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LONG PAPER

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Closing the digital divide: understanding racial, ethnic, social class, gender and geographic disparities in Internet use among school age children in the United States

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Abstract The purpose of this study is to explore the dynamics underlying disparities in Internet use among school age children in the US. The analysis found that a broad range of demographic, geographic and economic factors significantly influence Internet use among children. Significantly, the availability of household computing resources and adult Internet users in the household were most important in explaining disparities in use among children. To expand universal Internet access, future public policy should focus on providing support for in-home access; continued support for public access at out-of-home locations such as schools, and providing technical support, training and expertise to school age children.

Keywords Universal Internet access · Workplace capital · Household computing resources and expertise · School age children

1 Introduction

If a society is to continue to grow and remain viable for continuing socioeconomic change in the Information age, its citizens must be conversant in computers and communication technologies. Children, in particular, on whose future most societies rest, must be able to access, understand, and use the computer and Internet in order to develop the skills necessary to succeed individually and to contribute to future growth and prosperity of the Information society. More than ever, children need to acquire the basic skills of reading, writing and basic mathematics that comprise the building blocks necessary in order to acquire good jobs. As the number of unskilled jobs in society continues to shrink, there is a growing urgency to make sure that all children have these core skills [38, p 18]. Many believe that computing technologies can play a significant role in helping society achieve this end in new ways, by addressing the unique aspects of individual learners, although there are constraints such as the costs of developing and distributing good educational software [38, p 18].

However, in spite of tremendous progress in the rate of Internet access across the USA, a digital divide still exists, and in spite of a good deal of existing research on the magnitude of the digital divide in society, much less is known about the reasons for existing gaps in Internet use, particularly among our children. Often, barriers to access exist that prevent many in society from accessing computers and the Internet. To address the question about how to provide access to all those unable to afford it, particularly among children, the nature of the discrepancy in Internet use must first be understood more clearly. It is critical that a society be able to identify and understand the factors that contribute to the disparities in Internet use among children, in order to form appropriate strategies to close them. The focus of this paper is on gaining a better understanding of the magnitude of the digital divide among school age children, as well as of the underlying factors that account for inter-group differences.

Understanding the dynamics of disparities in access to computer technology and the Internet among children is important for three principal reasons: (1), the

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effects on the education of children in the information society; (2), the ability to secure future careers in the information economy; and (3), the central role in helping the information society remain economically competitive. In addition, because education is crucial to master the technology of modern communication and information, access to new educational opportunities that teach the necessary skills required to become proficient in the operational technologies of the information society must be made available to young people very early in the education process. "Research has shown that 3- and 4-year-old children who use computers with supporting activities that reinforce the major objectives of the programs have significantly greater developmental gains when compared to children without computer experiences in similar classrooms - gains in intelligence, nonverbal skills, structural knowledge, long-term memory, manual dexterity, verbal skills, problem solving, abstraction, and conceptual skills" [21]. Moreover, as Mansell points out, in general, organizations around the world believe that education is critically important to economic development. Ultimately, organizations "tend to suggest that knowledge gaps are the greatest barriers to economic development" and they can be narrowed through "increased attention to education provision and skills development" [29, p 414].

Disparities in access to the Internet and computer technology may also have profound effects on career options. Currently, computer skills are important for many jobs in the service and trade sectors and most jobs in the finance, technology, and manufacturing sectors. Computer, engineering, and information technology jobs were among the fastest growing occupations prior to the most recent recession and the rapid decline of the dot com industry, according to the occupational projections of the USA. Department of Labor's Bureau of Labor Statistics (BLS, Employment Projections 1998–2008, 2000, March 14). Furthermore, according to the National Telecommunications and Information Administration (NTIA) and the US Department of Education, the level of education and Internet usage continue to be highly correlated (NTIA, 1999, July, pp 6–8).

This study examines the issue of Internet use among school age children from a more expanded perspective. In addition to reviewing the influence of socioeconomic factors, the contribution of household computing resources and expertise and the potential impact of school-based Internet resources are also considered. The paper builds upon work conducted by NTIA and other agencies.

Specifically, the analysis presented in the paper examines the independent and combined influences of individual and family socioeconomic characteristics, family resources, household computing resources and expertise, and school resources on Internet use among school age children. The principal questions that this paper attempts to address, are the following:

1. How are the demographic characteristics of children (i.e., gender and age) and the characteristics of their households/families (i.e., gender, race, ethnicity and citizenship status of household heads, geographic location, and household type) related to Internet use among school age children? This question involves examining the influence of an expanded set of individual and household characteristics, beyond those used in previous research, on Internet use among children. Specifically, the analysis is extended to include demographic characteristics of the head of a child's household, as well as characteristics of the child.
2. How are family characteristics and resources such as education, marital status, and family income, related to Internet use among school age children?
3. How does household computing resources and expertise, in the form of computers available in the home and in the form of adults in the home with computing expertise/experience (in the form of adult expertise), relate to Internet use among school age children? Prior research did not examine the potential role of household computing resources and expertise. An essential question addressed in this study, is whether these types of resources and expertise affect the Internet use of school age children beyond more standard measures.
4. How are public school computing resources related to Internet use among school age children? This question involves examining the influence of identified public school computing resources on Internet use among children. In this regard, a central question is whether school computing resources, provided to the public through the states, can help to close the digital divide for Internet use among school age children.

2 Literature review

Since the mid-1990's, the role of Internet as a principal information conduit and communications medium has grown rapidly in the United States. The rate of growth of household Internet access across the USA has increased at a rate of 20% per year since 1998 (NTIA, 2002, February, p 10). Schement argues that full-fledged access to a democratic society in the Information Age of the twenty first century requires every home to be equipped with at least a telephone and a computer with Internet access [36, p 8]. Although the rate of growth of Internet access in the US continues to rapidly increase, not everyone shares this access to the same degree [24 - p.2]. Current data show that Internet growth continues to occur at an uneven rate throughout society (NTIA, 2002, February, pp 1–7). There are still significant disparities in society, including children, between those with access to the Internet and those without access [2, 10, 14].

A view held by many is that Internet access is a basic human right, and writers and decision makers have been wrestling for some time with the question of whether everyone in society should have access to the Internet. Sawhney, for example, believes that every person in the USA has a right to these services by the mere virtue of being a citizen [35, p.378]. Blackman [6] claims that access to telecommunications services is a basic right of all citizens, and is a basic element of the right to freedom of expression.

However, observed instances of inter-group disparities throughout society run counter to this belief. Therefore, we begin by describing the principal factors of, and the dynamics associated to, existing disparities in Internet access in society, particularly among school age children. This is followed by a discussion of underlying barriers to Internet access and use by children, including the cost of computing technology and education.

2.1 Existing disparities in Internet use in society

What are the major discrepancies in Internet use in the American society and are they similar to those experienced among children? It is believed that disparities in Internet use among school age children follow a pattern similar to that of adults, although Internet use across all age groups in society is highest among the older youth. It is well known that broad factors such as economics, fairness, and cost along with more specific factors such as age, race, geographic location, education, income, and home computer access influence the nature and scope of observed gaps in Internet access and use in the USA (NTIA, 2002, February).

A 2002 NTIA study found that age is an important factor affecting Internet use. A significant inverse relationship between Internet use and age exists among adults. A sharp decline in Internet use by age from 18 to 49 years of age (64.5%), to only 37.1% for persons over 50 was reported (NTIA, 2002, February, p. 28). By contrast, the study found very little difference in Internet use among males and females, with 53.9% of males in the study using the Internet compared with 53.8% of females (NTIA, 2002, February, p. 28).

Considerable progress in the rate of computer and Internet use by race has been reported to take place since 1997. However, differences in computer and Internet use continue to exist across racial categories. Whites, Asian Americans and Pacific Islanders continue to exhibit higher rates of Internet use than African Americans and Hispanics (NTIA, 2002, February, p 21, 26–27). Nearly two-thirds of Asian Americans, Pacific Islanders and Whites (about 60.0% each) reported that they use the Internet, while Internet use rates for both African Americans (39.8%) and Hispanics (31.6%) were significantly lower, although their growth rates were faster (NTIA, 2002, February, p 21, 26–27).

Household residence continues to be a significant indicator of Internet use. Internet use rates among people who live in non-central city urban locations were highest (57.4%) while strong growth rates were reported among those living in rural households (24%, annualized since 1998) and central city urban households (19%, annualized since 1998) (NTIA, 2002, February, p 20, 28–29).

Education and income continue to be major determinants of Internet use among individuals. Internet use remains strongly correlated with the level of education and a huge difference in rates of Internet use by level of educational attainment is still observed. Those with a bachelor's degree or higher are more likely to be Internet users than those with less than a high school education (83.7 and 12.8%, respectively).

Income as well, remains a critical factor of whether an individual (or household) will use the Internet. There continues to be a strong direct relationship between income and Internet use even though Internet use has grown considerably among people who live in lower income households. Among those living in households earning less than $15,000 per year, Internet use has grown from 9.2% in 1997 to 25% in 2001 (NTIA, 2002, February, p 11). Internet use growth is also faster among those with lower family incomes. Among those living in lower income households, where family income is less than $15,000 per year, Internet use grew by 25% from 1998 to 2001, while Internet use among those living in households with family incomes of $75,000 per year grew at a more modest 11% per year growth rate (NTIA, 2002, February, p 12).

Finally, although children show increasing rates of Internet use (NTIA, 2002, February, p 1), the question of Internet access remains an important issue. Children without any Internet access or greatly limited access relative to their peers may be at a serious disadvantage in American society. Children without Internet access could be at immediate risk in terms of their educational progress as well as at future risk in terms of potential future job opportunities. This suggests that apart from the potential cost, wider public access to the Internet may be necessary, especially for children, if everyone is to share in the country's future prosperity. In addition to "wiring" schools, libraries, and community centers, as mandated by the Telecommunications Act of 1996, the contributions of individual state technology policies and the availability of Community Access Centers (CAC's) across the USA may significantly contribute to improving the current situation. Kling asserts that community access centers may help fill the gap in access by providing technical assistance that increases social access to computers and the Internet [27, p5]. Furthermore, because the impact of information technology on education is so significant, the role that individual state policies can have in helping to promote equal access and narrow the digital gap becomes critical [8, pp 226–228].

