Handbook of Research on Overcoming Digital Divides:
Constructing an Equitable and Competitive Information Society

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Chapter 11
Generation, Education, Gender, and Ethnicity in American Digital Divides

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ABSTRACT

Through increasing access to knowledge and facilitating widespread discourse, information and communication technology (ICT) is believed to hold the potential to level many societal barriers. Using national probability samples of United States adults from 1983 to 2006, I examine how gender, ethnicity, and education interacted with generation to influence computer ownership and Internet use. Narrower digital divides in more recent generations can mean greater future digital equality through cohort replacement. However, although gender is now of far less consequence than previously in ICT access and use, significant divides, especially in PC ownership and selected Internet uses have widened by ethnicity and education over five birth cohorts. On the other hand, results from earlier research interpreted as "aging effects" are most likely generational influences instead. Implications of these findings are discussed.

INTRODUCTION

Within only a few decades of its public inception, information and communication technology (ICT) has become indispensable to most Americans. By 2006, about 80% of U.S. adults were at least minimally involved with computers, cell phones or the Internet (Horrigan, 2007). By late 2006, over 75% of Americans at least age 12 had gone online, most at home (Center for the Digital Future, 2007). Kennedy, Smith, Wells and Wellman (2008) found that 52% of U.S. households had broadband connections and 77% had a resident go online.

Online users are positive about ICT: 41% of men and 35% of women in 2002 felt it would be "very hard" to "give up the Internet" (Fallows, 2005). Seventy percent of 2006 workers said the Web increased their productivity (Center for the Digital Future, 2007). Nevertheless, a significant minority of Americans totally abstains from ICT, a minority differentially distributed across ethnicity, age, degree level and other variables; ICT access

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and use also often vary along these dimensions. "Digital divides" refer to gaps in ICT access and use across individuals and groups who occupy different societal situses.

Even in the early days, national governments, academics and commerce centers recognized the potential of ICT to create a more equitable society. Digital technology can generate greater demand for skilled workers and thus potentially create more opportunities for previously disenfranchised groups who possess digital skills (e.g., DiMaggio, Hargittai, Celeste & Shafer, 2004). Certainly the United States, with its history of gender, ethnic, and social class divisions, ideology of equality, and technological development, provides an appealing test case to track computer and Internet gaps across generations.

In this study, I focus on how generation, combined with education, gender and ethnicity affects U.S. computer ownership, and selected Internet uses, examining how generational effects contrast with those of age or life cycle stage. Age is often considered a predictor for ICT, but generation, especially over a period of several years, typically is not. This study will show that the generational construct provides valuable information about digital divides and that earlier research using only the variable "age" can mislead. Using the General Social Survey and the NSF Surveys of Public Understanding of Science and Technology I track five generations of U.S. adults over periods ranging from one to 28 years. Many scholars, executives (e.g., Gates, 2005), and government agencies emphasize the need for Americans to be "technically adept"; with their educational focus, they seem to pin their hopes on "the next generation" growing up.

Examining education, gender and ethnicity across generations may show whether the advantages of ICT are diffusing, or which, if any, groups lag behind. Cohort analyses are more informative than studying ICT use across time (which tells us where we have been) or by age (which in a single period provides a snapshot of the present). Generational changes provide data for the future as recent cohorts replace earlier ones. If aging effects are small or nonexistent, then cohort effects can suggest relative permanence in ICT skills and use across the life cycle. *Thus I juxtapose adult developmental issues versus cohort socialization experiences*.

When data from just one time point are analyzed, age and cohort are inevitably confounded because earlier generations are simultaneously older adults. Nearly all "one shot" surveys find that senior adults use ICT the least. Meanwhile young adults are said to "omnivorously devour" ICT, (e.g., Horrigan, 2007). These studies cannot disentangle whether something causal about aging processes occurs, whether youthful enthusiasm promotes ICT use, or whether more recent cohorts simply have acclimated more to ICTs.[1]

Confusing aging with generation effects can have substantial consequences. Age and generational issues are more complex than simply tracking ICT use across time as many studies do. If divides converge, or even vanish, in recent birth cohorts, this implies the benefits of digital technology are now more evenly spread throughout society, possibly generating greater overall future equality as cohort replacement occurs. If "new adults", regardless of gender, ethnicity or educational level, have similar digital skills, employers who hire or advance women or minorities will acquire valuable workers; better quality employment among these groups thus can create more social equality.

Some employers may hesitate to hire or promote older workers because they fear "seniors" lack digital skills, and may be neither interested in—nor able to—acquire them. Due to age stereotypes older workers themselves may feel unable to learn such skills. However, if birth cohort is more implicated in ICT use than age, future supervisors will no longer be able to assume that older workers by definition are digitally naïve. Future seniors could benefit from better job opportunities, thereby combating "ageism". However, if gender,

ethnic or educational divides are static, or even widen by generation, then the United States can be expected to remain a country of digital have and have-nots for some time to come.

What Underlies Social Change?

My emphasis in this study on generation rather than simply on change over time or on "age" is not just semantics or statistical sleight of hand. Social changes occur several ways. One possibility is through *aging processes*; perhaps older people have more trouble learning new digital skills due to slower working memory or reaction times (Boyd & Bee, 2009). Middle-aged presbyopia can make tiny screens hard to read, particularly on gadgets such as cell phones.[2]

Second, *overall cultural transformations* can occur. More affordable ICTs, positive government policies (e.g., DiMaggio, et al., 2004; U.S. Department of Education, 2006), or even more favorable ICT images can stimulate greater adoption so that an entire society, irrespective of age or generation, engages in more frequent ICT use. For example, advertisers can emphasize to older people how email can rapidly and cheaply communicate with children or grandchildren.

In *cohort replacement on concomitant variables*, recent cohorts systematically differ from earlier ones on particular attributes; these attributes in turn directly predict ICT access and use. For example, if Baby Boomers are better educated than earlier generations, and education directly causes ICT use, then as Baby Boomers replace earlier cohorts, we would expect overall ICT use to rise simply because of enhanced education among the large Baby Boomer cohort.

Finally in direct cohort effects, members of a specific generation experience relatively unique events, predisposing them as a group to adopt certain behaviors. This study takes such an approach. Gen Y matured using computers and the Web at school and their parents provided computers at home (Kennedy, et al., 2008). Although access is not necessarily use, over 70% of [then] American teenagers in 2003 (U.S. Bureau of the Census, 2008: Table 253) indicated they had used a PC at home and 88% had used one at school; 72% of five to seven year olds had used a school computer in 2003. By secondary school, Gen Y had used computer games, and spreadsheet, presentation, and word processing programs.

Thus, recent cohorts should be *cognitively primed* to consume ICTs and adopt such innovations more easily than their predecessors, even controlling variables such as education or income in their early occupations. Further, drops in the costs of PCs or dialup access as well as burgeoning growth in broadband or DSL availability (e.g., Greenstein & Prince, 2006; Prieger & Hu, 2008) have aided the young Gen Y's access to digital equipment.

Research Questions

- How does generation interact with time to influence computer and Internet use?
- How do education, gender and ethnicity interact with generation to influence ICT use?
- Are digital divides widening, converging or remaining stable across generations?
- What are some implications of widening or converging generational digital divides?

The Digital Divide

Past research indicates that American men used ICT more than women, Whites more than Blacks or Hispanics, young adults more than the elderly, and the well educated more than those less so (Losh, 2004). "Digital divides" a term coined by the U.S. Department of Commerce in its "Falling through the Net" series (Victory & Cooper, 2002; Organisation for Economic Co-operation and Development, 2001), refer to such ethnic, gender, age, and other gaps in information technology access and use.

Digital Divides: Gender

Although U.S. computer innovators were college educated White professional and managerial men, women clerical workers often performed data entry or word processing. Early online and high-speed Internet users were also affluent White males (Buente & Robbin, 2008; DiMaggio, et al., 2004; Losh, 2004). These earlier data compare to current research in other global regions (e.g., De Haan, 2009; Demoussis & Giannakopoulos, 2006; Ono, 2005).

However, by the mid-2000s, many U.S. gender digital divides had closed (Fallows, 2005; Losh, 2004). Since education and occupation often involve computer and Internet use, this is unsurprising. Over the last part of the twentieth century, women's educational gains, greater labor force participation, and higher concentrations in the life and health science occupations (U.S. Bureau of the Census, 2008) where technology use is common (see Losh, 2004) likely played major roles in closing digital gender gaps.

In 2002 U.S. employed women and men owned a home PC at roughly equal rates; by then most computer owners regardless of gender or labor force status, went online (Losh, 2004). Science or technology professionals or managers of either sex in 2002 also had work computer access more often, although employed men more often than women had Internet access. Recent studies report that similar proportions of women and men now go online, although the amount and type of usage varies (e.g., Center for the Digital Future, 2007; Fallows, 2005).

A considerable gender gap remains in income, which is reflected in consumption patterns involving services, e.g., broadband subscriptions or length of online time for dialup users. Women spend less time online and men more often have high-speed entry (Fallows, 2005; Horrigan, 2008; Losh, 2004). Given that most U.S. married couples now have two household workers, married adults average higher incomes than single persons (U.S. Department of Commerce, 2008). Single women have the lowest income of all gender-marital status categories. During the early 2000s, single women least often went online or had home high-speed access, and women more often cited cost as a reason to stay offline than men (Fallows, 2005; Losh, 2004).

Although gender convergence on computer access has occurred, the sexes tend to use the Web differently. Men more often view news, entertainment, weather, or finance news, or do job-related research; women more often access health, maps, or religious sites and contact their children via ICT more often (Fallows, 2005, Kennedy, et al., 2008; also see review in Royal, 2008). Men are more familiar with technical terms such as spyware (Fallows, 2005). However, the Pew surveys find greater gender similarities among current teenagers than among older adults in activities such as downloading files or creating Web pages (Fallow, 2005; Horrigan, 2007). *Thus these "age differences" actually suggest fewer ICT gender gaps among recent cohorts*.

Digital Divides: Ethnicity

Although the gender data are positive, U.S. ethnic cleavages in ICT access and use continue (e.g., DiMaggio, et al., 2004). Black and Hispanic adults are disproportionately offline although some evidence suggests younger Hispanics frequently text through cell phones (Fox & Livingston, 2007; Horrigan, 2007; Lebo & Corante, 2003). Internet use is particularly low among older or female Latinos (Lebo & Corante, 2003; Fox & Livingston, 2007), and English fluency, U.S. nativity, and educational level are important determinants of Hispanic online access and use (e.g., Fairlie, 2004; Ono & Zavodny, 2007). Black and Hispanic Americans less often had home Internet access or high-speed connections (DiMaggio, et al. from Current Population Survey 2001 data, 2004). The kind of access Americans employ is important because broadband and wireless subscribers use the

Internet in more diverse ways for longer periods than dialup users. For example, Horrigan (2008) found that 47% of broadband users obtained news online on a "typical day" compared with only 18% of dialup customers.

