children's education as early as preschool.[22] Experts in early childhood education have found that "early computer exposure before or during the preschool years is associated with development of preschool concepts and cognition among young children." These findings were developed from a study that examined 122 preschool children enrolled in a rural Head Start program.

The study measured the presence of a computer in the home and children's software programs on school readiness and cognitive development while controlling for children's developmental stage and family socioeconomic status. Researchers concluded "children who had access to a computer performed better on measures of school readiness and cognitive development, controlling for children's developmental stage and family socioeconomic status."

POTENTIAL OF HANDHELD COMPUTERS AS AN EDUCATIONAL TOOL

One large-scale evaluation found that one of the newer ICT devices—handheld computers—holds potential as a tool for improving student success.[23] The evaluation is based on a program involving teacher-designed and teacher-implemented use of handheld technology in classrooms across the United States in grades 2–12. Assessments of the effectiveness of the handheld technology were determined through the completion of several hundred questionnaires by teachers, after integrating the technology into their classrooms. While not based on measured outcomes, the results point to the potential of such technology for students.

Some of the findings from the study include:

- About 90% of teachers stated that the handhelds are an effective instructional tool that have the potential to positively impact students' learning and that they will continue to use them in the future; and
- Approximately 85% of teachers state that handhelds can improve the quality of learning activities and can have a positive effect on their teaching practices.

POTENTIAL OF COMPUTER OWNERSHIP AND EDUCATIONAL ATTAINMENT

Educational technology research in England found a positive association between home computer ownership and educational attainment among 15–17-year-olds in British schools.[24] Researchers used British government survey data and controlled for other variables that might influence education outcomes in order to isolate and understand the connection between computers and educational attainment. The statistical analysis included controls on individual, household, and geographic variables that could have influenced the measurement of computers and attainment. After implementing these statistical controls, researchers identified a link between more frequent use of computers and educational performance. The authors state "these findings suggest that the PC effects we observe may reflect a direct role of PCs in the educational [growth] for teenagers."

POTENTIAL OF HOME COMPUTERS AND INCREASED SCHOOL ENROLLMENT

Recent analysis of 2001 Current Population Survey data reveals that access to home computers increases the likelihood of school enrollment among teenagers who have not graduated from high school.[25] A comparison of school enrollment rates reveals that 95% of children who have home computers are enrolled in school compared to 85% of children who do not have home computers. Using a model measuring the probability of school enrollment with owning a computer shows that access to a home computer can increase school enrollment for teens by about 8%.

POTENTIAL OF PREPARING STUDENTS FOR COLLEGE AND THE WORKPLACE

In October 1998, Boston Public Schools became the first major urban school district to build high-speed technology networks in each of its school buildings and public libraries. Boston Digital Bridge Foundation (BDBF) programs such as Technology Goes Home provided access, training, content, and curriculum through public schools and neighborhood collaboration.[26] Furthermore, it offered student graduates and their families new computers, printers and Internet access for less than $15 per month. This equipment offer was conducted through a special guaranteed loan program with no interest and no down payment.

A formal evaluation found that the program had measurable impacts on increasing youth's opportunities.[27] Some of these impacts include:

- Enhanced employment opportunities—95% of participants made significant improvements in their computer skills; and
- Approximately 80% of graduates go on to college versus the district average of 65%.

The Debate Around Educational Technology

Although research has shown the benefits of educational technology for students, as mentioned at the outset, some experts claim that technology in the classroom is not always beneficial. There are those who claim that the infusion of technology in the classroom has been excessive and—at times—has come at the cost of traditional learning practices that are more effective and less costly.[28] Education experts such as Stanford professor Larry Cuban claim that educational technology aims for enhanced instruction, but does not help to the degree technology promoters promise.[29] Although Cuban is a skeptic regarding educational technology, his main criticism is not that technology cannot increase educational achievement, but that the lack of a strong research base precludes an objective way to judge the impact of technology. According to Cuban, there is "no body of serious research to measure whether technology will achieve its own goals—whether it can help in areas such as intellectual development."

The voice of these critics underscores the need for more high-quality research regarding educational technology so that the extent of its impacts on children and young adults will be clear to those on both sides of the debate.