The good news is that the problem is somewhat mitigated because many children in society have become quite accustomed to computers and Internet use over the past several years. Lloyd asserts that children of the "I-Generation" (Peach 1997) or "Nintendo Generation"(Kenway 1995) have grown up in the information age and are becoming regular and accomplished users of the Internet and other communication technologies. Some authors assert that childhood, as we have known it, is currently in transition and has been dramatically changed in the twenty first century because of the constant barrage of media information [28, p 1].

2.2 Internet access and education

The use of the Internet in education is now widely believed to be of value to school age children and, therefore, access and use of Internet technology is becoming increasingly more important to education. Soloway et al. [39, p 19] contends that computer technology and Web-based educational programs can cost-effectively help children with reading and math in ways that reflect the growing diversity of students in society [38, p 11, 15]. He also asserts that the Web is supportive of learning, especially among middle age teens in areas such as teamwork [39, p 21]. Moschella [32] strongly argues that unless all students are sufficiently exposed to the Internet today, those without exposure will be at a serious disadvantage in the job market of the future. Igbaria [23] discusses the need to expose individuals to technology at an early age in order to provide the opportunity to build knowledge and to be adaptive to change. Mengel [30] cites other advantages of Internet exposure for children, such as increased interaction with a wide segment of students and the availability of wide ranging information on a multitude of topics. Still others argue that the Internet, along with computers, has the capability of revitalizing American education by transforming the typical classroom from a teacher-directed to a student-centered environment [32].

As Internet use has become an increasingly more important educational tool, educational programing has become increasingly more adaptable to both the level and developmental capabilities of a child, regardless of age. Studies have shown that Internet use can be successfully integrated into a variety of educational settings [5, p 9]. According to Baumgarten, Internet software is now available for young children 6–9 years of age and 10–14 years of age, and can be integrated into educational curricula regardless of the physical, cognitive and psychosocial capabilities of the child. As their reading ability increases, children become more able and therefore, more likely to take advantage of existing Internet programs targeted to their specific level. As children age, they can begin to manipulate the content of Internet programs in ways that express creativity, independence, social awareness and programs that require logic, strategic and abstract thinking [5, p 9]. School curricula from elementary school through high school now regularly incorporate the use of computers and the Internet for educational instruction in science, social studies and other subject areas.

In addition, as the penetration rate of the Internet in the household continues to increase, data are beginning to appear that more clearly demonstrate that close links between Internet use and the level of academic performance in school exist. Attewell and Battle stress the importance to children of helping them raise the level of performance in school. They make a strong case for a close positive relationship between access to home computing and the academic performance of children in school and argue that lack of access could worsen current social inequality and widen the gap between the affluent and the poor [4, p 1]. Attewell further cites Giacquinta et al. (1993), who early on examined the use of home computing resources and found that the primary use was for playing games and, in the rare case for their use in education, that significant parental hands on use was required.

Internet access in the schools has become a critical technological requirement to the educational system. However, a key issue that remains to be addressed is how to deliver that access. One approach has centered on the federal government's efforts to subsidize the connection of all schools and libraries to the Internet through the e-learning program. Another has focused on the perceived need for more computers in the classroom, and the educational value of having home-based access to both PCs and the Internet [32]. It appears that at this time, however, there is no longer any real debate on the merits of Internet access and use in the educational system. Wiring of the nation's public schools continues and there is wide recognition of the value of Internet access in education [17]. However, it is still unclear how much training and expertise are required to help students and teachers achieve an optimal educational use of computer technology and the Internet.

2.3 Internet access and costs

Cost is another important aspect of Internet access and use for children. To begin with, Internet use is a function of the cost of the required computer equipment, but it is much more complex and costly than earlier communication technologies such as the telephone. For most Internet users, these expenses generally include the cost of computer hardware, software, Internet connectivity, selection of an Internet service provider (ISP) and finally the cost of training. These different aspects of Internet costs closely conform to the concept of the "total cost of ownership" (TCO) of technology, an idea that was developed to provide a more accurate estimate of the actual cost of computer technology for business enterprises.

According to the Gartner Group, the total cost of ownership (TCO) [20] is significantly higher than the total cost of simply purchasing technology hardware or services. Gartner's definition of the total cost of ownership for the K-12 environment consists of direct and indirect costs. Direct costs includes the cost of the computer hardware and software, hardware and software upgrades, maintenance, technical support, and training (formal and informal) while indirect costs consist of peer support, file and data management, and downtime [34, pp 4–5]. According to this definition, the principal determinants of the TCO of Internet use would not fall in the area of service (i.e., connectivity), but rather in the areas of computer hardware and software ownership, computer expertise, and finally the cost of training. Yet, as equipment costs decline, these costs become a proportionately smaller share of the total cost than other equally critical support costs such as expertise, training and maintenance. Kling points out, through industry surveys conducted in the late 1990s, that equipment costs were really a small part of TCO. In addition, the costs of acquiring the necessary expertise and training to use computer technology can be very high. He suggested that over time, support costs, which include training, maintaining equipment, upgrading and configuration, generally become the major costs in the utilization of the technology [27, pp 5–6]. Estimates vary but many indicate that the TCO is about three to four times more expensive than the cost of computer hardware alone (http://www.webopedia.com/TERM/T/TCO.html).

According to industry analysis cost models developed in 1997 independently by the Gartner Group and Forester Research, researchers were able to document the impact of expertise and training on overall costs. Gartner estimated that 45% of the annual industry cost of a PC was attributable to end-users. Over one-third (34%) of the cost to end-users was due to formal and informal learning and to peer support. Forrester found that PC training accounts for 12% of the overall annual cost of PC's (http://web.ics.purdue.edu/~kimfong/TCO/models.html). Furthermore, when applied to K-12 education, Gartner estimates that when direct and indirect costs are considered, 60% of the overall TCO can be attributed to indirect costs [34, pp 4–5]. Consequently, when connectivity and both formal and informal training costs are taken into account, it is estimated that the TCO of computer and Internet hardware and software is more than 12 times more expensive than the telephone.

Access to computer resources and the Internet from a location outside the home, e.g., from public school, a library, or a CAC, is generally less costly. Computer resources at such locations also generally involve a minimal fee or are free for individuals. Sometimes there is expertise and peer support available to assist at no cost as well. However, access to telecommunications services is only one aspect of access to this technology. When the total cost of using computer technology is considered, it becomes apparent that the expertise and training required to use this technology is equally important as simply purchasing or having access to computer and Internet service.

Although private firms and institutions can absorb the additional costs of both formal and informal Internet expertise and make it available within their organizations, individual households are generally less able to do so. Consequently, unless a household member has the available expertise to assist a child with an educational task on the Internet, it is unlikely that the child will be able to make maximum use of the technology for educational purposes.

This study explores the notions presented in this section and builds upon work begun by Attewell, Battle, Birenbaum, Giacquinta and others. Specifically, the paper examines Internet use among school age children anywhere, both at home and outside the home.

3 Methodologic approach

The present study draws on data from the November 2002 Current Population Survey (CPS) to examine Internet use among school age children. The current research expands beyond the work of previous studies by focusing on school age children, by incorporating additional demographic factors not examined in previous research (i.e., citizenship status), and by incorporating factors related to training and expertise resources potentially available to school age children. Specifically, the degree to which Internet use among school age children varies by individual and family is examined, along with the extent to which social and economic characteristics can be explained by the availability of household computing resources and expertise. It has also examined the degree to which school computing resources and expertise affect variation in Internet use among school age children by individual and family, social and economic characteristics, and by the availability of household computing resources and expertise. The methodology used in this paper is structured in three parts: sources of data, variables used for the analysis, and the statistical approach used for analysis, which are described in the subsequent subsections.

3.1 Sources of data

The primary data used in this study is the CPS for September of 2001 administered through the USA Department of Commerce, Bureau of the Census on a monthly basis. In the September 2001 CPS survey, the Census Bureau interviewed approximately 57,000 randomly selected sample households and administered a Computer and Internet Use Supplement. As with each monthly CPS survey, the national sample is selected from the 1990 decennial census files, which cover all fifty states and the District of Columbia. The sample is continually updated to account for new residential construction (NTIA, 1999, July, pp xv–xvi). The data used to examine Internet use among school age children consisted of 25,960 reported cases of school age children between the ages of 6 and 17. In addition to the CPS survey, a second source of data on available public school Internet resources was obtained from the 2001 nationwide school survey conducted by Education Week in collaboration with the Milken Exchange on education policy and the U.S.A. Department of Education. This survey provided a measure of the average level of Internet resources available to school age children. This survey unfortunately provides a somewhat imprecise measure of public school resources because it is a state level indicator (i.e., average number of students per Internet connections for a state). Obviously, it would be preferable to have a more precise measure (e.g., the number students per Internet connection for each student's own school), but this was not available.

3.2 Analytic approach

The analysis examines the potential effect of five major categories of explanatory variables on Internet use by children aged 6 to 17. The specific categories included in the analysis are:(1) family and child background characteristics (e.g., gender, age, race, ethnicity, citizenship status, geographic location, living quarters), (2) family structure and educational resources (i.e., marital status and education level of the reference person for the household[1]), (3) family financial resources,(4) household computing resources and expertise (i.e., the presence of a computer at home, Internet use among adults at home and Internet use among adults outside the home), and (5) public school Internet resources (i.e., the number of students per Internet connection). The last two categories of explanatory variables were not examined in previous research on Internet use among children.

The analysis first examines the bivariate relationship between explanatory variables and Internet use among school age children. In the second phase of the analysis, multivariate logistic regression analysis is used to examine the potential independent effect of each of the explanatory variables controlling for the other variables. The variables enter the analysis in terms of their approximate temporal relation to the dependent variable (i.e. Internet use by school age children). Thus family and child background characteristics, such as race and age, enter the multivariate analysis first, and this allows the effect of these variables to be assessed before other causally subsequent explanatory variables enter into the analysis. In an effort to be conservative in the assessment of the potential effect of the impact of computing resources and expertise on Internet use by school age children, these factors are examined only after family and child background characteristics, family structure, educational resources, and financial resources enter into the analysis.