Educational level is especially significant here partly because it intertwines with ethnicity, and with income and occupation. The latter play important roles in ICT use when comparing ethnic groups, and Blacks and Hispanics more often cite cost as a factor in Internet access (although education and income are not the entire story, see Fairlie, 2004; Ono & Zavodny, 2007; Prieger & Hu, 2008). Hispanics average less education and income than other U.S. ethnic groups and Blacks complete college at lower rates than Whites (U.S. Department of Commerce, 2008). Possibly due to lower incomes, Fox and Livingston (2007) found African Americans lacking a high school degree accessed the Internet less than their White counterparts. Blacks and Hispanics are also disproportionately concentrated in inner city areas where broadband may be less common or lower quality telephone lines make an Internet experience less satisfactory (e.g., see Greenstein & Prince, 2006; Prieger & Hu, 2008).

There are some more hopeful findings. *College graduates* in 2007 had similar online access regardless of ethnicity (Fox & Livingston, 2007). Young Hispanic and African American adults accessed the Internet in 2007 more often than earlier, although they lagged behind Whites the same age (Fox & Livingston, 2007). Some evidence (e.g., Horrigan, 2008) indicates that the recent *rate of growth* among broadband subscribers has been higher among Black Americans and Latinos than among Whites.

One recent study of Southeastern college students (Cotten & Jelenewicz, 2006) reported few ethnic differences in Web access or online time. However they analyzed an existing *Web survey* of freshman, thus only reaching students *who were online to begin with*. Most apparently received Internet access as part of their dormitory contract, thus obviating family income factors. Finally, Cotten and Jelenewicz (2006: 499-500) collapsed ethnicity into White versus "non-White", joining Asians, Blacks and Hispanics, dissimilar groups (see below) in ICT use.

Asian Americans receive scant attention in most studies of U.S. digital divides. This may be because Asian Americans are a smaller minority than Hispanics or Blacks, making sample projections unstable. Prior research is also inconsistent. Despite Greenstein and Prince's (2006) citation of NTIA data showing that Asians show more Internet use, Fairlie (2004) found Asians slightly less likely to use ICT than White Americans, as did Prieger and Hu (2008) in their Midwest data.

The reasons for such findings are unclear. Asian Americans are more educated than other ethnic groups (nearly half graduate college), more often earn science and math degrees, have higher incomes, and more often hold managerial, science, engineering, computer or mathematics jobs (U.S. Bureau of the Census, 2008: Tables 217, 218, 598 and 786). Net of income or education, for occupational reasons alone (e.g., Losh, 2004), Asian Americans should more often access or use ICTs. This is true even though equal percentages of Asian and Hispanic American students at all levels have at least one foreign born parent and speak a second language at home (U.S. Bureau of the Census, 2008: Tables 216 and 223), factors which depress ICT usage.

Although many U.S. gaps (e.g., "age") are reflected globally, I focus here on American digital divides for several reasons. First is to compare my findings with the copious prior research on U.S. adults. Consistency with earlier studies raises our confidence in the more unique results I report later, e.g., for Asians or "the elderly". Second, if not the most "connected" country, America is an international leader in digital access and use (Chinn & Fairlie, 2007). The overwhelming preponderance of English-language websites (Ono, 2005; Ono & Zavodny, 2007) makes English proficiency critical in the U.S. and abroad.

Generational results presented here may provide suggestions for other industrial and post-industrial countries, as well as for those just now entering the "information highway."

It is important to recognize that the United States is not alone in ethnic or cultural digital divides. For example, in this volume De Haan (2009) reports less ICT use among Moroccan and Turkish immigrants to the Netherlands than among the indigenous Dutch or Antilles migrants. U.S. immigrants use ICT less than natives (partly due to English fluency; Ono & Zavodny, 2007), and even after controlling income or education Northern and Southern Europeans differ (Demoussis & Giannakopoulos, 2006). Immigrants worldwide may even face discrimination using public facilities in schools, community centers or cyber cafés due to distinct appearances, speech or demeanor. And, many international studies simply omit ethnicity variables entirely although national histories (e.g., India or Japan) or new immigration patterns (e.g., Europe) would suggest the presence of ethnic prejudice or even caste lingering systems in several countries.

Digital Divides: Educational Level

As noted throughout, education is the most consistent global ICT predictor. Individuals with at least a baccalaureate are much more often innovators or early adopters of digital technology (e.g., DiMaggio, et al., 2004). The better educated more often own computers, have Internet home access, connect through broadband, and spend more time online (Buente & Robbin, 2008; DiMaggio, et al., 2004; Losh, 2004; Robinson, DiMaggio & Hargittai, 2003).

Part of educational level's effects is due to the more skilled occupations that well-educated workers hold and the digital demands and prerogatives of these jobs (Losh, 2004). Better-educated, skilled workers also earn more and thus can afford *at least* one computer (Center for the Digital Future, 2008) or high speed Internet. Horrigan (2008) reported that *85%* of U.S. households with at least $100,000 annual income subscribed to broadband, compared with only 25% of households with incomes of $20,000 or less.

But degree level means more than just being able to afford equipment and services. Well-educated adults are more cognitively primed to exploit the Internet: they have more online familiarity (thus typically more skills) and more experience in evaluating information. As a result, they can more often access the Web to improve their skills, locate useful information, or purchase bargains in goods or services, while the less educated more often access entertainment venues (Buente & Robbin, 2008; Robinson, et al., 2003).

Education may be one tool to surmount digital divides. As noted earlier, there are reports that irrespective of ethnicity the college educated access the Web equally. All U.S. ethnic groups have improved their high school and college graduation rates over time (U.S. Bureau of the Census, 2008: Table 217). Well-educated women and men have approximately equal connectivity. However, it is notable that those who earn less than college educated White men—women, Blacks and Hispanics, or older adults mistrust using credit cards online or purchasing online goods and services (Buente & Robbin, 2008; Fairlie, 2004; Fallows, 2005; Fox & Livingston, 2007).

Over 60% of American adults do not even have a two-year college degree. Although more recent cohorts have at least graduated high school, generations prior to the Baby Boom have less education (U.S, Department of Commerce, 2008). Thus we need to assess the status of digital divides for different degree levels across generations. Convergence by education could indicate that ICT is helping level classic U.S. social class divisions. On the other hand, if the digital divide widens across degree levels among more recent cohorts, the disparities will only add to the increasing "have" of the college educated, with their better jobs, higher incomes, and superior health contrasted with the "have-nots".

Digital Divides: Age Versus Generation

Do the "age differences" reported in ICT access and use reflect maturation processes or do they reflect unique experiences for specific generations that could exaggerate or minimize a digital divide? Physiological and social processes underlying cohort versus age differences differ. For example, midlife and senior citizens acquire new skills more slowly; once learned, however, young and middle-aged adults perform similarly (Boyd and Bee, 2009). Although senior citizens more often claim to be offline because they are "not interested," current midlife Baby Boomers, now ages 50 to 64 represent an ICT growth market (Horrigan, 2008).

Young adults spend more time than older adults creating social or romantic connections online, combating the tensions from school, and establishing a work life; thus they more often use the Web for romantic or entertainment purposes (Horrigan, 2007; 2008; Kennedy, et al., 2008; Pew Research Center, 2007). Midlife adults more often use the Web for business (Latinos less so, Fox & Livingston, 2007). "Everyone" except the very old uses email, although younger adults (including Latinos) more often send text messages (Fox, 2005). Both young and midlife adults use search engines more now (Fallow, 2008). These kinds of differences reported in America and globally (Center for the Digital Future, 2007; Demoussis & Giannakopoulos, 2006; Horrigan, 2008; Ono, 2005; Pew Internet and the American Life Project, 2007) are probably *age or life cycle stage*, rather than cohort related, social behaviors.

It is noteworthy that the number of older adults using computers and the Web is increasing (Horrigan, 2008). On a "typical day" Fallows (2008) found 40% of U.S. adults aged 50 to 64 used a search engine, as did 27% of those 65 or older. Seniors (32%) were second only to 18 to 29 year olds (49%) in saying the Internet improved their connections to friends and the *most likely to say* it improved their connections with family (Kennedy, et al, 2008: 26).

To examine generations, we need to know when particular cohorts begin and end (Glenn, 2005, Pew, 2007; Prokos & Padavic, 2005). Rather than using a constant time interval, cohorts are usually constructed considering both time and significant events occurring when older children or adults can consciously experience them. For example, "Gen Y" adults born in the late 1970s to late 1980s arrived too recently to remember "punch" or "IBM cards".

The generations differ considerably in their ICT exposure, new skills to be learned, and new services to purchase, e.g., broadband. Those from the late nineteenth and early twentieth centuries experienced telephones, radios, and air travel, but many either retired or died before widespread Internet availability. The "Lucky Few" (Carlson, 2008) matured in the boom economic years after World War Two; although unexposed to computers in their youth, due to free time during retirement and greater discretionary income this generation actually represents a growing ICT market (Horrigan, 2008). "Baby Boomers" matured in affluence, became well educated (often using computers in college)—only to face stiff job competition; their economic constraints to some extent limited their equipment or broadband purchases. However, Baby Boomers too are increasing home high-speed Internet use (Horrigan, 2008). PCs were common as "Generation X" matured while "Gen Y" has had the most youthful and young adult exposure to Internet access at school, work and home (see earlier review under direct cohort effects).

These cohort—and possible age—differences in ICT ease have implications for other digital inequalities. Do American women overall slightly lag behind men in particular ICT uses because they are older than men as a group or is some form of "sex difference" involved, such as "nurturing human relations," searching for different information online than men, or using the Internet somewhat less than men do "just for fun" (Buente & Robbin,

2008; Fallows, 2005)? Gender may also interact with ethnicity (Fallows, 2005, reported Black women use more online time than Black men). Since Black and Hispanic Americans are younger overall than Whites, ethnicity may intertwine with age. Is ICT use less among Hispanics because this group is younger, thus less apt to have the economic resources to buy, say, broadband services, or are other, more cultural and less transient, factors involved? These questions imply that multivariate controls are needed to disentangle just what particular digital divides really mean.

METHODS

The Data: The NSF Surveys of Public Understanding and the General Social Survey

American surveys about science and technology adult "literacy" date from at least the 1950s (e.g., Withey, 1959). The best-known series is the National Science Foundation Surveys of Public Understanding of Science and Technology (see Miller, Kimmel & ORC Macro, 2005 and Davis & Smith 2006), which also coordinate with several international surveys, such as the Eurobarometer (e.g., Allum, Sturgis, Tabourzi & Brunton-Smith, 2008). The 1979-2006 NSF Surveys archive is the most comprehensive study of U.S. adult civic science and technology literacy available[3], comprising 23,906 unweighted interviews in 12 probability sample surveys. Items monitor several knowledge, attitude and practice dimensions.