III. ECONOMIC OPPORTUNITY: POTENTIAL IMPACTS OF INFORMATION AND COMMUNICATIONS TECHNOLOGY

- *Three of the 10 fastest-growing occupations through the year 2012 are computer-intensive.*[30]
- *The percentage of U.S. workers using computers at work has increased from 25% in 1984 to 56% in 2001.*[31]

The Organization for Economic Cooperation and Development—an international organization promoting democracy and a market economy—states that innovations through information technology "are transforming the way in which economies, and the people within them, are working."[32] These changes include: the shift in labor toward workers capable of using new technologies and the migration of job search and recruitment activities to the Web. The U.S. Bureau of Labor projects that three of the 10 fastest-growing occupations through the year 2012 are computer-intensive and several others are related to ICT skills and infrastructure.[33]

Common sense tells us that computers, the Internet, and their many applications are growing parts of our economy. The economic need for proficiency with technology begins with conducting job searches and submitting employment applications online and expands to building a repertoire of technology skills that are increasingly essential in technical and nontechnical careers. Although anecdotal evidence reveals that children will need ICT skills to enter and advance in the workforce, social science research has produced few direct measures of how ICT skills increase career opportunity and income. The research base on this topic is very thin and is fertile ground for future academic investigation.

In spite of the scarcity of research on the link between computer skills and career success, business, government, and academia concur that ICT know-how is an indispensable part of 21st century skills. These are skills that are necessary to ensure long-term employment for individuals and continued economic competitiveness for the nation.

Case Study:

TECHNOLOGY ACCESS FOUNDATION'S TECHNICAL TEENS INTERNSHIP PROGRAM

The Technology Access Foundation (TAF), founded in 1996 by former Microsoft employee Trish Millines Dziko, delivers technical and workforce development training to Seattle's low-income communities.[34] Among the Foundation's various programs is the Technical Teen Internship Program (TTIP). This is a four-year, after-school, technology-training program where students attend classes six hours per week for eight months and work during the summer in paid internships where they further develop their technology skills.

The intensive program offers four tracks: Web development, network engineering, media production and programming. Each year builds on the skills learned the previous year. For every year a TTIP student successfully completes the training and internship, he or she is awarded a $1,000 scholarship toward higher education. Internships are offered in companies such as Microsoft and RealNetworks.

According to Foundation statistics:

- 85% of students in the program finish the required courses; and
- 95% are hired for internships.

The TTIP program has served over 250 students ages 14–18 since 1997, and has led to a variety of full-time, technical career opportunities for program graduates who otherwise would not have had access to technology skills training in their communities. One student, after performing several successful internships at United Parcel Service (UPS), was given a scholarship for college and then offered a full-time UPS technical position. Many other students have similarly parlayed their experience at TAF to succeed in higher education and, subsequently, to find technology-related jobs in a variety of companies.

Examples of ICT's Potential to Improve Economic Opportunity

POTENTIAL OF PROVIDING AT-RISK YOUTH WITH MARKETABLE CAREER SKILLS

In California, a community-based demonstration project, Pathways to Our Future, provided at-risk youth with training in marketable technology and multimedia skills through classes taught at community technology centers.[35]

The classes taught technology skills relevant to today's economy and included: Web site development and graphic design, digital photography and imaging, video production, and music creation. Some of the specific computer skills taught in the program include PhotoShop, Dreamweaver, HTML, and Final Cut Pro. The nine sites chosen for this program also used project-based learning methods that supported students as they carried out projects of value to the community or a local business.

In addition to the technology skills training, the 167 students in the program also learned how to search for a job, write a resume and cover letter, interview for a job, and find career opportunities in the technology sector. Many of the programs included internships so that students could practice their acquired technology skills in the workplace. At the end of the program, students demonstrated their proficiency in multimedia skills by creating a portfolio and completing an internship or community service project. Students demonstrated their proficiency in these skills through the development of Web sites, slide presentations, videos and digital portfolios.

An assessment of the program found that students:

- Acquired marketable technology and multimedia skills;
- Learned how to look for and apply for jobs;
- Secured internships or jobs through the program;
- Considered college or a career in the multimedia field;
- Grew in maturity and self-esteem; and
- Increased their community involvement.

POTENTIAL OF ICT SKILLS FOR FINDING LONG-TERM EMPLOYMENT

Private industry and the public sector have championed the teaching of 21st century skills in order to prepare youth for an increasingly competitive labor market. Technology literacy is a key component, as more jobs require greater facility with ICT. The Partnership for 21st Century Skills, a national group of industry leaders, reports: "Students need to learn how to use technology intelligently, creatively, and ethically to accomplish intellectual pursuits."[36]

Providing ICT access and skills to today's youth is an advantage in the job market. As one report states, "… the ICT sectors of the economy have grown and… a majority of workplaces have come to use computers and the Internet as normal operating technologies." The share of U.S. workers using the Internet at work increased from 17% in 1997 to 41% in 2001, and the share of workers using computers has increased from 25% in 1984 to 56% in 2001. The long-term trends indicate that ICT access and ability will impact youth's success in finding long-term employment over the span of their working lives.[37]

POTENTIAL OF JOB SEARCHES ON THE INTERNET

ICT skills are not only important for youth once they are on the job. The use of the Web to post job openings and receive employment applications has made computer and Internet skills an important part of conducting a thorough job search and submitting applications. ICT skills can help young adults enter the workforce before they even walk in the door of a potential employer.