[1]The US Census Bureau's definition of household reference person is household "person number 1" in Census surveys and "refers to the person (or one of the people) in whose name the housing unit is owned or rented (maintained) or, if there is no such person, any adult member, excluding roomers, boarders, or paid employees. If the house is owned or rented jointly by a married couple, the householder may be either the husband or the wife. The person designated as the householder is the "reference person" to whom the relationship of all other household members, if any, is recorded reference person." (http://www.census.gov/population/www/cps/cpsdef.html)

3.3 Variables used for the analysis

3.3.1 *Family and child background characteristics*

The first set of exogenous/explanatory variables used in this analysis includes a variable for the gender of each child in the study. Also included is a dichotomous variable for the gender household reference person. The age of children in the study is a variable, which is coded as 1 = 6–11 years of age, 2 = 12–13 years of age, and 3 = 14–17 years of age. The race and ethnicity of the household reference person is classified into four categories, 1 = white, non-Hispanic, 2 = Black, non-Hispanic, 3 = Hispanic, and 4 = other non-Hispanic racial categories. We also include the citizenship status of the household reference person as an explanatory variable, which was classified as 1 = natural born citizen, 2 = naturalized citizen, and 3 = not a citizen. Geographic location of the household residence is included as an explanatory variable. For this purpose, the USA Census classification (available in the CPS survey data) is used, which groups locations into four geographic categories: 1 = central city, 2 = balance of central city, 3 = non-metropolitan areas and 4 = not identified. Finally, a variable is also included that classifies the residential living quarters of survey respondents into three categories, 1 = owned by a household member, 2 = rented for cash, 3 = occupied without payment of cash rent.

3.3.2 *Family marital status and education*

The second set of exogenous/explanatory variables includes the martial status and the education level of the household reference person, coded as 1.0 = married, 2.0 = once married, and 3.0 = never married. The educational level of the household reference person is coded into the categories 0 = 1–6 years of education, 1.0 = 7–9 years of education, 2.0 = 10–12 years of education with no high school degree, 3.0 = high school degree, 4.0 = some college, 5.0 = a college degree, and 6.0 = masters degree or higher.

3.3.3 *Family financial resources—family income*

The total income reported by families in the CPS survey is used to measure family financial resources. The family income variable is coded as 1.0 = under $5,000 per year, 2.0 = $5–9,999 per year, 3.0 = $10–19,999 per year, 4.0 = $20–34,999 per year, 5.0 = $35–49,999 per year, 6.0 = $50–75,999 per year and 7.0 = $75,000 and above per year.

3.3.4 Household computing resources and expertise

Measures of household computing resources and expertise are included as explanatory variables to study the potential importance of available household expertise (by adults in a household) on Internet use by school age children. A measure of computing resources is provided by information on computers in the household and is coded into a dichotomous variable with 0 = no computers in the household and 1.0 = one or more computers in the household. Measures of available adult computing and Internet expertise in the household were developed by aggregating the number of adults (i.e., any person 18 years of age and older) in the household that used the Internet at home or the number of adults that used the Internet outside the home. From this information two measures of potential adult Internet expertise are developed. The first is a count of the number of adults in the household that used the Internet at home coded as 0 = no adults, 1 = one adult, and 2 = two or more adults. The second is a count of the number of adults in the household that used the Internet outside the home (e.g., at work, school, etc.) coded as 0 = no adults, 1 = one adult, and 2 = two or more adults.

3.3.5 School Internet resources

The final resource related variable included in the analysis is the average number of students per Internet connection in public schools within a given state. Although this attribute is measured at a level of aggregation that is too high, the variable provides a gross measure of the level of Internet resources available to public school students within a given state. A much better measure of available school resource would have been the average number of students per Internet connection within a given school, but such data were not available. Nevertheless, the state level variable available to this study provides a first cut estimate of the potential impact differences in school computing resources on students' use of the Internet. The average number of students per Internet connection in public schools within a state ranged from a high state resource level of 3.4 students per Internet connection to a low level of 10.1 students per Internet connection.

3.4 Statistical approach

The analysis first examines the bivariate relationships between Internet use among school age children anywhere and the independent explanatory factors that are potential determinants of Internet use. Internet use is defined as school age child using the Internet either within or outside the home, and is coded as 0 = no use of the Internet or 1 = use of the Internet at home, outside the home or both. Tables 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13 and 14 present the basic cross-tabular analyses, and Chi square tests provide tests of the statistical significance of the bivariate relationships.

Following the bivariate analysis, the unique contributions of each of the explanatory variables on Internet use among school age children is then assessed employing logistic regression analysis. Logistic regression models estimate the average effect of each independent explanatory variable on the odds that a dependent variable outcome will occur (school age child will use the Internet at any location).

In the present study, the odds ratio is the ratio of the probability of Internet use to the probability of non-Internet use. It is the probability that a child uses the Internet anywhere divided by the probability that a child does not use it. For example, if a child's likelihood of using the Internet anywhere is 0.75 (P), then the probability of non-use is 0.25 (1-P). The odds ratio in this example is 0.75/.25 or 3 to 1. The odds of Internet use anywhere in this case are 3 to 1.

In the model adopted in this study, the dependent variable is the natural logarithm of the odds ratio, y, of a school age child using the Internet anywhere. Thus, $y = p \; / \; 1 - p$ and;

$$\ln(y) = \hat{a}_0 + (X)\hat{a}_\mathrm{i} + \xi_\mathrm{i}$$

where $\hat{a}_0$ is an intercept, $\hat{a}_\mathrm{i}$ are the i coefficients for the i independent variables, X is the matrix of observations on the independent variables, and ξ_i is the error term.

To make the B coefficients more understandable, they are typically converted into adjusted odds ratios, calculated by exponentiating the coefficient of interest. An odds ratio measures the change in the odds that an event will occur for each unit change in a given independent variable. When the variable is dichotomous, the odds ratio measures the change in the odds that is due to belonging to the selected category versus the comparison category. The adjusted odds ratio is an estimate of the odds ratio independent of (or after accounting for) other variables [13, p 64].

When interpreting odds ratios, an odds ratio of 1, means that someone with that specific characteristic is just as likely to exhibit the characteristic as not. An odds ratio of exactly 1.0 indicates that the likelihood of a child using the Internet anywhere changed by a factor of 1.0, or not at all. Odds ratios greater than one indicate a higher likelihood of Internet use among school age children that have a positive value for that particular independent variable. When the independent variable is continuous, the odds ratio indicates the increase in the odds of Internet use for each unitary increase in the predictor.

Finally, in order to insure variable integrity, a series of multicollinearity diagnostic tests were run on the exogenous variable attributes in this model to determine whether there was a presence of multicollinearity. Test results indicated that there was virtually no multicollinearity found among the exogenous variables in the model. The variance inflation factor (VIF) for each of

Table 1 Internet use anywhere by gender of the child

Internet use any where		Gender of Child		Total
		male	female	
Total	% yes	62.2	63.7	62.9
	Count	(13,346)	(12,614)	(25,960)
	%	100.0	100.0	100.0

Pearson Chi Square 6.584, $P = 0.010$

the exogenous variables appearing in the model was found to be well within acceptable limits. Various texts provide slightly different thresholds to the presence of multicollinearity in a regression model, but in general, if the VIF is 5.0 or greater, some degree of mulitcollinearity exists [1, p 573]. Among the exogenous variables uses in this model, the calculated VIF's attached to each ranged from a low of 1.001 for the variable gender of child (PESEX2) to a high of 3.285 for the variable family income with missing values (RFAM1_NM). All were well within the threshold, indicating that multicollinearity was not present.

4 Analysis

The analysis is organized into two parts. The first part concerns the bivariate analysis of internet use among school age children, and the second is a multivariate logistic regression analysis of Internet use. In both parts, the analysis proceeds in terms of the presumed relative temporal order of the explanatory variables relative to the dependent variable, Internet use anywhere by school age children.

4.1 Bivariate analysis of Internet use among school age children

4.1.1 Internet use by family and child Background characteristics

Examination of family and child background characteristics found that Internet use among school age children was essentially the same for boys and girls, 62.2% for males vs. 63.7% for females (see Table 1). Thus, slightly more girls than boys indicated that they use the Internet anywhere. In contrast and in terms of the gender of the household reference person, Internet use among school age children anywhere was found to be significantly higher in households where the household reference person was a male. As shown in Table 2, Internet use among school age children is higher in male-headed households than in female-headed households (66.6 vs. 59.1%, respectively). The fact that households with male reference persons are more likely to be two parent households where financial resources are provided by two adults rather than one as in many female-headed households may help account for this association.

The age of school age children is an important determinant of Internet use. As Table 3 shows, Internet use among school age children increases directly with age, with less than half (47.1%) of children 6–11 years of age using the Internet to nearly four-fifths (77.8%) using the Internet among children 14–17 years of age. This appears reasonable since, as children age, their literacy skills and knowledge tend to increase as well.

Attributes of the reference persons of households such as race and ethnicity are important predictors of disparities in Internet use among school age children. As Table 4 shows, Internet use among school age children varies widely by race and ethnicity. Nearly three-fourths (70.3%) of the children residing in households with white non-Hispanic reference persons use the Internet anywhere while less than half (44.5%) of the children residing in households with Black non-Hispanic reference persons use the Internet anywhere. For households with Hispanic reference persons only 40.9% of the school age children use the Internet. Finally, as shown in Table 4, nearly two-thirds (61.0%) of the children in households with other non-Hispanic reference persons use the Internet.

The citizenship status of the household reference person of school age children is also a significant predictor of Internet use among school age children. Table 5 shows that Internet use among school age children was highest among natural born citizens where nearly two-thirds (65.3%) of the school age children in these households reported that they used the Internet. In contrast, only 40.5% of children from households where the reference person was not a citizen reported using the Internet. Over half (56.8%) of children from households whose reference person is a naturalized citizen use the Internet.