This research uses the NSF data on computer and information technology available for 1983, 1985, 1988, 1990, 1995, 1997, and 1999, all Random Digital Dial telephone surveys of U.S. adults plus the 2002 and 2006 General Social Survey data (GSS), in-person probability area sample U.S surveys.[4] Only 2002 and 2006 respondents with landlines or cell phones (95 percent of the total) are analyzed to maximize comparisons with the earlier NSF data. The total case base for this study when all nine surveys are analyzed is 18,125 adults 18 years and older.

Time Series Measures on IT Access and Use

Most analyses are more circumscribed than the total. Data on PC ownership stretch from 1983 to 2006. Home Internet access and estimated annual online hours are available from 1995 to 2006. Data on online hours through 2002 were estimated using the grand total from several questions (e.g., home, work, email); in contrast, only one item was available in the 2006 survey, thus 2006 figures are slightly lower than in earlier years. Although primary sources used by the individual to access general news (e.g., newspaper or television) are present for 1985, 1988 and 2006, and science news sources for 1990, 1995 and 2006, the Internet as a primary source is really only available for 2006 (in 1995 only three people relied on the Web for science news). Thus sample sizes range from 1962 (2006) to 18,125[5] and ns are referenced in tables and figures.

Time Series Measures on Background Variables

Data on gender, education, age and birth cohort are available from 1983 to 2006. Although its utility as a predictor is well established, income data are unavailable for the NSF series. Data on ethnicity are available for 1999, 2002 and 2006 (still highly relevant years as ICT access and use evolve). Education has four levels: at least some graduate school, a baccalaureate degree, an Associate of Arts or two year vocational degree, and at most a high school diploma. Gender is used as a dummy variable (male = 1); when it is a factor, ethnicity is coded: White ("Euro") American; Black (African) American, Asian American and Latino or Hispanic (not

elsewhere classified). In regression analyses, these are coded as dummy variables with White as the reference or omitted category.

Birth Cohort or Generation and Age Categories:

One example of cohort debates is when the U.S. "Baby Boom" ended. Scholars agree that it began in 1946 (Carlson, 2008). Some end "the boom" in 1957, when birth rates peak, others in 1961 when the absolute number of births peaks. Since "Generation X" is generally agreed to begin in the early 1960s, I ended the Baby Boom in 1961, beginning "Generation X" in 1962. The five created cohorts are: Gen Y, sometimes called "Generation Next" or "Millenials", born 1979 to 1988; Generation X (1962 – 1978); Baby Boomer (1946 – 1961); The Lucky Few (1930 – 1945); and the Early Years (1891 –1929).[6]

Pragmatically some cohorts are small in these data. I omitted 86 respondents born before 1891 because they are scarce in recent data and because dementia rates rise after age 80, making their later responses possibly unreliable. Cumulatively, by 2006, 711 Gen Y respondents were age 18 or more. Future surveys, of course, will enlarge this cohort. Pre WWI respondents (n = 1836) not only have aged (or died by 2006), but many items analyzed here were not asked until 1988 or later, decimating their numbers still further.

For analysis (including cross-tabulation tables and analyses of variance), I represent respondent age in five groups approximately corresponding to U.S. federal government use: 18-24; 25-34; 35-44; 45-64; and age 65 and over. Although age group and cohort positively correlate overall (r = 0.65) because older individuals in the study years tend to be from earlier cohorts, there is still some independence between these two variables.

GENERAL ANALYTIC PLAN

First I present overall results for computer ownership, home Internet access, estimated online time, and using the Internet as a primary news or science news source. Later I show how these ICT uses vary by education, gender and ethnicity. Because I presented many of the cross time results through 2002 earlier (Losh, 2004), here I center either on exceptions to earlier trends or on how time and ethnicity combine for 1999 to 2006. *My primary focus is on how generation interacts with education, gender and ethnicity* because cohort replacement gives us a better indication of many future trends than simply observing change over time.

My early analyses employ two-way analyses of covariance, examining how generation and, in turn, education, gender and ethnicity affect ICT access and use. Depending on the focal predictor, degree level and gender become covariates. Ethnicity is controlled only for the 2006 news access questions. If ethnicity is a set of dummy covariates for PC ownership, home Web access or online time, the series shrinks to 1999 to 2006 (however, see the regression analyses, which do include ethnicity). Age group is a covariate for computer ownership, home Web access and online hours, but not for news access; with only the 2006 data, generation and age group are synonymous and the analytic system is unsolvable. Finally a set of five regression equations on ICT access and use are shown, each including degree level, age group (except for news access), cohort, gender, and ethnicity (with Whites as the omitted dummy variable category).

Means or percentages for outcome variables are shown throughout. I use the following conventions: when only main and covariate ANCOVA effects occur, Multiple Classification Analysis (MCA), a general linear model program in SPSS ANOVA (Nie, Hull, Jenkins Steinbrenner & Bent, 1975: Chapter 22), is used to create adjusted mean scores. MCA provides adjusted "Beta" predictor

Table 1. Percent of general population owning a home computer over time and by gender

Year	1983	1985	1988	1990	1995	1997	1999	2002	2006
% who own (all)	7.6	14.8*	18.5*	22.2*	36.6*	42.5	53.9	58.3	68.8*
Male	7.3	16.7*	21.4*	26.5*	40.9*	43.9	54.8	59.1	71.0*
Female	7.9	13.1*	16.0*	18.3*	32.8*	41.3	53.0	57.7	67.1*
n	1645	2019	2041	2033	2006	2000	1882	2616	1817

*Comparisons by Gender that year, $p < 0.05$

coefficients, deviations from the dependent variable grand mean. However, MCA Betas do not incorporate interaction terms, so when statistical interactions occur between year or generation, and predictors such as ethnicity, the observed, unadjusted mean scores from the analyses of variance are shown. MCA also produces an "R" statistic analogous to eta (η) in analysis of variance or R in multiple regression.

OVERALL RESULTS

Over the 28 years (maximum) covered by these data, critical for ICT adoption, Americans vastly increased their ICT access and use. Table 1 shows how the percentage of individuals owning a computer rose dramatically from 8% in 1983 to 69% by 2006 with the greatest gains in the mid- to late 1990s ($X^2_{(8)} = 3093.32$, $p < .001$, $r = 0.41$).

Similarly, overall U.S. home Internet access leaped from 1995 to 2006. In 1995 7% reported home access; for all households this rose to 16% in 1997, 28% in 1999, 52% in 2002 and 64% by 2006 ($X^2_{(4)} = 2117.77$, $p < .001$, $r = 0.44$). For PC owners the fraction of home Web users was higher still (Table 2). By 2006 virtually every U.S. computer owner had home Internet access. Indeed many households probably acquired a computer precisely to use the Web. Thus owning a PC is now "the gateway" for Internet access. Those who can only use a computer at school, work, cafés, libraries or community centers, with their limited hours of operation, typically cannot exploit the Internet as much as those who own their own computer.

The number of annual online hours rose from 5.6 in 1995 to 316 by 2006 ($F_{4,10299} = 351.08$, $p < .001$, $\eta = 0.35$). Between 1999 and 2002 (calculated identically) a jump occurred from 86 to 386 hours. The slight dip in 2006 may reflect question changes noted earlier—but it may also mirror the increasing American norm of home Web access, with less experienced users going online for fewer hours than earlier adopters who came on board between 2002 and 2006. It is also possible that amalgamating many usage items caused overestimates for 1995 to 2002.

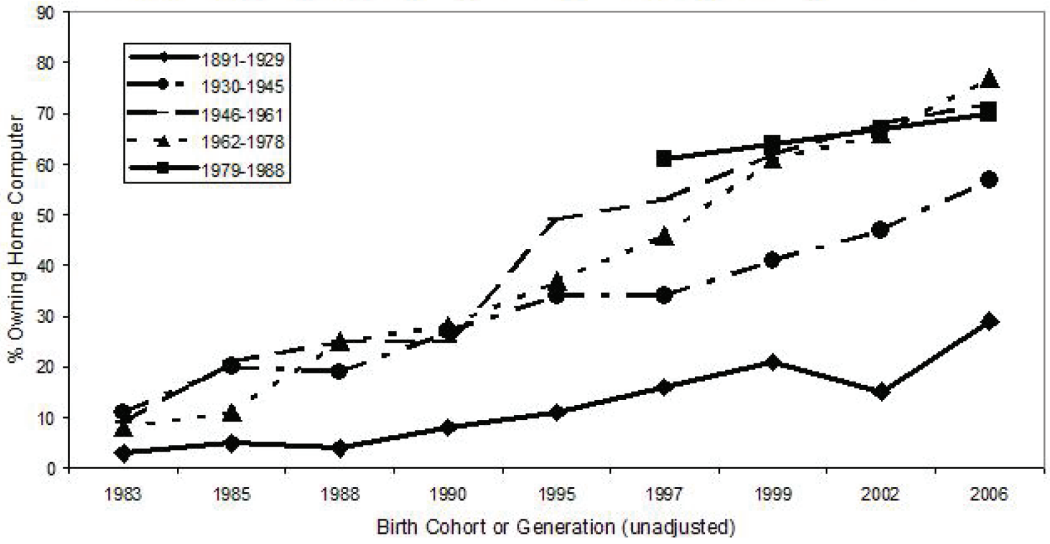
Finally, in 2006, 14% of the sample used the Internet as their major news source, compared with

Table 2. Percent of those owning a home computer who have home internet access

Year	1995	1997	1999	2002	2006
% with home Internet access (all)	32.5*	71.3*	86.1*	95.5	100.0
Male	37.4*	79.2*	90.4*	95.6	100.0
Female	26.3*	62.7*	81.8*	95.4	100.0
n	418	453	610	1361	1250

*Comparisons by Gender that year, $p < 0.05$

Figure 1. Time and generation effects on % home PC ownership 1983-2006 (n=18011)



50% relying on television, 24% on newspapers and 6% on radio. Significantly more adults, 23%, used the Internet as their primary science news source (paired *t*, 9.82 with $n = 1818$, $p < .001$); 41% watched science news on television, 11% read newspapers, 11% read magazines, and only 2% largely obtained science news via radio. Using the Internet for science information is particularly impressive when we realize how many outlets TV and magazines provide. Unlike newspapers, magazines, or even television, Internet news is constantly updated, adding to its appeal. Websites can also report in more depth than most radio or television broadcasts. However, an infinite variety of online news sites exist, some of them unabashedly partisan or even biased in what they choose to present.

GENERATIONAL EFFECTS OVERALL

Any narrowing of digital divides across recent cohorts is generally considered promising for those who hope that greater social equity will follow more digital equality. Furthermore, such convergence could mean that employers can expect more uniform ICT experiences among more recent birth cohorts regardless of gender or ethnicity. However, the generational data are mixed. Figure 1 shows how computer ownership varied by cohort over time. Because of the cohort and time interaction ($F_{27, 17971} = 13.33$, $p < .001$) Figure 1 presents unadjusted mean scores (MCA adjustments only consider main and covariate effects, not statistical moderators).