Labor market research reveals that in 2001 half of unemployed Americans with home access used the Internet for job searches and recruitment.[38] Employers have found the Internet to be an effective source for job postings. In 2001, all but one of the top 20 *Fortune 1000* firms advertised jobs on homepages and allowed for online application. This propensity for Internet job postings is due to lower transaction costs. Researchers note that the eight largest job boards in the U.S. drew some 1.8 million unique visitors and charged an average of $98 for each vacancy filled. By contrast, the eight largest newspapers with Sunday circulation of 1 million readers charged $3,840 for placing a 30-day advertisement.

POTENTIAL OF MORE JOBS AND HIGHER WAGES FOR YOUNG ADULTS WITH ICT SKILLS

Between 2000 and 2010, there are projected to be more than 2.5 million new jobs for IT professionals.[39] For young people fortunate enough to work in the information technology sector, the average wage is often twice the average overall private-sector industry wage. Bureau of Labor Statistics figures from 2004 show that computer software programmers earn an hourly wage of about $38 compared to the overall private-sector wage of about $16. Computer systems designers' hourly earnings of $31 also compare well with the average private-sector hourly earnings. [40]

IV. COMMUNITY AND CIVIC PARTICIPATION: POTENTIAL IMPACTS OF INFORMATION AND COMMUNICATIONS TECHNOLOGY

- *Among young people ages 12–17 with Internet access, 38% go to a Web site where they can express opinions about something.*[41]
- *Among young people ages 12–17 with Internet access, 39% go to a Web page for clubs, groups, or teams where they are members.*[42]

There has been no large-scale quantitative assessment of the extent to which youth are impacted by political and civic-oriented Web sites. Therefore, the question of the impact of technology on youth civic participation is still largely unanswered.

Although there is a lack of data on the impacts of ICT on youth civic participation, studies suggest that ICT holds potential to increase youth's community involvement and engagement. Some research touches upon the potential of ICT to impact youth's civic and political participation. Much of this research is not exclusive to youth and includes adults. Therefore, in addition to research focused exclusively on youth, we cite other relevant data on adults that has implications for youth civic engagement.

Research shows that the Internet can serve as a way to increase group decision-making and action among neighbors. It can also open the policy-making process to individuals and groups that previously were not included or involved. Computers and the Internet can also make government and public officials and services more accountable and accessible to adults and youth alike.

But the potential of ICT to enhance community involvement and civic participation has not been seriously explored. Researchers examining content on 177 youth engagement sites on the Web found that "the potential of the Web… has not been developed. At present, young people cannot travel easily in the political Web sphere."[43]

The following review examines the most promising research on how ICT is being used to increase participation in civic affairs and contact with government.

Case Study:

INCREASED CONTACT WITH GOVERNMENT AGENCIES VIA ONLINE DISCUSSION

Research by investigators at the U.S. Department of Transportation and the University of Southern California found that Web-based discussions on public policy and political issues can extend opportunities for participation and attract more new voices than traditional means of soliciting public input, "thereby changing decision-makers' information environment."[44]

In this case study, researchers from the Department of Transportation solicited public input on a long-term strategic plan involving the Federal Motor Carrier Safety Administration (FMCSA). Researchers used a traditional docket for written comments typically employed for these discussions and compared it to an experimental Web-based discussion run in parallel with this traditional docket. This use of technology created a natural experiment with the control group consisting of users of the traditional docket and the intervention group consisting of those who lent their voices to the Web-based discussion.

Researchers found that 78% of the messages submitted to the conventional docket were from groups that typically lent their opinions on such discussions. These groups included local, state, and governmental bodies, industry, and trade associations. Only 15% of comments to the traditional written docket were from nonstandard participants and only 5% from commercial drivers. The messages submitted to the Web discussions, on the other hand, were more diverse. Much of the participation in the discussion (57%) was from nonstandard participants, and 20% of the messages came from individual commercial drivers. Researchers stated that the participation of individual drivers was particularly significant because they were unlikely to provide comments to the traditional docket, yet they were a group that is directly affected by the strategic plan.

The researchers concluded that the Web-based discussion "attracted input from stakeholders who typically do not meet or discuss commercial vehicle safety issues with regulatory authorities. The tone and approach of these messages suggest that many were written by political neophytes with no experience contacting officials."