Geographic location and residential ownership are also associated with Internet use among school age children. Table 6 shows that slightly over one-half (53.3%) of children who reside in central cities use the Internet while nearly two-thirds of children who reside in other locations outside the central city use the Internet anywhere. Specifically, 65.7% of children in metropolitan non-central city areas, 65.1% of children in non-metropolitan areas, and 65.2% of the children in undefined areas use the Internet.

Finally, Table 7 shows that home ownership is also associated with Internet use among school age children. Internet use is highest among children who live in households owned by a household member with over two-thirds (68.0%) of the children in these households

Table 2 Internet use anywhere by gender of household reference person

Internet use any where		Gender of household reference person		Total
		Male	Female	
Total	% yes Count %	66.6 (13,484) 100.0	59.1 (12,172) 100.0	63.1 (25,656) 100.0

Pearson Chi Square 154.769, $P = 0.000$

Table 3 Internet use anywhere by age of child

Internet use any where		Age of Child (years)			Total
		6–11	12–13	14–17	
Total	% yes Count %	47.1 (10,776) 100.0	69.6 (6,665) 100.0	77.8 (8,519) 100.0	62.9 (25,960) 100.0

Pearson Chi Square 2096.050, $P = 0.000$

Table 4 Internet use anywhere by race/ethnicity of household reference person

Internet use any where		Race/ethnicity of household reference person				Total
		White non-Hispanic	Black non-Hispanic	Hispanic	Other non-Hispanic	
Total	% yes Count %	70.3 (18,016) 100.0	44.5 (3,052) 100.0	40.9 (3,141) 100.0	61.0 (1,447) 100.0	63.1 (25,656) 100.0

Pearson Chi Square 1519.915, $P = 0.000$

Table 5 Internet use anywhere by citizenship of household reference person

Internet use any where		Citizenship status of household reference person			Total
		Natural born citizen	Naturalized citizen	Not a citizen	
Total	% yes Count %	65.3 (22,445) 100.0	56.8 (1,346) 100.0	40.5 (1,865) 100.0	63.1 (25,650) 100.0

Pearson Chi Square 481.124, $P = 0.000$

using the Internet while only about one-half (48.4%) of children living in housing that is rented, report using the Internet.

4.1.2 *Internet use and family marital status and education*

The marital status of the household reference person is a significant predictor of Internet use among school age children. As Table 8 shows that Internet use is highest among school age children residing in households where the household reference person is married (66.8%), while significantly less than half (41.5%) of the children reported using the Internet in households where the reference person was never married. Reported Internet use among school age children from households whose reference person is either separated or divorced is 58.2%.

Internet use among school age children also varies dramatically with the education of the household reference person. As the level of education of the household reference person increases, Internet use among school age children increases as well. As Table 9 shows, in households where the highest level of education is grammar school, slightly more than one-quarter (27.8%) of the children use the Internet, while over four-fifths (80.9%) of the children who reside in households where the highest level of education is a master's degree or higher, report using the Internet anywhere.

4.1.3 *Internet use and financial resources—family income*

Family resources as measured by family income are strong determinants of Internet use among school age children. Internet use among school age children varies directly with the income of the family. As shown in Table 10, Internet use among school age children increases steadily from 34.0% in households where the household income is less than $5,000 per year, to four-fifths (80.9%) of the children who reside in households where family income is $75,000 per year or more.

Table 6 Internet use anywhere by central city status

Internet use any where		Central city status				Total
		Central city	Balance of metro area	Non-metro area	Not identified	
Total	% yes Count %	53.3 (5,322) 100.0	65.7 (9,854) 100.0	65.1 (6,468) 100.0	65.2 (4,316) 100.0	62.9 (25,960) 100.0

Pearson Chi Square 268.068, $P = 0.000$

Table 7 Internet use anywhere by living quarters status

Internet use any where		Living quarters status			Total
		Owned by hh member	Rented for cash	Occup. w/l cash rent	
Total	% yes Count %	68.0 (19,031) 100.0	48.4 (6,585) 100.0	59.6 (344) 100.0	62.9 (25,960) 100.0

Pearson Chi Square 806.560, $P = 0.000$

4.1.4 Internet use and household computing resources and expertise

Household computing resources and expertise are potentially among the most important determinants of Internet use among school age children. As Table 11 shows, the availability of a computer in the home is critical to the use of Internet among children. Nearly three-quarters (74.6%) of all school age children residing in households with computers reported using the Internet, while only slightly more than one-fourth (28.4%) of children residing in households without a home computer reported using the Internet anywhere.

The presence of adult(s) that use Internet in the household is also an important predictor of Internet use among school age children. Household computing expertise is measured by counting the number of adults that use the Internet within their household and by counting the number of adults that use the Internet outside of their household (e.g., at work, school, etc.). As Table 12 shows, Internet use among school age children anywhere increases as the number of adults in the household who the Internet at home increases. Over four-fifths (81.8%) of children in households with two or more adults report using the Internet anywhere, while in households with no adult, uses the Internet at home, only slightly over one-third (36.0%) of the children report using the Internet anywhere.

Finally, the presence of adult(s) that use the Internet outside the household is also an important predictor of Internet use among school age children. As Table 13 shows, Internet use among school age children anywhere increases from less than one-half (47.9%) in households where no adults use Internet outside the home, to over three-fourths (81.9%) in households where two or more adults use it outside the home. These findings suggest that use of the Internet by adults regardless of location may be a significant predictor of Internet use among children. This may occur because, as more adults in a household use the Internet, the more exposed children living in these households get the knowledge of how to use the Internet and to the potential value of the Internet to their success.

4.1.5 Internet use and public school internet resources

Finally, public computing resources may be a critical resource for children, especially in cases where there are no family or household Internet resources in the household. The average number of students per Internet connection per state provides a measure of the relative availability of public school computing resources for school age children. For the purposes of the tabular analysis, the variable was recoded into five quintile categories. The values for the recoded version range from 1 = 3.4–5.6 students per Internet connection to 2 = 5.7–6.3 students, 3 = 6.4–6.9 students, 4 = 7.1–8.3 students, and 5 = 8.4–10.1 students. Table 14 indicates that public school Internet resources show a relatively modest effect on Internet use among children anywhere, although, as noted, this affect may be somewhat attenuated in part because this measure is based on

Table 8 Internet use anywhere by marital status of household reference person

Internet use any where		Marital status of household reference person			Total
		Married	Divorced-separated	Never married	
Total	% yes Count %	66.8 (18,674) 100.0	58.2 (4,887) 100.0	41.5 (2,095) 100.0	63.1 (25,656) 100.0

Pearson Chi Square 578.284, $P = 0.000$

Table 9 Internet use anywhere by education of household reference person

Internet use any where		Education of household reference person							Total
		Grades 1–6	7–9	10–11[a]	HS degree	Some college	College degree	MA or higher	
Total	% yes	27.8	39.3	44.8	58.0	67.5	75.3	80.9	63.1
	Count	(719)	(966)	(1,890)	(8,092)	(7,595)	(4,223)	(2,171)	(25,656)
	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Pearson Chi Square 1611.212, $P = 0.000$

[a] This category can include students who reached grade 12 but did not graduate from high school

Table 10 Internet use anywhere by family income

Internet use any where		Family income							Total
		$4999 or less	$5–9999	$10–19999	$20–34999	$35–49999	$50–74999	$75000– plus	
Total	% yes	34.0	37.9	42.9	54.4	66.7	71.0	79.3	64.1
	Count	(553)	(916)	(2,415)	(4,276)	(3,724)	(5,022)	(5,824)	(22,730)
	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Pearson Chi Square 1831.212, $P = 0.000$

Table 11 Internet use any where by presence of a household computer(s)

Internet use any where		Household computer(s)		Total
		No computer	One + computers	
Total	% yes	28.4	74.6	62.9
	Count	(6,584)	(19,376)	(25,960)
	%	100.0	100.0	100.0

Pearson Chi Square 4498.167, $P = 0.000$

aggregated state level data. As Table 14 shows, Internet use among school age children is slightly higher (67.0%) in states with the lowest of the average number of students per Internet connection in public schools (i.e., quintile 1) vs states with the highest average number of students per Internet connection (i.e., quintile 5) where 56.3% of school age children report using the Internet. This measure should be explored in greater detail in future studies. Data on students per Internet connection collected at the school district or individual school level would provide better estimates of the potential effect of school resources on student Internet use.

4.2 Multivariate analysis of Internet use among school age children

To examine whether the attributes examined in the bivariate analysis remained significant predictors controlling for the effects of the other factors, a multivariate analysis of the independent effect of each of the explanatory variables on Internet use by school age children was conducted. As with the bivariate analysis, the potential effect on Internet use among each of the five sets or blocks of explanatory variables is assessed. The five blocks are (1) family and child background characteristics, (2) family marital status and education, (3) financial resources – family income, (4) household computing resources and expertise, and (5) school Internet resources.

Each block of explanatory variables enter the analysis according to its presumed temporal position relative to the dependent variable and the other independent variables. The independent effects of individual explanatory variables are first assessed at the temporal stage when they enter the analysis. Importantly, this enables the researchers to examine the mediating effects of individual blocks of explanatory variables introduced into the analysis at earlier stages.

Table 15 lists the specific explanatory variables included in the logistic analysis, along with their variable definitions. The explanatory variables are coded to conform to the requirements of the logistic regression analysis. With the exception of family income, most of the explanatory variables in the study have very little (1.2% or less) missing data. In case of family income, however, 12.4% of the observations have missing information. There are a variety of techniques available to researchers that deal with the problem of missing data in multivariate analyses (see Little and Rubin 1987 for a full discussion). For the purpose of the logistic regression, a dummy variable (see Table 15, variable 16) was included in the analysis to control the missing information in the family income variable.