Very few individuals owned a PC in 1983 and thus ownership initially varied little across the four earliest sample generations. However, by 1988, gaps began between the 1891-1929 cohort (whose youngest members were then just under 60) and those born later. In 1997, another wedge opened between the Lucky Few cohort (1930-1945) and more recent generations. By 2006, at least 70% of Baby Boomers, Generation X and Gen Y owned a home computer compared with 57% of the Lucky Few and only 29% of the by now elderly earliest cohort. Time ($F_{8, 17971} = 355.17$, $p < .001$) and cohort ($F_{4, 17971} = 543.45$, $p < .001$) main effects were also significant (total $R = 0.46$).

Figure 2. % home Internet access (those with home PC) by generation and time (n=4142)

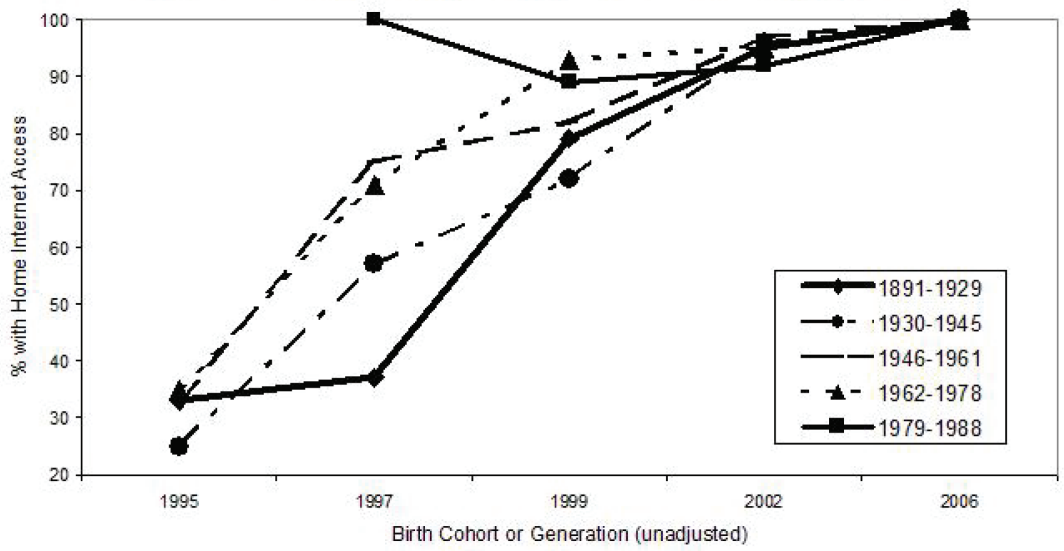


Figure 2 presents a dramatic example of how PC ownership has become the Internet gateway, irrespective of other factors. Given the study year-cohort interaction ($F_{15, 4118} = 6.10, p < .001$), I present unadjusted percentages. Although more recent generations obtained home Web access at younger ages than earlier cohorts, most generation gaps closed by 2002 for computer owners, totally converging by 2006. Quite simply, a home computer in the United States now is synonymous with home Internet access. Main effects for year ($F_{4, 17971} = 543.53, p < .001$) and generation ($F_{4, 17971} = 21.94, p < .001$) were also statistically significant ($R = 0.59$).

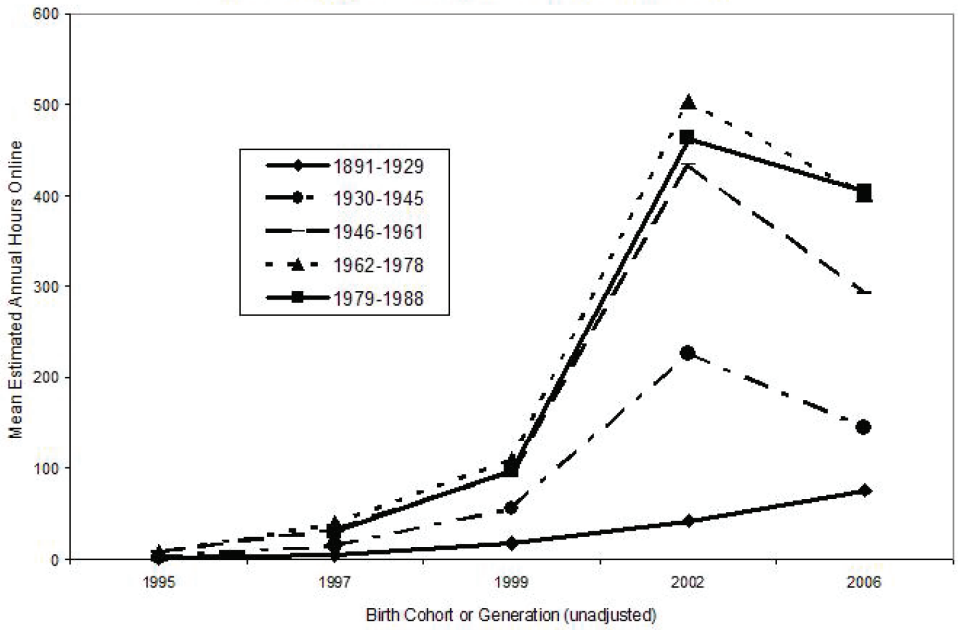
Even among PC owners, however, cohort affected online time. Figure 3 shows how generation and study year affected the hours users spent online. An interaction occurred between study year and cohort ($F_{4, 10241} = 13.44, p < .001$); all significance tests control gender and education. Although all generations increased their online time between 1995 and 2006 (main effect, year, $F_{4, 10241} = 272.45, p < .001$), Baby Boom, Generation X and Gen Y members took the most advantage of Internet access (main effect, cohort, $F_{4, 10241} = 34.48, p < .001$). Even with the slightly different estimates of online time in 2006, the interaction, coupled with the data presented in Figure 3, indicate that differences across generations widened over time.

Generation predicted using the Web as a primary news source ($F_{4, 1807} = 33.47, p < .001$, total R with covariates = 0.33) or for science news ($F_{4, 1807} = 34.05, p < .001$, total R with covariates = 0.32); 29% of Gen Y used the Internet as a primary news source, as did 18% of Generation X compared with only 8% of Baby Boomers, 5% of the Lucky Few and 1% of the Early Years. For science news, 42% of Gen Y turned first to the Web, compared with 26% of Generation X, 19% of Baby Boomers, 10% of the Lucky Few and 3% of the Early Years.[7]

Generation and Education

Obviously individuals *within* generations differ on many characteristics. In particular, I examine degree level, gender and ethnicity, which in the U.S. and globally predict digital splits. If digital divides across levels of these attributes converge by cohort, one outcome will be an interaction effect between generation and the particular

Figure 3. Generation and time effects on annual online hours (n=10268)



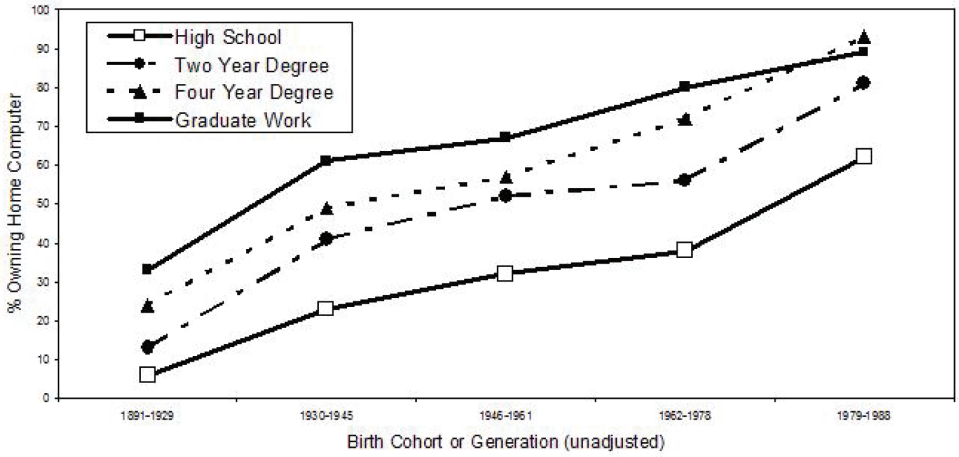
characteristic examined (e.g., degree level), as differences narrow among more recent cohorts compared with earlier ones. One such example was shown in Figure 2 for home Internet access by generation over time.

Note however, that statistical interaction can also happen *if differences across attributes widen by cohort*. It turns out that greater divides occur quite often. Finally, the lack of such an interaction implies that differences by education, gender or ethnicity on a particular ICT remained parallel or static by generation, neither widening nor converging.

Educational level has consistently been a top ICT predictor, partly because baccalaureates more often hold jobs in which digital technology use is critical, partly because well-educated individuals are wealthier, and partly because the college educated tend to be more cognitively prepared to utilize online opportunities. Among the most recent cohort, "Gen Y" young adults with two-year degrees significantly progressed on PC ownership compared with earlier cohorts (Figure 4)—thus almost certainly having home Internet access[8]. However, high school educated young adults lagged behind: only 62% owned a computer, compared with 81% of those with a two-year degree, 93% of baccalaureates and 89% of those with graduate school. Net main effects for education ($F_{3, 17982} = 409.87$, $p < .001$), cohort ($F_{4, 17982} = 801.33$, $p < .001$), and their interaction ($F_{12, 17982} = 2.10$, $p < .05$, total R including covariates gender and age = 0.46) were all statistically significant. All figures in this education section show unadjusted means because comparable degree-generation interaction effects occurred on all ICT variables analyzed.

Online time varied by education and generation (Figure 5). This analysis illustrates how an interaction ($F_{12, 10247} = 2.71$, $p < .001$) can occur because educational differences widened across generations. A gap in online time opened and enlarged between those with at least a four-year degree and those with less education. The division begins in the Early Years cohort, then increases. Both cohort ($F_{4, 10247} = 121.44$, $p < .001$) and de-

Figure 4. Generation and degree level effects on % home PC ownership 2006 (n=1812)



gree ($F_{3,10247} = 88.70$, $p < .001$, total R including covariates = 0.27) main effects occur as well as the interaction.