Examples of ICT's Potential to Improve Community and Civic Participation

POTENTIAL OF GOVERNMENT WEB SITES AS A SOURCE OF INFORMATION AND TO OBTAIN SERVICES

Research indicates that Internet users are increasingly visiting Web sites in order to initiate contact with federal, state, and local government. One study in Georgia found that Web sites appear to have become a major new form of the traditional citizen-initiated contact with government.[45]

Using a phone survey of adults, researchers found that 38% of online Georgians visited a government Web site. While 64% of those who visited a Web site said they did so in order to obtain information, about one-third went online to request a service (38%) and 32% visited the site to express an opinion.

Given that youth must interact with the government for a variety of services such as obtaining a driver's license, the increased use of Web sites among adults as an alternative means to interact with government suggests a similar civic and community use for teens and young adults. The study found that 68% of visitors to Web sites in the survey rated the sites as good or excellent. Almost all respondents who had visited government sites said they planned to return to the Web site in the future.

While this research represents the beginning of attempts to ascertain adults' use of Web sites for e-government and civic participation, there has been no research to date on how youth interact with these sites. This is a promising area for scholars seeking to understand youth's use of ICT to engage government and increase political participation.

POTENTIAL OF INTERNET USE AND INCREASING THE LIKELIHOOD OF VOTING

Researchers investigating the effect of Internet access on voting propensity found that, after holding other factors constant (race, income, age, etc.), Internet access increased the probability of voting by 7% in the 1996 presidential election and 13% in the 2000 presidential election.[46]

In this study, researchers stated that "the Internet and online election news appear to provide an important source of information, potentially mobilizing new voters to participate in elections." They found that this impact transcended race and was more relevant to high-visibility presidential elections than off-year elections. While not a panacea for disenfranchised or civically uninvolved populations, researchers concluded that the Internet is a new medium for political information and communication. Although this study dealt with those ages 18 and over, it supports the notion that exposing children and youth to the civic network on the Web has the potential to increase the likelihood of voting among young people.

POTENTIAL OF YOUTH CIVIC CULTURE ON THE INTERNET

Researchers have documented hundreds of Web sites created to encourage and facilitate youth civic engagement, part of an Internet sector researchers call "youth civic culture."[47] This expanding segment of the Internet includes sites maintained by nonprofit organizations, government, private-sector initiatives, and individual efforts that range from local to international in scope. There are also an increasing number of Web logs or "blogs" created by young people on which they can comment on the issues of the day.

Given this foundation of Internet sites aimed at motivating youth to greater civic participation, researchers and experts believe that the Web's capacity to increase interaction with others in a range of contexts, and increase flexibility on how and when information is accessed, results in the *potential* to engage young people more deeply in their local community.

Nevertheless, as mentioned above, there is much research that needs to be conducted in order to assess the extent of young people accessing civic participation and government sites on the Internet to obtain information and conduct services and transactions. As researchers on young people's use of the Internet have stated "whether the relationships forged in online communities translate into the same kind of social capital as those forged offline, however, is still unclear."

POTENTIAL OF THE INTERNET AND ENHANCED "NEIGHBORING"

Research based at the Massachusetts Institute of Technology (MIT) found that "high-speed, always-on access to the Internet, coupled with a local online discussion group, transforms and enhances neighboring."[48] Investigators found that the Internet supports increased contact and neighborly ties that facilitate community discussion and mobilization around local issues. These conclusions were based on a three-year study of an experimental "wired suburb" near Toronto that was given a series of information and communication technologies. The research was published in a number of scholarly journals, and findings were based on survey and ethnographic data.

The community was given a high-speed Internet network and ancillary services free of charge in order to facilitate the research. The experiment was conducted from December 1996 to January 1999. In order to test hypotheses on the role of ICT in communities, researchers asked participants to identify neighbors whom they knew by name, talked with on a regular basis and visited in the past six months. When controlling for other variables, researchers found that being wired is most important for recognizing neighbors by name, less so for talking with neighbors, and not at all significant for visiting neighbors. Researchers noted that although ICT was not associated with "strong" ties between neighbors, the "weak" ties supported by ICT are important for accessing information and resources, linking groups, and providing social identities. Project researchers found that computer-mediated communication can also serve as an important tool for community involvement and organizing.

Conclusion

The relevant research now aggregated in one place through this report provides a starting point from which to monitor progress in providing digital opportunity, begin applying early lessons to practice and policy, and develop the next generation of needed research. Still, there are considerable limitations to the research base that exists today that need to be addressed. What is known is often based on research involving small numbers of people for short periods of time, sometimes focused on adults and not children, and in many cases does not address some of the most important questions. In order to strengthen the research base, the next generation of research needs and goals should be defined so there is a wise research agenda to fund and implement.

See *Measuring Digital Opportunity for America's Children: Where We Stand and Where We Go From Here* for The Children's Partnership's recommendations for developing a long-term research agenda.

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