Table 12 Internet Use Any Where by Internet Use Adult(s) (18+) at Home

Internet use any where		Internet use by adults (18+)at home			Total
		No adults	One adult	Two + adults	
Total	% yes Count %	36.0% (9,983) 100.0	75.3% (5,113) 100.0	81.8% (1,086) 100.0	62.9% (25,960) 100.0

Pearson Chi Square 5094.33, $P = 0.000$

Table 13 Internet use any where by internet use adult(s) (18+) outside the home

Internet use any where		Internet use by adults (18+) outside home			Total
		No adults	One adult	Two + adults	
Total	% yes Count %	47.9% (11,678) 100.0	71.6% (9,245) 100.0	81.9% (503) 100.0	62.9% (25,960) 100.0

Pearson Chi Square 2211.79, $P = 0.000$

Table 16 presents the results of the logistic regression analysis. Eleven variables representing family and child background characteristics enter the logistic regression analysis in the first stage/block. These include dichotomous representing the gender and age of the child, the gender, race/ethnicity and citizenship status of the household respondent (variables 1 – 9), the geographic location of the household residence and the ownership/rental status of the household residence.

In the basic model (block 1) the Exp (B) coefficient for the gender of the child (variable 1 in Table 16) shows that the odds of female school age children using the Internet anywhere are 1.075 times greater than male school age children, controlling for the other variables in the analysis. As other variables (i.e., variables 2 – 20), enter the analysis in later blocks, this effect becomes nearly statistically insignificant and the Exp (B) effect remains modest.

The Exp (B) coefficient in the basic model for the gender of the household reference person (variable 2, Table 16) indicates that the odds of children from a household with a female reference person using the Internet is 0.854, controlling for the other variables in block 1 of the analysis. The Exp (B) value of 0.854 indicates that children from female reference person households, show a 14.6% lower use of the Internet than their counterparts from male reference person households. The effect of the Exp (B) coefficient for female household reference person decreases steadily from a coefficient of 0.854 controlling only for the block 1 basic model explanatory variable to 0.920, 0.944, 0.949, and 0.954 (a coefficient of 1 equals no or zero effect), as blocks 2 – 5 explanatory variables enter the analysis. Importantly, the statistical effect of a female household reference person on children's Internet use becomes statistically insignificant as later explanatory variables enter the analysis.

In contrast to a child's gender, the age of children in this study is a strong predictor of Internet use. For school age children 14–17 years of age (variable 4, Table 16), the Exp (B) coefficient in the basic model is 4.041, controlling for the other variables in the analysis. The results indicate that the odds of a child using the Internet anywhere are, on average, much higher (304.1%) for students in this age group than it is for children aged 6 to 11 in the reference category. Importantly, the effect of age on Internet use is largely unaffected by the explanatory variables entered in subsequent steps. In fact, the effect of age actually increases modestly as successive blocks of explanatory variables enter the analysis. Thus, as family resources and household computing resources and expertise, and public school resources are added stepwise to the model, the Exp (B) coefficient for the dichotomous variable representing the age group 14–17 increases from 4.041 in the first block to 4.491, 4.519, 5.310, and 5.304, respectively.

Children aged 12–13 also show significantly higher levels of Internet use, although somewhat lower levels than their 14–17 year old counterparts. The Exp (B) coefficient for this age group when it first enters into the analysis is 2.719 (variable 3, Table 16). As family resources, household computing resources and expertise, and public school resources are added stepwise to the

Table 14 Internet use anywhere by level of school internet resources (state average Internet connections per student)

Internet use any where		Internet connections per student					Total
		(1) 3.4–5.6	(2) 5.7–6.3	(3) 6.4–6.9	(4) 7.1–8.3	(5) 8.4 +	
Total	% yes Count %	67.0 (6,004) 100.0	63.7 (4,526) 100.0	65.2 (5,246) 100.0	61.6 (5,187) 100.0	56.3 (4,997) 100.0	62.9 (25,650) 100.0

Pearson Chi Square 154.664, $P = 0.000$

Table 15 Logistic analysis explanatory variables

Sequence	Variable name	Variable definition
Block 1	1. PESEX2	Dichotomous variable for gender of child (0 = male, 1 = female)
	2. PESEX12	Dichotomous variable for gender of HH ref. person (0 = male, 1 = female)
	3. PEAG1213	Dichotomous variable for child's age 12 to 13[a]
	4. PEAG1417	Dichotomous variable for child's age 14 to 17[b]
	5. PREHHBNH	Dichotomous variable for HH ref. person Black non-Hispanic [b]
	6. PREHHHIS	Dichotomous variable for HH ref. person Hispanic [b]
	7. PREHHONH	Dichotomous variable for HH ref. person other non-Hispanic [b]
	8. PRCITNAT	Dichotomous variable for HH ref. person naturalized citizen [c]
	9. PRCITNOT	Dichotomous variable for HH ref. person not a citizen [c]
	10. GEMSTAT1	Dichotomous variable for household located in central city [d]
	11. HETENUR1	Dichotomous variable for residence rented [e]
Block 2	12. PEMARNEV	Dichotomous variable for HH ref. person never married [f]
	13. PEMARDIV	Dichotomous variable for HH ref. person divorced/separated [f]
	14. PEEDUCHH	Education level of the HH ref person coded 0 to 6 [g]
Block 3	15. RFAMI_MD	Family income coded 0 to 6 [h]
	16. RFAMI_NM	Dichotomous variable for missing data on family income [i]
Block 4	17. HESC11	Dichotomous variable for computer(s) in the household [j]
	18. PRNET2A2	Number is adults in the HH that use Internet at home [k]
	19. PRNET3A2	Number is adults in the HH that use Internet outside the home [k]
Block 5	20. SPIC	Average number of students per Internet connection—state level

[a] Reference category is children aged 6 to 11
[b] Reference category is white non-Hispanic children
[c] Reference category is natural born citizen children
[d] Reference category is children in residences outside of central cities
[e] Reference category is children in owner occupied houses
[f] Reference category is children in households with a married reference person
[g] Category 0 = grades 1 to 6, 1 = 7 to 9, 2 = 10 to 12 (no degree), 3 = high school grad., 4 = some college, 5 = college grad., and 6 = Masters or higher
[h] Category 0 = under \$5,000 or missing, 1 = \$5,000 to \$9,999, 2 = \$10,000 to 19,999, 3 = \$20,000 to 34,999, 4 = \$35,000 to 49,999, 5 = 50,000 to 74,999, and 6 = \$75,000 or higher
[i] Dichotomous variable for missing data on family income where 0 = data reported on family income and 1 = no data reported on family income
[j] Category 0 = no computer in the household and 1 = one or more computers in the household
[k] Category 0 = no adults in the household use the Internet, 1 = one adult, and 2 = two or more adults

Table 16 Logistic regression of the effects of background attributes, family characteristics and financial resources, household computing resources and expertise, and public school internet resources on internet use among school age children

Attribute	Block 1			Block 2			Block 3			Block 4			Block 5		
	B	Sig	Exp(B)	B	Sig	Exp(B)	B	Sig	Exp(B)	B	Sig	Exp(B)	B	Sig	Exp(B)
1. PESEX2	0.072	0.010	1.075	0.083	0.004	1.086	0.082	0.005	1.085	0.069	0.025	1.072	0.069	0.026	1.071
2. PESEX12	−.158	0.000	0.854	−0.083	0.009	0.920	−0.058	0.071	0.944	−0.052	0.130	0.949	−0.047	0.170	0.954
3. PEAG1213	1.000	0.000	2.719	1.056	0.000	2.874	1.071	0.000	2.920	1.188	0.000	3.282	1.187	0.000	3.278
4. PEAG1417	1.396	0.000	4.041	1.502	0.000	4.491	1.508	0.000	4.519	1.670	0.000	5.310	1.668	0.000	5.304
5. PREHHBNH	−0.919	0.000	0.399	−0.747	0.000	0.474	−0.670	0.000	0.512	−0.284	0.000	0.753	−0.250	0.000	0.778
6. PREHHHIS	−0.990	0.000	0.372	−0.599	0.000	0.549	−0.561	0.000	0.570	−0.281	0.000	0.755	−0.246	0.000	0.782
7. PREHHONH	−0.252	0.000	0.778	−0.243	0.000	0.784	−0.190	0.004	0.827	−0.033	0.638	0.967	−0.022	0.754	0.978
8. PRCITNAT	−0.008	0.902	0.992	−0.039	0.568	0.961	−0.029	0.672	0.971	0.001	0.990	1.001	0.044	0.558	1.045
9. PRCITNOT	−0.410	0.000	0.663	−0.306	0.000	0.736	−0.287	0.000	0.751	−0.182	0.008	0.833	−0.148	0.031	0.862
10. GEMSTAT1	−0.085	0.019	0.919	−0.106	0.004	0.900	−0.119	0.001	0.888	−0.121	0.003	0.886	−0.107	0.008	0.899
11. HETENUR1	−0.448	0.000	0.639	−0.220	0.000	0.803	−0.068	0.069	0.935	0.075	0.062	1.078	0.084	0.039	1.087
12. PEMARNEV				−0.389	0.000	0.678	−0.216	0.000	0.806	0.120	0.056	1.128	0.123	0.052	1.130
13. PEMARDIV				−0.201	0.000	0.818	−0.033	0.423	0.967	0.289	0.000	1.335	0.297	0.000	1.345
14. PEEDUCHH				0.343	0.000	1.410	0.271	0.000	1.312	0.093	0.000	1.097	0.093	0.000	1.097
15. RFAMI_MD							0.325	0.000	1.384	−0.329	0.000	0.720	−0.302	0.000	0.739
16. RFAMI_NM							0.200	0.000	1.221	0.009	0.509	1.009	0.016	0.248	1.016
17. HESC11										0.917	0.000	2.503	0.922	0.000	2.515
18. PRNET2A2										0.668	0.000	1.950	0.670	0.000	1.955
19. PRNET3A2										0.380	0.000	1.462	0.374	0.000	1.453
20. SPIC													−0.053	0.000	0.949
Constant	0.342	0.000	1.408	−1.036	0.000	0.355	−1.639	0.000	0.194	−2.110	0.000	0.121	−1.800	0.000	0.165
Nagelkerke R Square			0.193			0.236			0.253			0.381			0.382
Cox& Snell R Square			0.141			0.173			0.185			0.279			0.280

model, the Exp (B) coefficient increase from 2.719 to 2.874, 2.920, 3.282, and 3.278, as successive blocks of explanatory variables enter the analysis, and they always remain statistically significant.