Figure 6 shows how cohort and degree affected accessing news in 2006; Figure 7 shows how both affected science news access. Given differences in online time by generation and degree, the interactions for accessing regular news ($F_{12, 1793} = 4.50$, $p < .001$) and science news ($F_{12, 1793} = 2.65$, $p = .002$) are consistent. The better educated ($F_{3, 1793} = 28.20$, $p < .001$), and Generations X and Y ($F_{4, 1793} = 32.39$, $p < .001$, total R with gender as a covariate = 0.33)[9] most often accessed Web news, and differences widened by education among more recent cohorts. Comparable main effects for degree ($F_{3, 1793} = 27.44$, $p < .001$) and cohort ($F_{4, 1793} = 33.04$, $p < .001$, total R with gender as a covariate = 0.33), as well as greater educational

Figure 5. Generation and degree effects on annual online hours 1995-2005 (n=10,259)

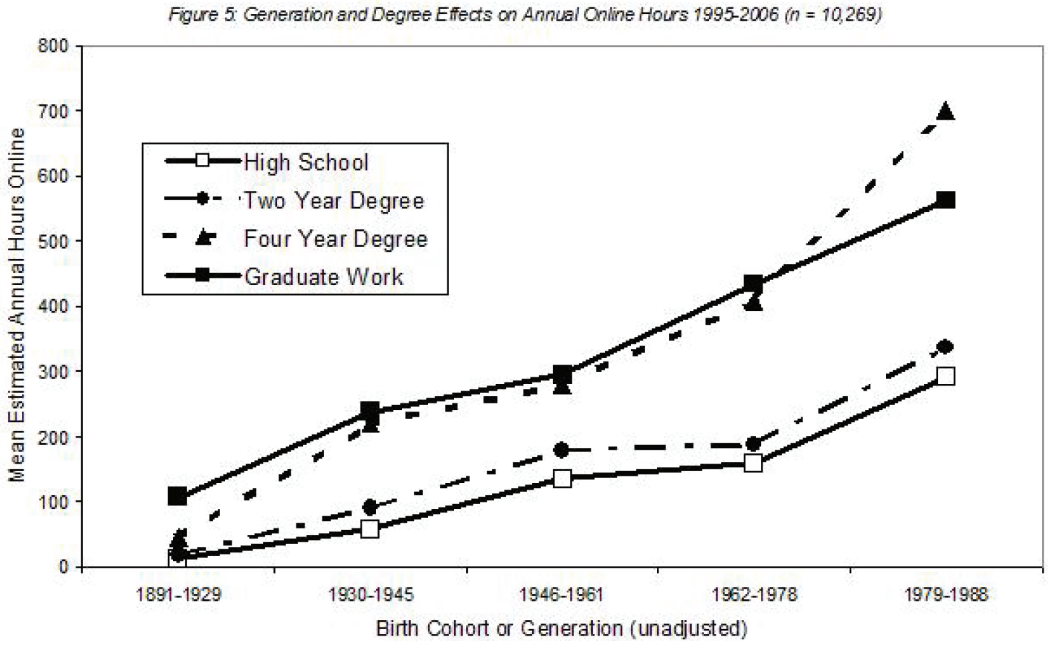
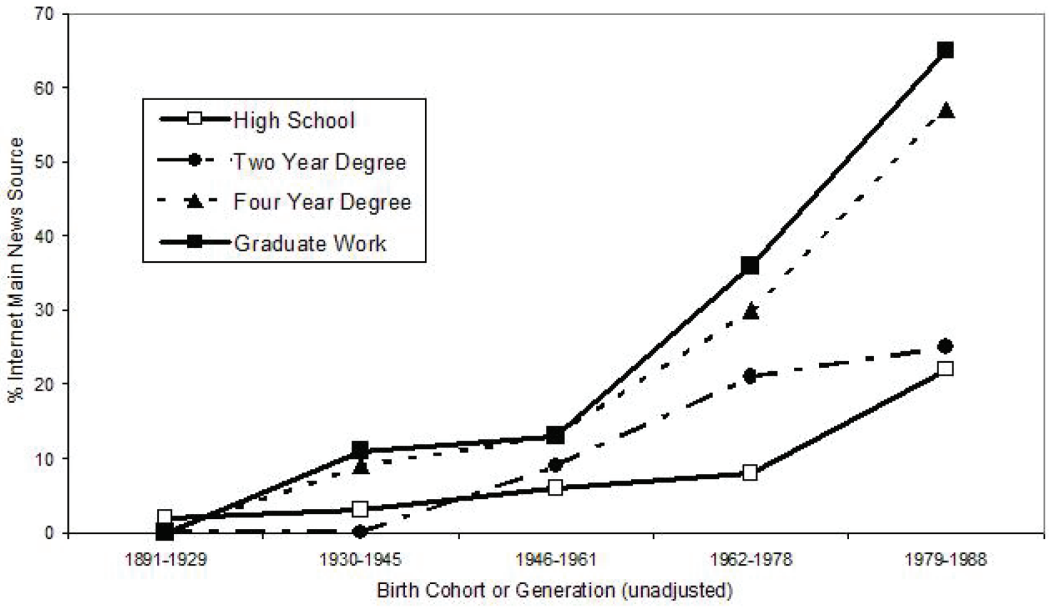


Figure 6. Generation and degree level effects on % accessing Internet news 2006 (n=1814)



gaps among more recent cohorts, also occurred for accessing Internet science news. The largest differences were between those with at least four years of college and those with less education.

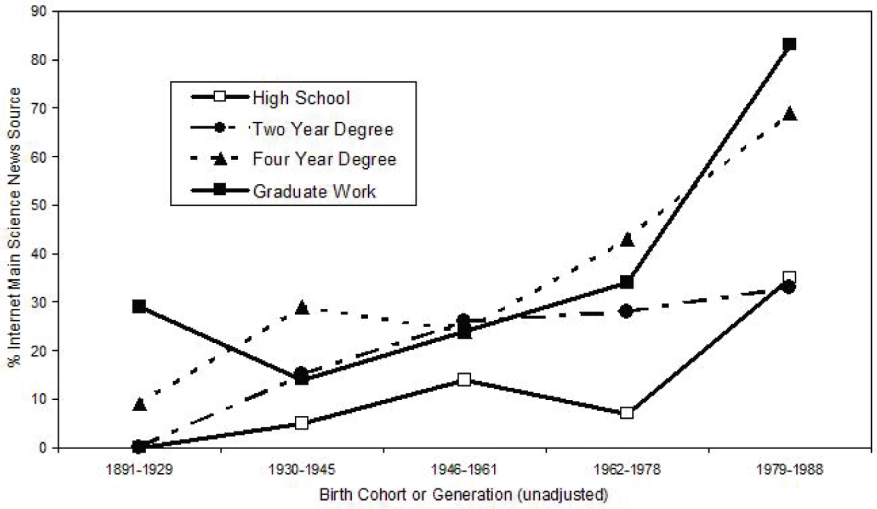
Generation and Gender

At one point, gender was a primary digital divide. American scholars still report gender differences in Internet use (Fallows, 2005; Royal, 2008). Gender still influences ICT access and use in many Asian and European nations (Demoussis & Giannakopoulos, 2006; Ono, 2005). However, much gender convergence in U.S. PC ownership (thus also in home Web access) has occurred (Figure 8), whether all aggregated study years are considered or just 2006. This time, there is a statistically significant gender by cohort interaction for the entire sample ($F_{4, 17992} = 3.18$, $p = .013$) because male and female "Gen Yers" are nearly equivalent in computer ownership. The 2006 data show a very minimal overall gender division (males, 71%, females 67%, $t_{1815} = 1.82$ $p = .07$).

This similarity of gender by cohort in PC ownership and home Web access also occurs for online time and accessing general or science news. For parsimony, therefore, graphs with these digital divide convergences are omitted[10] although the results are summarized below. There was no gender-cohort interaction on annual online time ($F_{4, 10257} = 1.03$, $p = .390$) although men used the Internet for slightly more hours than women (all, 193 versus 162 hours; for Gen Y, 359 versus 317; $F_{1, 10257} = 6.55$, $p = .011$). The huge gap was across cohort: 337 hours for Gen Y versus 21 for the Early Years cohort ($F_{4, 10257} = 107.18$, $p < .001$, total R including covariates = 0.27). The steepest difference (over 100 hours per year) occurred between Generations X and Y.

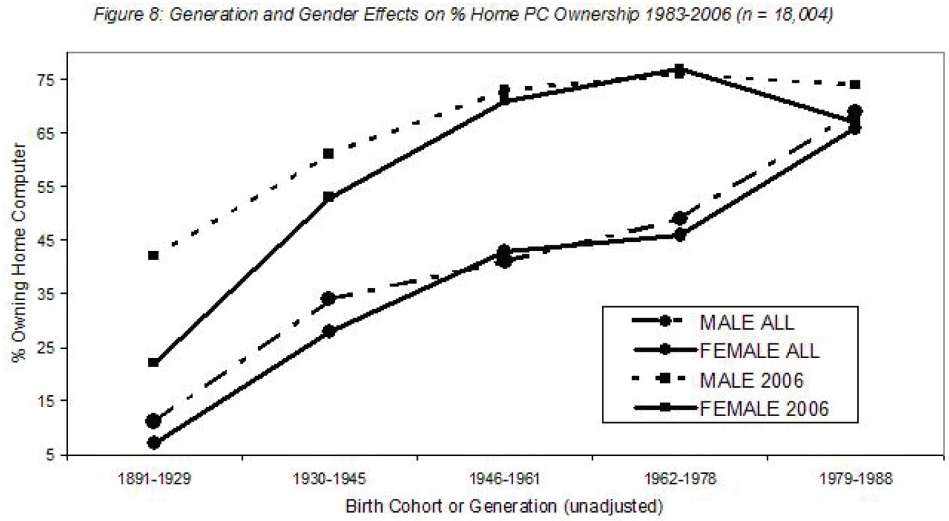
Very borderline gender-cohort interactions occurred for using the 'Net as a primary news source ($F_{4, 1803} = 1.95$, $p = .100$) or as a science news source ($F_{4, 1803} = 2.03$, $p = .087$). Gen Y women accessed general online news (30 versus 28%) and science news (45 versus 39%) slightly more than men. Overall, men ($F_{1, 1803} = 10.43$, $p = .001$) and more recent cohorts (29% for Gen Y

Figure 7. Generation and degree level effects on % Internet science news 2006 (n=1814)



versus 1% for the Early Years, $F_{4, 1803} = 33.54$, $p < .001$, R using education as a covariate = 0.33) accessed Internet news more often. Only a borderline sex difference occurred on science news ($F_{1, 1803} = 3.02$, $p = .082$) although again a sizable cohort difference occurred (42% for Gen Y versus 3% for the Early Years, $F_{4, 1803} = 34.12$, $p < .001$, overall $R = 0.32$).

Figure 8. Generation and gender effects on % home PC ownership 1983-2006 (n+18,004)



Contrasting with the educational findings, gender by generation results present a more positive picture of digital convergence among U.S. adults. Perhaps women's greater labor force participation, particularly in biological and health sciences, have made ICT acquisition more affordable and its use much more functional and attractive. As the literature cited earlier suggests, women also increasingly use the Internet to solidify social ties, and this desire, too, can contribute to greater ICT use and a closing of the American gender digital divide.

Generation and Ethnicity

The news is mixed for generation and ethnicity. Figure 9 shows computer ownership by ethnicity and time while Figure 10 presents it by ethnicity and cohort, controlling education, age and gender. Because Black and Hispanic Americans are younger, they may not yet have become economically established enough to afford a PC or Internet service. Sample Asian Americans had the highest degree levels (54% had at least a baccalaureate in 2006) compared with White- (31%), Black- (11%) or Hispanic Americans (5%; $X^2_{(9)} = 130.94$, $p < .001$).