Examination of the Exp (B) coefficients for the race and ethnicity of household reference persons in Table 16 indicates that the odds of school age children in households with a Black non-Hispanic or Hispanic reference person are significantly less likely to use the Internet than children from households with a white reference person. For children from households with Black non-Hispanic households (i.e., households with a Black reference person), the Exp (B) value of 0.399 indicates that the odds of a child using the Internet anywhere are, on average, 60.1% lower, from these households than for children from white non-Hispanic households. As the subsequent blocks of explanatory variables enter the analysis (i.e., blocks 1 through 5), the Exp (B) coefficient for the effect of race of householder on Internet use steadily improve from 0.399 for only block 1 explanatory variables to 0.474, 0.512, 0.753, and 0.778, respectively, as successive set of variables enter the analysis (see variable 5, Table 16). Thus, the disparities in Internet use by children from Black households improve from 60.1% below to 22.2% below their white non-Hispanic counterparts, controlling for all the subsequent explanatory variables. Thus, much of the disparity in Internet use for children from Black non-Hispanic households can be accounted by family educational, financial, and computing resources. Equally important among these factors, the greatest impact on Internet use among school age children from Black non-Hispanic households occurs with the addition of household computing resources and expertise to the analysis. Therefore, as family resources, household computing resources and expertise, and school computing resources are added to the basic model, disparities in Internet use among children in Black non-Hispanic households decline. Significantly, the greatest decrease occurs when household computing and expertise are added to the analysis. Specifically the Exp (B) coefficient improves from 0.512 to 0.753 (see variable 5, Table 5), and children from Black non-Hispanic households fall only 24.7% below their counterparts from white non-Hispanic households Internet use compared with 48.8% below before household computing resources and expertise enter the analysis.

The results of the multivariate analysis for children from Hispanic households (i.e. households with a Hispanic reference person) are very similar to those for children from Black households. The results of the multivariate analysis for children from 2.719 to 2.874, 2.920, 3.282, and 3.278, as successive blocks of explanatory variables, and indicates that the odds of a child using the Internet anywhere are, on average, 62.8% lower for Hispanic households compared with the children from white non-Hispanic households. As family resources, household computing resources and expertise and public school resources enter the analysis, the Exp (B) coefficient improves dramatically from 0.372 to 0.549, 0.570, 0.755, and 0.782, for explanatory variable blocks 1–5 respectively (see variable 6, Table 16). Therefore, like children from Black non-Hispanic households, as family resources, household computing resources and expertise, and school computing resources are added to the basic model, disparities in Internet use among children in Hispanic households decline. Significantly, the greatest decrease occurs when household computing and expertise enters the analysis. Specifically the Exp (B) coefficient improves from .570 to .755 (see variable 6, Table 5), and children from Hispanic households fall only 24.5% below their counterparts from white non-Hispanic household's Internet use compared with 43.0% below before household computing resources and expertise enter the analysis.

The Exp (B) coefficient in the basic model for other non-Hispanic races households (households with a reference person that is an other non Hispanic race, including Asian, pacific islander and Native American) is 0.778 (see variable 7, Table 16). The Exp (B) value of 0.778 indicates that the odds of a child from these households using the Internet are on average, 22.2% lower than for children from non-Hispanic white households controlling for the explanatory variables in the basic model in block 1. Importantly, with the introduction of the subsequent blocks of explanatory variables in block 2–5, the Exp (B) coefficient improves steadily from 0.778 to 0.784, 0.827, 0.967, and 0.978, respectively. Thus, when subsequent explanatory variables enter the analysis, and in particular, when household computing resources and expertise enter the analysis, disparities in Internet use among children in non-Hispanic other race households become statistically insignificant.

The citizenship status of households also has an impact on Internet use by school age children. The Exp (B) coefficient for households with a household reference person that is not a citizen (variable 9, Table 16) shows that the odds ratio of Internet use among school age children from non-citizen households is 0.663 controlling for the other explanatory variables in block 1, the basic model. This indicates that the odds of a child using the Internet are 33.7% lower for children from non-citizen households compared with households where the reference persons are citizens. As in the case of Black non-Hispanic and Hispanic households, as subsequent explanatory factors enter the analysis, the Exp (B) coefficient steadily improves from 0.663 to 0.736, 0.751, 0.833, and 0.862 (as blocks 1–5 are added). Therefore, as computing resources and expertise are added to the basic model, the disparities in Internet use among children living in households where the household reference person is not a citizen (as is the case for Black non-Hispanic and Hispanic households), show the greatest decline.

In contrast to households where the reference person is not a citizen, children from households where the reference person is a naturalized citizen show no significant differences with other children when the explanatory variables in the basic model are controlled. The Exp (B) coefficient for households with a naturalized citizen reference person is 0.992, controlling for the other block 1 variables, and is statistically insignificant (variable 9, Table 16). As the subsequent explanatory variables enter the analysis of the Exp (B) coefficient, these households remains statistically insignificant.

Geographic location appears to have a modest effect on Internet use by school age children, independent of the other explanatory variables in the analysis. The Exp (B) coefficient for central city status (variable 10, Table 16) for children residing in central city households is 0.919, controlling for the other variables in the basic analysis. The Exp (B) value of 0.919 is the odds ratio of Internet use among school age children in households located in central cities, and indicates that, the odds of a child using the Internet is, on average, 8.1% lower for households located in central cities. As the subsequent explanatory variables enter the analysis, the Exp (B) coefficient for central city households remains stable, going from 0.900 to 0.888, 0.886, and 0.899 for blocks 2–5 respectively. Therefore, independent of family characteristics and resources, the modest disparities in Internet use among children living in central city households versus those outside the central cities remain unchanged and statistically significant. This finding is consistent with census data, which show clearly that a larger proportion of lower income households are located in central cities across the US.

Examination of the Exp (B) coefficient for ownership status of households (see variable 11, Table 16) is 0.639, controlling for the other variables in the block 1 analysis. These results indicate that the odds of a child living in rented household quarters are 36.1% lower than for children living in owner occupied households. As explanatory variables from blocks 1 to 5 enter the analysis, the Exp (B) coefficient improves from 0.639 to 0.803, 0.935, 1.078, and 1.087, respectively. Therefore, as the analysis controls for family education, family financial resources, household computing resources and expertise, and public school resources, disparities in Internet use among children living in rented households decline sharply and become statistically insignificant.

The second stage of the analysis (block 2) introduces the marital status and education level of the household reference person into the analysis. The Exp (B) for level of education of the reference person is 1.410 (variable 14, Table 15). Thus, the odds of a child using the Internet anywhere increase by an average of 41.2% as the level of education of the household reference person increases. Importantly, the effect of education is nearly fully mediated with the introduction into the analysis of household computing resources and expertise. When these resource variables enter the analysis in block 4, the Exp (B) for education drops to 1.097.

Marital status is introduced into the analysis through two dichotomous variables; one that identifies household reference persons that were never married (variable 12, Table 16) and a second that identifies reference persons that are divorced or separated (variable 13, Table 16). The Exp (B) coefficient for never married households is 0.678, when it enters the analysis in block 2 and controlling for the other variables in the analysis at that point. The Exp (B) value of 0.678 indicates that the odds of a child using the Internet are, on average, 32.2% lower for households with never married household reference person compared with households with married reference persons. As family income and household computing resources and expertise (block 2–5), enter the analysis, the Exp (B) coefficient improves steadily from 0.678 to 0.806, 1.128, and 1.130, respectively. Although the effects of never married household reference persons on Internet use actually become positive, they do not achieve statistical significance. Nevertheless, the analysis indicates that the availability of family financial resources and household computing resources and expertise appear to account for disparities in Internet use of children living in households with reference persons who were never married.

Examination of the Exp (B) coefficient for divorced or separated household reference persons (variable 13, Table 16) indicates that the odds of a child from one of these households using the Internet anywhere are, on average, 18.2% lower for households with married household reference persons. As family income, household computing resources and expertise, and school computing resources enter the analysis; the Exp (B) coefficient for these households improves steadily from 0.818 to 0.967, 1.335, and 1.345, for blocks 2–5, respectively. With the introduction of these additional resources, the impact of Internet use among children in households where the household reference person is divorced becomes positive and statistically significant. This indicates that with an infusion of resources, Internet use increases and is actually greater than in households with married reference persons.

Family financial resources are measured using reported family income (variable 15, Table 16). When family income enters the analysis in block 3, the Exp (B) coefficient for this variable is 1.384. Importantly, household computing resources and expertise, which enter the analysis in block 4, appear to mediate most of the effect of family income. When the variables for household computing resources and expertise enter the analysis, the Exp (B) coefficient for family income drops from 1.386 to 1.097 and become statistically insignificant.

Household computing resources and expertise enter the analysis in block 4. The Exp (B) coefficient for the presence of a computer(s) in the household (variable 17, Table 16) is 2.503, controlling for the other variables in blocks 1–4, indicates that the odds of a child using the Internet anywhere are, on average, 150% higher for households in which there is a computer present. However, as school computing resources enter the analysis, the Exp (B) coefficient remains largely unchanged, increasingly slightly from 2.502 to 2.515. This indicates that children living in households where a computer is present are far more likely to access the Internet at home than at school.

In addition to household computing resources, the presence of adult computing expertise in the household also appears to have a significant effect on the use of the Internet by children. Examination of the Exp (B) coefficient for Internet use among adults at home (variable 18, Table 16), shows an odd ratio of 1.950, controlling for the other variables in blocks 1–4. The Exp (B) value of 1.950 is the odds ratio of Internet use among school age children when adults use the Internet at home. The results indicate that the odds of a child using the Internet anywhere are, on average, 95.0% higher in households for each adult (up to two adults) that uses the Internet in the home. This indicates that children living in households where adults use it at home are more likely to access the Internet at home than their counterparts from households where no adults use the Internet at home.

Similarly, the Exp (B) coefficient for Internet use among adults at home (variable 19, Table 16) shows an odds ratio of 1.462, controlling for the other variables in blocks 1 through 4. The Exp (B) value of 1.462 indicates that the odds of a child using the Internet are, on average, 46.2% higher in households where each adult (up to two adults) uses it outside the home. This indicates that children living in households where adults use the Internet outside the home, e.g., at work, are far more likely to access the Internet at home rather than at school.