With education, age and gender controlled, across time White and Asian Americans most often owned a PC. There were statistically significant effects for age (older people less often owned a computer), degree (high school graduates less often owned a PC), time ($F_{2,6151} = 55.88, p < .001$) and ethnicity ($F_{3,6151} = 33.67, p < .001$) but no overall gender difference. Because the year by ethnicity interaction was not statistically significant ($F_{6,6151} = 0.88$, $p = .507$, total $R = 0.24$), adjusted MCA percentages are reported in Figure 9.

Similar effects occurred when generation was substituted for time; however, the cohort by ethnicity interaction was statistically significant ($F_{12, 6137} = 2.10$, $p < .05$, total $R = 0.43$) due to an Hispanic-African-American similarity to other ethnicities only for Baby Boomers, which widened again for Generations X and Y. Recent cohorts more often owned a PC ($F_{4,6137} = 71.49, p < .001$) and Whites and Asians owned a computer (the adjusted means by cohort were identical) more than Hispanics, followed by Blacks (ethnicity $F_{3,6137} = 34.09$, $p < .001$).

Figure 9. Time and ethnicity effects on % home PC ownership (n=6178)

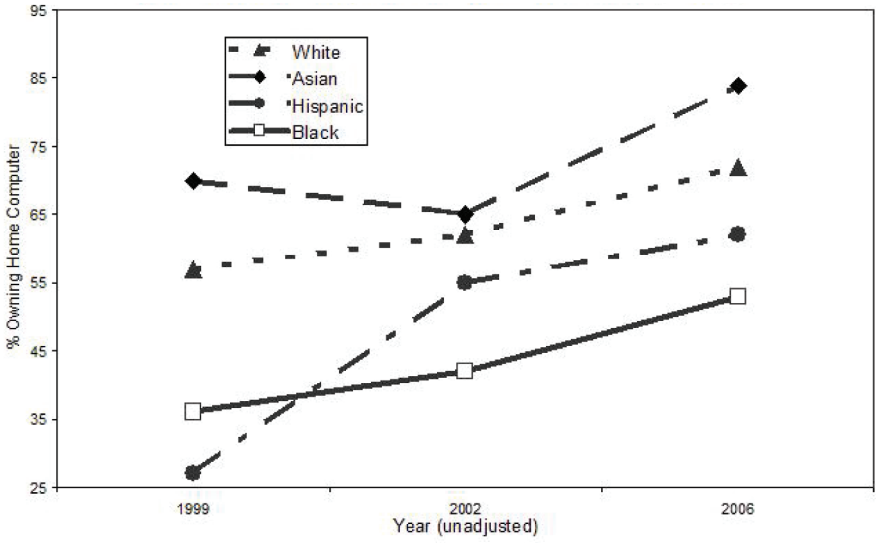
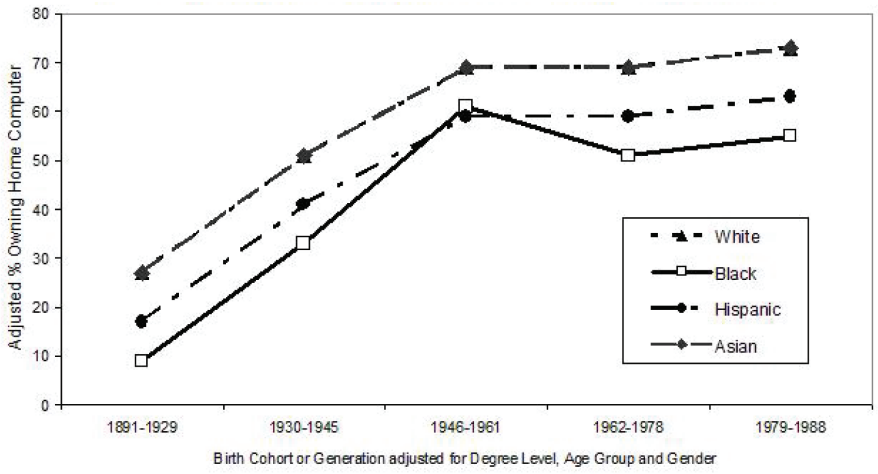


Figure 10. Generation and ethnicity effects on home PC ownership 1999-2006 (n=6160)



Although PC ownership is synonymous with Internet access, divides can still occur in online use. A divide in online hours can reflect ethnic income disparities making broadband more of a financial hardship. Thus we would expect White and Asian Americans to be online longer than Hispanic or Black Americans. Any divides in news access, on the other hand, may be more driven by education than by other factors since news access entails no additional connection costs.

Figures 11 and 12 show how online hours varied by ethnicity over time and, next, by cohort. Ethnic divides continued even in 2006 (year, $F_{2, 6138} = 189.36$, $p < .001$; ethnicity, $F_{2,6138} = 3.69$, $p = 0.01$, total $R = 0.33$). Asians spent the most time online, followed by Whites and Hispanics, then Black Americans. Because the ethnicity by year interaction was not significant ($F_{6,6138} = 1.20$, $p = 0.304$), adjusted mean hours are shown in Figure 11.

Because there was a significant interaction between ethnicity and cohort ($F_{12,6124} = 2.29$, $p = .007$, total $R = 0.26$ controlling age, education and gender), unadjusted online time is shown in

Figure 11. Ethnicity and time effects on estimated annual online hours (n=6163)

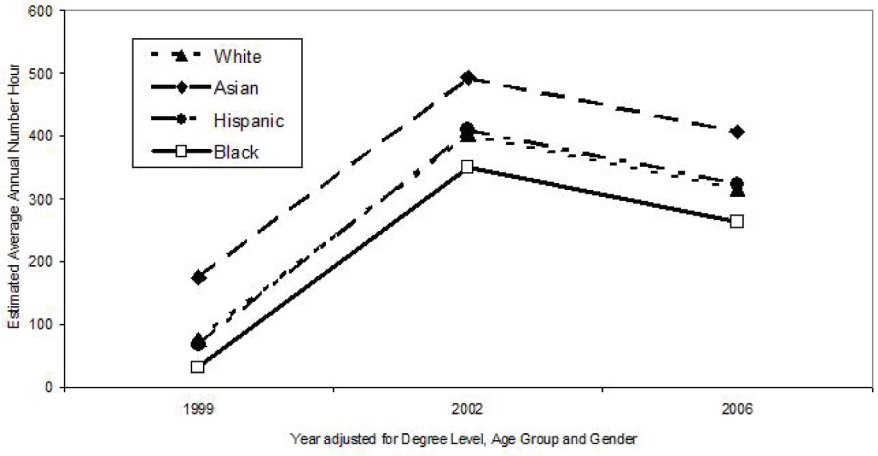


Figure 12. Generation and ethnicity effects on online hours 1999-2006 (n=6147)

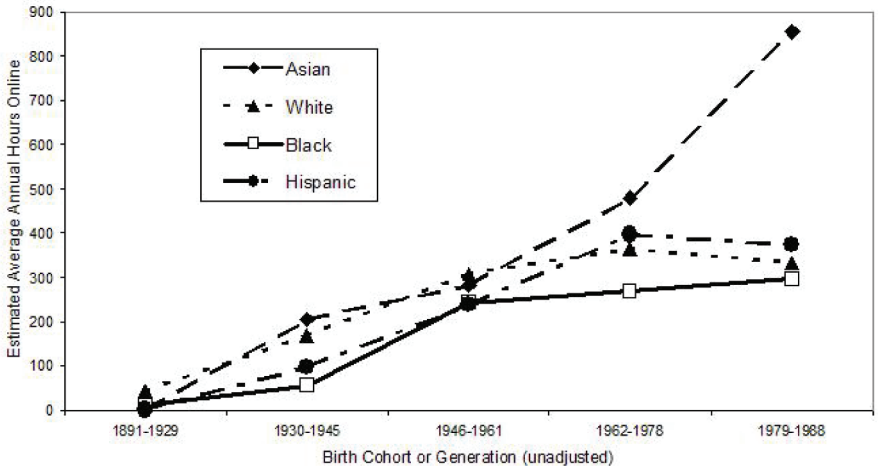


Figure 12. The interaction is due to the jump in connectivity among Asian Americans for Generations X and Y ($F_{3,6124}$ ethnicity = 3.49, p = .015; $F_{4,6124}$ cohort = 22.37, $p < .001$). By Gen Y, Whites, Blacks and Hispanics were relatively close in (fewer) online hours. In addition, among Whites, Hispanics and Asians, males spent more time online; however, as reported in some earlier studies Black women (mean annual hours = 232) spent slightly more time online than Black men (209 hours), a difference (nor any related interaction) that was not statistically significant.

Finally, Figures 13 and 14 show how ethnicity and generation affected primarily accessing the Internet for general news and for science news. Gender and education were covariates. Because no interaction occurred between ethnicity and cohort for general news ($F_{12,1721} = 1.32$, $p = .203$, total $R = 0.34$), adjusted percentages are used in Figure 13. However, there was a statistically sig-

Figure 13. Generation and ethnicity effects on accessing Internet news 2006 (n=1743)

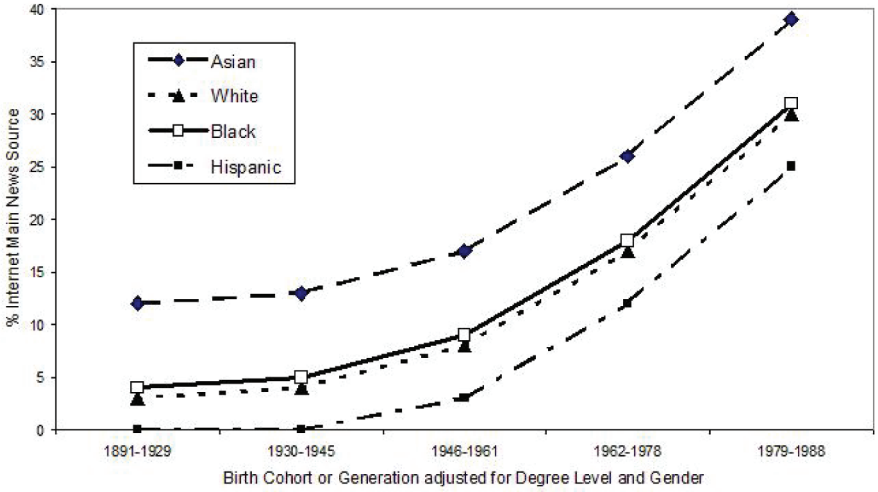
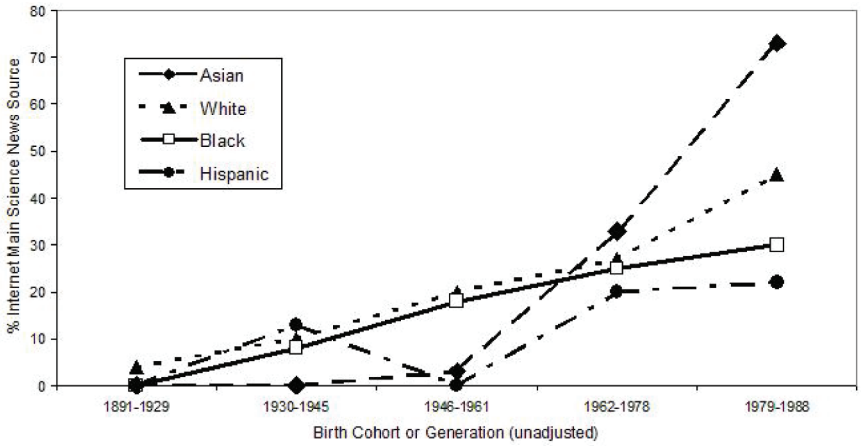


Figure 14. Generational and ethnicity effects on Internet science news 2006 (n=1743)



nificant interaction between cohort and ethnicity for science news ($F_{12,1721} = 1.96$, $p < .05$, total $R = 0.33$) so unadjusted percentages are shown in Figure 14.

Both cohort ($F_{4,1721} = 31.76$, $p < .001$) and ethnicity ($F_{3,1721} = 4.80$, $p < .01$) affected using the Web as a primary news source. Gen Yers most often did so (29%) and percents monotonically dropped to 1% in the Early Years. Asians (29%) referenced the Internet for news more than twice as much as Blacks or Whites (both 14%) or Hispanics (10%).

The picture is more complex for accessing online science news. In early cohorts, there was a low—and relatively egalitarian—usage of science news (the overall main effect for ethnicity is not significant; $F_{3,1721} = 2.07$, $p = .102$). However, in the two most recent cohorts, Gen Y Asians, distantly followed by Whites, used the Web for science news most often followed by African Americans and then Hispanics (for generation, $F_{4,1721} = 34.04$, $p < .001$).

Putting It Together: Multivariate Effects

Table 3 shows how age (except for news and science news), gender, education, cohort, and ethnicity affected computer ownership and Internet use. Because so many of these variables intertwine, especially ethnicity, age, generation, and education, it was important to institute multivariate controls to ascertain net effects. Table 3 also shows the net linear increments to explained variance from educational level, cohort, gender and ethnicity.

Consistently, in tandem with global results, the better educated more often owned a PC, accessed the Internet at home, spent more time online, and more often used the Web for news. The relative effects of education were most apparent for PC ownership. With education controlled (again consistent with earlier research), ethnicity mattered less—with the exception of computer ownership. Compared with Whites and Asians, Hispanics- (-13%) and especially Blacks (-18%) less often owned a PC. Black Americans spent less time online and Hispanics less often turned to the Internet as a primary science news source. Gender did not affect PC ownership or home Web access. Men spent slightly more annual hours online (B = 36.3) and were about 5% more likely (net effect) to use the Internet as a general news source. There were no overall sex differences in using the Internet as a primary science information source.

Table 3. Multivariate Predictors of Information and Communication Technology

Predictors	Home	PC[a]	Home Access[b]	Internet	Annual Hours	Online	Web Source	Main News	Web Main *Science*	Source News
Final Bs	B	Beta	B	Beta	B	Beta	B	Beta	B	Beta
Degree Level	0.135***	0.28	0.012***	0.02	99.3***	0.18	0.061***	0.18	0.067***	0.17
Age Group	-0.002***	-0.06	0.005***	0.34	2.46***	0.08	--	- -	--	--
Generation	0.089***	0.20	0.080***	0.37	122.1***	0.24	0.079***	0.25	0.100***	0.26
Gender [c]	-0.007***	-0.01	0.013***	0.03	36.3***	0.03	0.050***	0.07	0.033***	0.04
Asian Ethnicity[c]	-0.012***	-0.00	0.023***	0.02	94.9***	0.03	0.093***	0.06	0.047***	0.02
African-American[c]	-0.182***	-0.13	-0.012***	-0.02	-44.0***	-0.03	0.002***	0.00	-0.017***	-0.01
Hispanic Ethnicity[c]	-0.132***	-0.07	0.000***	0.00	-23.4***	-0.01	-0.045***	-0.04	-0.085***	-0.06
Constant	0.736***		0.941***				0.262***		0.397***	
R^2 Degree Level and Age	0.147***		0.005***		0.056***		0.037***		0.031***	
ΔR^2 Cohort	0.004***		0.016***		0.005***		0.062***		0.065***	
ΔR^2 Gender	0.000		0.001		0.001**		0.004***		0.001	
ΔR^2 Ethnicity	0.019***		0.001		0.001*		0.004*		0.004*	
R	0.41***		0.151***		0.253***		0.328***		0.318***	
R^2	0.17		0.02		0.06		0.10		0.10	
Case Base		6177		3226		6163		1748		1748

[a] Home computer, home Internet and online hours for these equations only are 1999 – 2006; Internet news items were only available for 2006.

[b] Home Internet access only asked to those with computers or Web-TV

[c] Dummy variables 1 = Male; Asian=African American=Hispanic; White American = omitted category. See footnote 13 about interaction effects.

* p < .05 ** p < .01 ***p < .001

All data: The NSF Surveys of Public Understanding of Science and Technology and the General Social Survey

Even controlling age, education, gender and ethnicity, cohort continued to affect ICT access and use. Recent generations more often owned a computer and accessed the Internet from home more often. They garnered more online time, and more often trolled the Web for news.

Given the juxtaposition of generation and age in these data, it was interesting that age had no net effect on PC ownership or online time. Older Americans actually more often had home Internet access. Indeed, age and cohort had comparable and sizable positive standardized effects on home Internet access. These findings challenge the typical global conclusions that older people eschew ICT due to some unspecified aging process. Rather than older citizens avoiding computers or the Internet, it is more accurate to say that earlier cohorts, who neither grew up with PCs or the Web nor learned digital skills at an early age, use ICTs less.

Finally predicting ICT access and use was strongest for owning a computer (R = 0.41) and accessing Internet news (R = 0.33 for general news; R = 0.32 for science news). Predicting home Web access (R = 0.15) and time spent online (R = 0.25) was less successful. [11]

SUMMARY

The results from this study, coupled with other current research, indicate that at least some American digital gaps have diminished or even disappeared. For example, of those owning a computer, regardless of gender, degree, age, ethnicity or cohort, virtually all had home Internet access by 2006. By 2006, nearly as many women as men owned a PC; for those owning a computer, gender home Internet access converged by 2002. Women and men also increasingly spent comparable time online. On the other hand, in 2006, men more often used the Internet than women as a primary source for general news. Gender is a bright spot in narrowing American digital divides: whether considering access (i.e., owning a PC) or certain uses (e.g., online time or news access; see Buente & Robbin, 2008; DiMaggio et al., 2004; Robinson, et al., 2003) American women and men are now similar.

Further, age does not retard computer and Internet access the way other studies suggest. What has been treated as age in research that either uses one-shot surveys or a few surveys over short time periods is almost certainly generational effects. Because age and cohort are synonymous in these short-term studies, it previously has been impossible to establish which is more important. Given the 23 year time span on the NSF data for PC ownership or the 12 years for home Internet access or online time, we can now begin to disentangle age from cohort influences on ICT access or use. The positive effect then found of age on home Internet access may reflect greater income among an older group that is more occupationally established and thus more able to afford the recurrent costs of Internet connection services. It is indeed unfortunate that this database does not contain an income variable to test this hypothesis. In any event, these results indicate that there is no reason to expect adults to discontinue their email use, search engines, or online bargain hunting simply because they hit middle age.

Yet considerable educational, cohort and ethnic ICT divisions remain. By the early 2000s, owning a computer became the gateway to home Internet access but such possession was disproportionately concentrated among better educated White and Asian Americans, and the educational gaps across generation indicate these disparities will continue in the near future. U.S. Whites and Asians, and the better educated, initially logged—and continue to log—more Web time than Hispanics or Blacks. Even controlling education, Hispanic and Black Americans less often owned a computer and thus could less easily access the Internet. In 2006, Asian Americans far and away used the Internet most often, and most often as their primary news source, especially for science information.

Because of small subsample sizes, Asian

Americans typically are either excluded from analyses of the digital divide or are collapsed with Hispanic- or African-Americans into a "non-White" category. This study clearly indicates that either approach (especially collapsed categories) misleads. Because they are more educated and hold more science and technology jobs, greater involvement of Asian Americans with home computers and the Web is predictable; greater participation of American Hispanics and Blacks in college and in technical or scientific jobs ultimately should lead to more use of PCs and the Internet.

More recent American cohorts who at most had completed a two-year college degree, especially adults with a high school diploma or less, fell further behind those with at least a baccalaureate. They owned PCs less often (hence had less home Internet access), logged fewer online hours, and less often accessed Internet news. General educational differences widened by generation (despite other controls) and were most pronounced among recent cohorts. What all this implies is that as young, well-educated Americans increasingly tap into the Internet, those with even a couple of years of college exposure will continue to lag. Unless dramatic changes occur, as more recent cohorts replace earlier ones, these educational gaps will increase.

More recent cohorts, probably due to early home and school experiences with computers and the Internet, are clearly more ICT-savvy: they more often own a computer and log more Web time. In larger numbers than prior cohorts they turn to the Web for news. Indeed, many U.S. newspapers are increasingly parochial, printing local news, apparently assuming their better-educated readers will obtain national and international news online, or else they simply stop their print editions,12 thus, inadvertently robbing earlier generations—who are now older people—of their traditional window on the world.

More disturbing are the widening ethnic and educational digital gaps. The less educated, or Black or Hispanic Americans, can less often search or apply for jobs online, take online courses to upgrade their skills, locate health information, exploit bargains on travel and purchases, benefit from the constant Internet updates, from cautions about food poisoning to threatening weather, or enjoy online entertainment. In turn, employers may expect less from their less educated, Black or Hispanic colleagues or employees, which can damage future prospects for either employment or advancement among these groups. On the other hand, these data indicate that discrimination on the basis of age stereotypes about digital skills is probably uncalled-for and should be even more unwarranted in the future.

In sum, this chapter indicates that although American gender digital gaps are largely gone, in an era when electronic access and use have become increasingly important, significant differences in computer and Internet access remain. Replicating prior research, these divides fall along prior social stratification cleavages; many of these groups, Blacks, Hispanics, or the poorly educated were economic "have-nots" during the twentieth century. Thus, as we head into the twenty-first century, the promise of information technology to benefit traditionally disadvantaged demographic groups and provide a more level playing field for academic and economic marketplace achievement is only partly being fulfilled.

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REFERENCES

Allum, N., Sturgis, P., Tabourazi, D., & Brunton-Smith, I. (2008). Science knowledge and attitudes across cultures: A meta-analysis. *Public Understanding of Science (Bristol, England)*, *17*(1), 35–54. doi:10.1177/0963662506070159

Boyd, D., & Bee, H. (2009). *Lifespan development* (5th ed.). Boston: Pearson.