Finally, the potential impact of the availability of public school Internet resources has been examined. School Internet resources are measured as the average number of Internet connections in public schools per student for each state (variable 20, Table 16), and are introduced in the final step of the analysis, block 5. The Exp (B) coefficient for school computing resources is 0.949, controlling for the other variables in the analysis. The results indicate that the odds of a child using the Internet anywhere are, on average, 5.1% lower for households in which children use it at school. The effect of available school Internet resources on the use of the Internet by children, though statistically significant, is relatively modest when compared to a number of the other explanatory variables. However, as noted, this attribute is only available for the purposes of the present study at a level of aggregation that is too high, and, as a result, this variable provides only a rough measure of Internet resources available to public school students. A much better measure of available school resources would be the average number of students per Internet connection within a given school, but data were not available. An analysis that incorporated a more refined measure of available school resources might also find a larger effect due to these resources than are found here.

Although logistic regression techniques do not produce a genuine measure of explained variance (i.e., R^2), there are estimated measures of R^2 that are useful for providing an indication of the relative contribution of a variable or set of variables to a logistic analysis. Overall, the explanatory variables in block 1 account for nearly 20% of all variation in Internet use among school age children using the Nagelkerke estimation for a logistic regression for an R^2 ($R^n = 0.193$, see Table 16). When family characteristics (i.e., marital status and education level) enter the analysis in block 2, the Nagelkerke R^2 rises to 0.236, and when family financial resources (block 3) enter the analysis, the Nagelkerke R^2 rises to 0.253.

With the entry of household computing resources and expertise into the analysis in block 4, the largest increase in the Nagelkerke R^2, which rises from 0.253 to 0.381, is observed. Thus, an analysis of the Exp (B) coefficients indicates that the availability of household computer resources and expertise appear to be one of the major determinants of Internet use among school age children. Importantly, as noted above, when household computing resources and expertise enter the analysis, the greatest decline occurs in disparities in Internet use for children from Black non-Hispanic, Hispanic, and non-citizen households.

The importance of household computing resources and expertise in the performed analysis highlights the critical role of access to persons with technical experience for the acquisition of computing related skills. A major source of technical expertise for members of families undoubtedly comes from the occupational experience of adults. The current analysis suggests that technical experience, some of which is obtained in the workplace, can be transferred to other non-working members of the household. In this way, some of the frequent significant amounts of technical training given to US employees may be transferred to children in households where adults have benefited from such training. This human capital developed in the workplace, or "workplace capital", might then be transferred to other members of the household.

Of course, this type of transfer is not available to all households with children, because not all jobs require the same level of computer related expertise. Table 17 examines this question with regard to Internet use by adults across different types of occupations. Not surprisingly, there is a strong positive relationship between the level of occupational skill complexity and Internet use among adults. As Table 17 shows, over four-fifths (85.8%) of adults in managerial or professional occupations report they use the Internet, while only slightly over one-third (38.6%) of adults who are employed as machine operators or laborers report any use. Furthermore, only one-fourth (27.9%) of adults who are unemployed or not in the labor force report they use the Internet. Thus, Internet use among adults appears highly correlated with the procedural and technical requirements of their job. Professional and managerial occupations require significant amounts of these technical skills which, when learned, provide workers with increases in human capital that can also be transferred to the children in their households.

Table 17 Internet use of adults (18 years and over) by occupation

Occupation		Internet Use Anywhere by Adults		Total % Total#
		Yes	No	
1. in school - not in labor force(%)	%	82.1	17.9	100.0 (2,028)
2. managerial-professional(%)	%	85.8	14.2	100.0 (22,597)
3. Tech, sales, admin support(%)	%	73.9	26.1	100.0 (20,686)
4. Service occupations(%)	%	45.8	54.2	100.0 (9,707)
5. Precision prod, craft and repair(%)	%	48.3	51.7	100.0 (8,083)
6. Operators, laborers, etc.(%)	%	38.6	61.4	100.0 (11,617)
7. Not in labor force or unemployed(%)	%	27.9	72.1	100.0 (31,096)
Total percent	%	54.7	45.3	100.0 (105,811)

4.3 Summary of findings

The analysis found that a broad range of background characteristics, including the age of a child, the race and ethnicity of the household reference person, the gender of the household reference person, the geographic location of the household, and the ownership status of the family's residence were important determinants of Internet use among school age children. In terms of these factors, the most critical disparities in Internet use among school age children occurred among children from Black (non-Hispanic), Hispanic, and non-citizen households.

The analysis also showed that the level of family education, marital status and family income are important independent determinants of Internet use among school age children. In addition, the introduction of these factors into the analysis accounts for some of the disparity in Internet use among children from Black, non-Hispanic and Hispanic households and for children from non-U.S. citizen households. This indicates that children from these families in part, show lower levels of Internet use because they come from families with less income and education.

The most important finding of this analysis is that the availability of household computing resources and expertise showed the greatest impact of any set of attributes in reducing observed disparities in Internet use among school age children in Black (non-Hispanic), Hispanic and non-citizen households. Apart from family and child background characteristics entered in the first step of the analysis, the introduction of household computing resources and expertise appears to represent the single most important set of determinants of Internet use among school age children. Each of the three factors included in this step of the analysis, specifically, the presence of a computer(s) in the household, an adult(s) that uses the Internet at home, and/or an adult(s) that uses Internet outside the home are statistically significant and independent determinants of Internet use among school age children. The entry of household computing resources and expertise into the analysis also mediates much of the effect of family education, marital status, and income.

These findings indicate that children from Black (non-Hispanic) Hispanic and non-citizen families in part show lower levels of Internet use because they come from households that lack a computer(s) in the household, an adult(s) that uses the Internet in the household, and/or an adult(s) that uses the Internet outside the household. The effects are larger and independent of the effects of family income, education, and marital status.

This suggests that households with computing resources and expertise are much more able to support and encourage children to learn on the Internet. Some of these households may benefit in part from a type of transfer of capital skills that adults often learn in the workplace to children residing in their homes. This can be seen as a form of a transfer of "workplace human capital" or human capital acquired in the workplace to other members of the household. In addition, in home expertise is a form of "in kind" peer support contribution to children on a continual basis, similar to peer and co-worker support in the workplace. The technological complexity of certain occupations can provide a comparative advantage in terms of computer support and expertise to households beyond those obtained from income and benefits alone. Therefore, the availability of such expertise and support (independent of where adults acquire it) greatly increases the likelihood that children residing in households with such support will use Internet anywhere.

Finally, there is some evidence that schools are a factor in providing Internet access to school age children who do not have the resources to access the Internet at home. Evidence was found that school computing resources do make a difference in Internet access when school age children have little or no home based computing resources or expertise. School-based resources can mitigate mismatches in access depending on the availability of family resources. Unfortunately, the number of students per Internet connection is a poorly measured variable indicator. School level data are not captured at an appropriate level for adequate analysis that is consistent with the CPS personal and household level data used in this paper. Further analysis needs to be conducted with more recent school use data at the sub-state level, preferably at the school district level.

5 Conclusion and policy implications

The results of this study show that there are certain key factors, which, when present, can help reduce the observed disparities in Internet use among Black and Hispanic school age children and close the digital divide gap that exists among children in the US. The results of the performed study show that Internet use among school age children is significantly affected by the availability of computing resources and expertise. In particular, we found that Internet use among children appears most strongly affected by the presence of both in home access to a computer and the availability of technical support, expertise and informal training in the home.

Future public policy should focus on providing ways to expand and enhance universal access to the computer and Internet throughout society. In order to achieve the goal of universal access, a three-part policy strategy should be explored. The first part is to provide enhanced and expanded in home Internet access to support continued improvement in Internet access. This includes providing enhanced Internet access that could make access to broadband technology more available throughout the nation and supporting market policies that encourage continued decline in the total cost of ownership in order to enable more people to afford in-home access. The second part is to continue to support, through the Universal Service program, computer and Internet access provided to the public at out of home locations such as schools, libraries and CAC, many of which already have computers and Internet access. In addition, implicit in this strategy is to enhance access by making broadband technology more available in these public locations. The third crucial part is to provide readily available and appropriate technical support, training and expertise for Internet access anywhere, which will enable a wider range of children, perhaps with limited computing skills, to access the Internet.

5.1 In home Internet access

Providing expanded and enhanced in-home Internet access is perhaps the most effective method of increasing Internet use among school age children. As the results of the conducted study show, providing in-home Internet access is an important determinant of Internet use among school age children. However,The research also shows, that expertise in the home is an equally important determinant of Internet use. Some authors claim that in-home expertise is crucial to successful use of the Internet for educational purposes. Attewell [3], for example, asserts that a "social envelope" around computing, which includes the attitudes, competencies, and involvement of parents and siblings exists and is crucial to appropriate computer and Internet use for educational purposes.

The educational and occupational backgrounds of a child's parents [3, p 257] influence the level and extent of this social envelope. As Franzke pointed out, projects involving computer implementation within communities are often fraught with frustration because parents with limited skills are unable to obtain the necessary training and support to install and run their home computer systems [19, pp 15–16].

Providing broadband access both in the home and outside the home through schools, libraries and CAC would improve Internet access and performance (including interactive) and allow Internet to evolve toward a more educationally oriented medium. The improved speed of web access and navigation reduces the frustration associated with communication time delays, downloading programs and services, and learning. Broadband technology increases the likelihood of people accessing the Internet because it allows for the future merging of television broadcasting, interactive communication, and education to maximize interest.

This may become especially important when the next "broader band" version of the Internet is introduced to society. Although the USA continues to add broadband users at a steady rate of growth, they currently lag behind other developed countries, particularly the Far East, in acquiring and developing this technology. Among the top 15 developed nations, the USA currently ranks 11th in broadband penetration. While broadband penetration rates (which includes DSL, Cable, and other) for the Republic of Korea, Hong Kong and Canada are 21.3, 14.9 and 11.2%, respectively, the USA lags significantly behind at 6.6% [25, p 5 summary]. As the speed and penetration rates of broadband access around the world continue to grow, the USA must keep pace in order to strengthen its global position to help shape its future direction.

5.2 Out of home Internet access

For those unable to access the Internet from home, policymakers should recommend increasing spending to provide access to all segments of society including, schools, libraries, and CAC, which currently serve as a bridge between those who can and those who cannot access the Internet. This increased spending should include equipping these facilities with broadband technology.

NTIA supported the conclusion of increased spending to improve Internet access among children who access the Internet outside the home to continue to provide Internet the access at CACs. Providing Internet access to such external sources is crucial to those with low incomes (NTIA, 1999, July, p 78). In addition, NTIA indicated that the data supports the argument for continued funding of CACs by both industry and government through programs such as the Telecommunications and Information Infrastructure Assistance Program (TIIAP).

TIIAP has already funded a number of pioneering CAC efforts (NTIA, 1999, July, p 78).

Upgraded CACs could be supplied with an expanded number of state-of-the-art desktop computers with Internet connections. Connectivity could be improved to include access to broadband, in order to intensify services and make the centers more interactive. Additional software for purposes ranging from self-exploratory career development and job search to new learning techniques could improve the tools available to individuals, both adult and school age children, for information gathering, research, and exploration.

5.3 Providing training, technical support and expertise

The barriers to Internet access go well beyond just the cost of connectivity. In addition to connectivity fees, the availability of Internet hardware, software, and finally technical expertise and support resources, are critical in determining, ultimately, whether significant Internet connectivity is achievable throughout society. Findings indicate that access to in-home expertise in computers and the Internet can allow children to learn in an informal and peer-supported manner. Attewell points out that possession of computers and Internet technology alone does not ensure that children are able to use it effectively. There also must be recognition among parents of the importance of spending time with their children on the computer and the Internet [4, p 9]. Access in the home provides the foundation for the proper learning environment but it must be supported by informal and peer-supported instruction in order to be successful. In addition to spending time with children on the computer and the Internet, it is equally important that parents acquire the expertise to provide that support to children. This assumption is often better understood by more affluent and educated parents than by those less affluent and educated. This is not very different from how adults often acquire technology related skills, particularly in the workplace. According to the Gartner Group, many firms in the private sector pay significant fees for computer expertise and training, both on a formal and an informal basis.

Access to computer expertise and training must also be provided to those unable to access Internet from home. Furthermore, contrary to the belief of many, Internet use requires a certain level of basic skills, such as literacy and computer familiarity [43]. Providing expertise and training to children accessing the Internet in remote locations may be most important because these children have much less exposure to expertise and training on a regular basis than children with in-home access.

5.4 Impact on education

The central role of education in the debate over the expansion of universal access to the Internet has been widely recognized for some time. The focus in that debate has been to enhance education and there appears to be growing empirical support linking success in education and online access to the Internet. One of the first studies to compare the performance of students with online access to those without such access found a significant difference in developed skills in information management, communication, and presentation of ideas [18]. Hudson [22] notes that access to new telecommunication policies enhances the chances that developing structures will expand and improve access to distance education. Both argue that online communications have the strongest potential for breaking down the inequities faced by students of different socioeconomic, racial, and other backgrounds [18, p 4].

Although it appears that the impact of public school resources on reducing the disparities in Internet use among various groups of school age children is currently less than home computing resources, the problem may be in part because the school resource indicator is poorly measured. Public school resources devoted to Internet use among school age children are measured with a state level, aggregate variable. In order to gain a better understanding of where school resources are currently under spent throughout the nation, this indicator needs to be measured on an individual school level.

In addition to federal funding of Internet access in the public school system, state supplemental funding commitments are also important to the success of completing the task of wiring schools throughout the USA. State funding commitments make an important difference because richer states have an advantage over poorer ones in providing children with the future tools they will need to compete in the Information Age of the future [42].

This discussion highlights the need for an ongoing dialog, which should focus on incorporating both computing technology and policymaking into the mainstream of public education. Furthermore, these results highlight the need to engage in the larger ongoing dialog on the proliferation of computers and Internet use throughout society and their impact on the public educational system. On another level, Jackson and McDowell [26] have already articulated the importance of this type of dialog with regard to the introduction and use of new computing technology into higher education.

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References

1. Aczel AD, Sounderpandian J (2002) Complete business statistics, 5th Edition. McGraw-Hill, Irwin
2. Atkinson Rt, Leigh, A (2001) Clear thinking on the digital divide., Progressive Policy Institute, pp 1–20

3. Attewell P(2001) Comment: the first and second digital divides., Sociol Edu 74:252–259
4. Attewell P, Battle J (1999) home computers and school performance., Inform Soc 15:1–10
5. Baumgarten M (2003) L kids and the Internet: a developmental summary. ACM Comput Entertain 1(1); 2: 21-10
6. Blackman CR (1993) universal service: obligation or opportunity. Telecommun Policy 19(3):172–74
7. Canavan JE (1997) universal service policy in the United States: Where do we go from here?. Telecommunications 31(11):45–48
8. Cleary PF (1999) An Analysis of Internet use among school age children in the age of information., Ph D Dissertation, Northeastern University p 226–233
9. Companie, Benjamin M, Weintraub, Mitchell J (1997) Universal access to online services: an examination of the issue. Telecommun Policy 21(1):15–33
10. Connected to the Future (2002) The Corporation for Public Broadcasting, Grunwald Associates, pp 1–8
11. Corporation for Public Broadcasting (2003) Connected to the future: a report on children's internet use from the corporation for public broadcasting. Grunwald Associates.
12. Craig JD, Orlofsky GF (1999) Raising the bar on school technology., In: Technology Counts '99, Education Week, 19, (n4), p.58–69.
13. Creighton S, Hudson L (2002) Participation trends and patterns in adult education: 1991–1999., National Center for Education Statistics, U.S. Dept. of Education, pp1–81
14. DeBell M, Chapman C (2003, October) Computer and Internet use by children and adolescents in 2001., National Center for Education Statistics, U.S. Dept. of Education, pp 1–56
15. Druin A, InkpnKori (2001) Where are personnel technologies for children? vol 5. Springer, Berlin Heildelberg New york, pp 191–194
16. Dyson E (1997) Commun ACM 40(2):35–36
17. Education Week (2003) Tracking tech trends. Technology Counts.: State of the States Report
18. Follansbee S, Gilsdorf N (1996) The role of online communications in school: a national study. Center Applied Special Technology, Peabody
19. Franzke M, McClard A (1996) Winona gets wired: technical difficulties in the home. Commun CM 39(12):64–66
20. Gartner Group Report, 1998, October 12
21. Haugland SW (1992) The effect of computer software on preschool children's developmental gains. J Comput Childhood Edu 3(1):15–30
22. Hudson HA (1996) Universal service: the rural challenge, changing requirements and policy options. Benton Foundation, Communications Policy Working Paper Number 2, Washington, D.C. http://www.benton.org/Library/Rural/working 2.html, (24 November 1998)
23. Igbaria M (1999) The driving forces in the virtual society. Commun ACM 42(12):64–70
24. Internet Software Consortium (2000) http://www.isc.org/, 19 Jan 2001, p 1–2
25. ITU World Telecom Indicators Database (2003 September)
26. Jackson M, McDowell S (2000) Enhancing discourse on new technology within higher education. informa, commun soc, vol. 3, no. 4, Taylor& Francis, London, pp 629–638
27. Kling R (1998) Technological and social access to computing, information and communication technologies. White Paper for Presidential Advisory Committee on High-Performance Computing and Communications, Information Technology, and the Next Generation Internet, http://www.ccic.gov/ac/whitepapers.html
28. Lloyd M (2002) Reinvention of childhood in a networked world.. Australian Computer Society, Inc., pp1–4
29. Mansell R (2002) From digital divides to digital entitlements in knowledge societies.. Current Sociology, vol 50 no. 3. Sage, Beverly Hills, pp 407–426
30. Mengel S (1995) K12 and the Web, ACM SIGICE Bulletin, pp 20–24
31. The Milken Exchange (1998) Technology counts.: State of the States Report. Education Week
32. Moschella D, Atkinson R (1998) The Internet and Society. Progressive Policy Institute, Washington, D.C.
33. Mueller M (1993) Universal service in telephone history: a reconstruction. Telecommun Policy 12:352–369
34. Rust B, Stegman E (2003) Taking TCO to the classroom: a report and estimating tool for K-12 school districts. Why Total Cost of Ownership (TCO) Matters. Gartner Group Report, pp 1–9
35. Sawhney H (1994) Universal service: prosaic motives and great ideals. J Broadcast Electronic Media 38(4):375–395
36. Schement JR, Forbes SC (2000) Identifying temporary and permanent gaps in universal service. Inform Soc 16(2):117–127
37. Smolinski M (2000) The digital divide and american society. The Gartner Group, pp 1–34
38. Soloway E, Norris C (1998) Using technology to address old problems in new ways. Commun ACM 41(8):11–18
39. Soloway E, Norris C et al (2002) K-12 and the Internet. Commun ACM 43(1):19–23
40. TCO Models (1997) Compaq Computer Corporation, http://web.ics.purdue.edu/~kimfong/TCO/models.html
41. Technology Counts 98, The State of the States, Education Week, p.1–23, (www. Edweek.org/sreports/tc98/st/st-n.htm)
42. Trauth EM (2000) The culture of an information economy, influences and impacts in the Republic of Ireland. Kluwer, Dordrecht
43. Trauth EM, Kahn BK, Warden F (1991) Information literacy: an introduction to information systems. Macmillan, New York
44. U.S. Department of Commerce, Bureau of the Census (1999) A nation online: how Americans are expanding their use of the internet. National Telecommunications and Information Administration (NTIA)
45. U.S. Department of Commerce, Bureau of the Census (2002) Falling through the net: defining the digital divide, economics & statistics administration. National Telecommunications and Information Administration (NTIA)
46. U.S. Department of Labor, Bureau of Labor Statistics (BLS) (2000, spring) Occupational Outlook Quarterly, Occupational Projections, Washington, D.C., p 48
47. Webopedia, http://www.webopedia.com/TERM/T/TCO.html
48. Xavier P (1997) Universal service and public access in the networked society. Telecommun Policy, 21(9/10):829–843
49. Zastrocky M (1998) The Gartner Group, pp 1–34