Buente, W., & Robbin, A. (2008). Trends in Internet information behavior 2000-2004. *Journal of the American Society for Information Science and Technology*, *59*(11), 1743–1760. doi:10.1002/asi.20883

Carlson, E. (2008). *The lucky few: Between the greatest generation and the baby boom*. New York: Springer.

Center for the Digital Future. (2007). *Online world as important to Internet users as real world?* Los Angeles, CA: University of Southern California.

Chinn, M. D., & Fairlie, R. W. (2007). The determinants of the global digital divide: A cross-country analysis of computer and Internet penetration. *Oxford Economic Papers*, *59*(1), 16–44. doi:10.1093/oep/gpl024

Cotten, S. R., & Jelenewicz, S. M. (2006). A disappearing digital divide among college students? Peeling away the layers of the digital divide. *Social Science Computer Review*, *24*(4), 497–506. doi:10.1177/0894439306286852

De Haan, J. (2009). Late on the curve: Causes and consequences of differences in digital skills. In E. Ferro, Y. K. Dwivedi, J. R. Gil-Garcia & M. D. Williams (Eds.), *Overcoming digital divides: Constructing an equitable and competitive information society*. Hershey, PA: IGI Global.

Demoussis, M., & Giannakopoulos, N. (2006). Facets of the digital divide in Europe: Determination and extent of Internet use. *Economics of Innovation and New Technology*, *15*(3), 235–246. doi:10.1080/10438590500216016

DiMaggio, P., Hargittai, E., Celeste, C., & Shafer, S. (2004). Digital inequality: From unequal access to differentiated use (pp. 355-400). In K. M. Neckeman (Ed.), *Social inequality*. New York: Russell Sage Foundation.

Fairlie, R. W. (2004). Race and the digital divide. *Contributions to Economic Analysis & Policy*, *3*(1), 1–38.

Fallows, D. (2005, December). *How men and women use the Internet*. Washington, D.C.: Pew Internet and American Life Project.

Fallows, D. (2008). *Search soars, challenging email as a favorite Internet activity*. Washington, D.C.: Pew Internet and American Life Project. Retrieved on November 15, 2008, from http://Pew Research Orgs/Pubs/921/Internet-Search

Fox, S. (2005). *Digital divisions*. Washington, D.C.: Pew Internet and American Life Project.

Fox, S., & Livingston, G. (2007). *Latinos online*. Washington, D.C.: Pew Hispanic Center and Pew Internet Project.

Gates, B. (2005). *High schools for the new millennium: Imagine the possibilities*. Retrieved on August 10, 2008, from http://www.gatesfoundation.org/nr/Downloads/ed/EdWhitePaper.pdf

Glenn, N. D. (2005). *Cohort analysis* (2nd ed.). Thousand Oaks, CA: Sage Publications.

Greenstein, S., & Prince, J. (2006). *The diffusion of the Internet and the geography of the digital divide in the United States*. NBER Working Papers 12182. Cambridge, MA: National Bureau of Economic Research.

Horrigan, J. B. (2007). *A typology of information and communication technology users*. Washington, D.C.: Pew Internet and American Life Project.

Horrigan, J. B. (2008). *Home broadband adoption*. Washington, D.C.: Pew Internet and American Life Project.

Kennedy, T. L. M., Smith, A., Wells, A. T., & Wellman, B. (2008). *Networked families*. Washington, D.C.: Pew Internet and American Life Project.

Lebo, H., & Corante, P. (2003, July 21). *Internet use by Latinos lower than for non-Latinos, but home online use higher for Latinos, UCLA study reports*. Press release. Los Angeles, CA: University of California.

Losh, S. C. (2004). Gender, educational, and occupational digital gaps 1983-2002. *Social Science Computer Review*, *22*(2), 152–166. doi:10.1177/0894439303262557

Miller, J. D., Kimmel, L., & Macro, O. R. C. (n.d.). National Science Foundation surveys of public attitudes toward and understanding of science and technology, 1979-2001: [United States] [Computer file]. ICPSR version. Tallahassee, FL: Losh, SC, Florida State University, Department of Educational Psychology & Learning Systems/ Arlington, VA: National Science Foundation, Division of Science Resources Statistics/Arlington, VA: American Statistical Association [producers], 2004. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor], 2005. doi:10.3886/ICPSR04029. Retrieved on November 15, 2008, from http://www.icpsr.umich.edu

Nie, N., Hull, C. H., Jenkins, J. G., Steinbrenner, K., & Bent, D. H. (1975). *SPSS: Statistical package for the social sciences* (2nd ed.). New York: McGraw-Hill.

Ono, H. (2005). *Digital inequality in East Asia: Evidence from Japan, South Korea, and Singapore*. EIJS Working Paper Series 219. Stockholm, Sweden: The European Institute of Japanese Studies.

Ono, H., & Zavodny, M. (2007). *Immigrants, English ability, and the digital divide*. IZA Discussion Papers 3124. Bonn, Germany: Institute for the Study of Labor (IZA).

Organisation for Economic Cooperation and Development. (2001). *Understanding the digital divide*. Paris, France: OECD Publications. Retrieved on July 27, 2008, from http://www.oecd.org/dataoecd/38/57/1888451.pdf

Pew Research Center. (2007). *How young people view their lives, futures, and politics: A portrait of "generation next."* Washington, D.C.: Pew Research Center for the People and the Press.

Prieger, J. E., & Hu, W. (2008). The broadband digital divide and the nexus of race, competition, and quality. *Information Economics and Policy*, *20*(2), 150–167. doi:10.1016/j.infoecopol.2008.01.001

Prokos, A., & Padavic, I. (2005). An examination of competing explanations for the pay gap among scientists and engineers. *Gender & Society*, *19*(4), 523–543. doi:10.1177/0891243205274462

Robinson, J. P., DiMaggio, P., & Hargittai, E. (2003). New social survey perspectives on the digital divide. *IT & Society*, *1*(5), 1–18.

Royal, C. (2008). Framing the Internet: A comparison of gendered spaces. *Social Science Computer Review*, *26*(2), 152–169. doi:10.1177/0894439307307366

U.S. Bureau of the Census. (2008). *The statistical abstract of the United States*. Washington, D.C.: U.S. Government Printing Office.

U.S. Department of Education. (2006). *Answering the challenge of a changing world: Strengthening education for the 21st century*. Washington, D.C.

Victory, N. J., & Cooper, K. B. (2002). *A nation online: How Americans are expanding their use of the Internet*. U.S. Department of Commerce, Economics and Statistics Administration.

Withey, S. B. (1959). Public opinion about science and scientists. *Public Opinion Quarterly*, *23*(3), 382–388. doi:10.1086/266890

KEY TERMS AND DEFINITIONS

Aging, age, seniors, older workers: A set of processes associated with chronological aging, e.g., slowing of reaction time, slower learning processes or presbyopia. Stereotyped views of aging may predispose employers to avoid older workers for digital skills jobs.

Baby Boomer, Boomers: Member of the "Baby Boom" generation, born between 1946 and 1961 (when the absolute number of U.S. births peaks; U.S. birth rates peak in 1957); very large generation with profound effects on occupational opportunities and consumer demand.

Cognitive Priming: Typically through specifics experiences, individuals possess a heightened readiness to perceive particular events or predisposition to more easily learn particular skills; applied to "Gen Y's" proclivity toward information and communication technology.

Ethnicity: A particular "racial" or cultural heritage, e.g. Hispanic or Latino background.

Gender, sex roles: The social construction of what it means to be male or female, contrasted with biological sex.

Generation, birth cohort, cohorts: Individuals born during a restricted time period who typically experience a social-time specific set of experiences.

Generation X, Gen X: The birth cohort born between 1962 and 1978.

Generation Y, Gen Y, Generation Next, Millennials: Born after 1978, these (currently) young adults grew up with information and communication technology.

ICT: Abbreviation for information and communication technology.

The Lucky Few, Depression or War Babies: Term coined by Elwood Carlson (2008) to describe members of the generation born approximately between 1930 to 1945. This relatively small birth cohort enjoyed superior occupational opportunities due to high demand for labor as it matured during the 1950s and 1960s.

ENDNOTES

1 For example, the Pew Research Center (2007) focused on birth cohort, especially the recent Gen Y or "Generation Next". However, with only one survey year in the analysis, this report confounds age and generation as noted above.

2 ICT encompasses many tools, e.g., cell phones and elaborated communication devices such as *i*phones in addition to computers. I focus on PC ownership and Internet access and use. Current literature indicates that primarily communicative devices, compared with Internet access through a computer, are more often used to communicate with known individuals or to *receive* information (e.g., weather or financial quotes), than *interactively for extensive educational or occupational purposes* (e.g., Kennedy, et al, 2008).

3 This database is an extension of the one I created through the 2002 data, and extends the data through 2006 (see Miller, Kimmel & ORC Macro, 2005 for the original database).

[4] In fact, the 2006 NSF data were gathered through the 2006 GSS.

[5] Data are weighted with a combination of gender, ethnicity, education, and region weights.

[6] The "Early Years" generation actually collapses two cohorts born prior to 1930 due to their decreasing numbers in the 2002 and 2006 data.

[7] Given the synchrony between age and cohort at one time point, either could be used to analyze 2006 news access. I use generation for consistency with the other analyses and because I believe generation provides more information about future trends. There is no reason to expect accessing Internet news or science news to drop by age or life cycle stage.

[8] Because by 2006, owning a PC became synonymous with home Internet access, further analyses on home Web access are not shown here until the multiple regression equations. Detailed results are available from the author.

[9] Again age group is not a covariate in 2006 analyses because of its overlap with generation in a single year.

[10] These graphs are available from the author upon request.

[11] Because of the earlier results, dummy variable interaction terms were separately added for gender by cohort, and for ethnicity by cohort. A multiplicative term for degree by cohort was also used. Space and ease of comprehension precludes presenting all terms in Table 3. I added interactions separately because of the multicollinearity that would result from including all interaction terms containing generation simultaneously. The following net gender interaction resulted: a small ($t = -2.06$, $p = .04$) decrease among Gen Y men in PC ownership compared with women. The following net ethnicity interactions resulted: an increase in Asian online hours among Gen Y ($t = 3.67$, $p < .001$) and the dramatic increase among Gen Y Asian-Americans accessing online science news ($t = 3.64$, $p < .001$). Net interaction effects for degree level reflected the convergence of the college and graduate school educated across generations for computer ownership but the widening gap for the high school educated ($t = 2.63$, $p < .01$), the widening gap between those with and without a college degree for online hours ($t = 3.45$, $p < .001$), and greater access among the college educated in Generations X and Y for regular 'Net news ($t = 6.53$, $p < .001$) and for science news ($t = 2.77$, $p < .001$). These findings parallel the ANCOVA results presented earlier; the reader is urged to examine those figures to see the form of each interaction.

[12] In Fall 2008, the prestigious *Christian Science Monitor* announced it would only publish an online edition. The *Detroit News-Free Press* discontinued home delivery. Given rising publication costs in a poor economy it is likely that many U.S. newspapers will soon follow suit.