

GENDER AND EDUCATIONAL DIGITAL CHASMS IN COMPUTER AND INTERNET ACCESS AND USE OVER TIME: 1983-2000

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ABSTRACT

Using several nationally representative surveys of American adults, this study tracks gender, education and computer access and use from 1983 to 2000, and Internet access and use from 1995 to 2000. Access to computers and the Internet rose dramatically over this time among both sexes and all educational groups. Increases in home computer ownership were particularly marked among the high-school educated. Otherwise, gender and educational gaps in IT access and use remained roughly stable. Unmarried women least often owned a home computer or had online access. Less-educated women and better-educated men used work computers significantly more often. College-educated men were most likely to have work Web access or email, and men or the well-educated were more likely to use home email or subscribe to a home network service. Education or gender gaps in online time rose from 1995 to 2000, with men or very well-educated individuals increasing their online hours the most. However, women with graduate degree did achieve gender parity in many areas of IT access or use by 2000. Results are interpreted in part as stemming from gender and educational occupation differences. Implications for policy makers and educators are discussed.

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Using several national surveys of American adults, this study tracks gender, educational level, and computer and Internet access and use from 1983 to 2000. Of all the innovations of the twentieth century—space travel, heart transplants, effective birth control, genetic engineering, television—at the turn of the millennium, a National Public Radio study (2000) reported that Americans rated computers as the most important. Because gender and education can be critical stratification variables, it is important to understand their influence on information technology developments.

Most research findings indicate that men use information technology more than women for diverse tasks and entertainment. The better educated also use information technology more than the less educated. The relationship between information technology use and economic well-being is plausibly reciprocal: policy makers and educators worry that inequitable access to and use of information technology accentuates pre-existing gaps between women and men, among wealthier and poorer individuals, and across ethnic groups. Conversely, wealthier or better-educated individuals have easier access to information technology, afford it more readily, and may have cognitive frameworks that make it easier to use.

The “digital divide” refers to these gaps in information technology access and use among individuals holding different status positions. Considerable research and some controversy have been attached to the extent of these gaps and the extent to which gaps may have changed. However, to assess change we must examine data over time. Otherwise, as occurs in some recent research, our comparisons become hypothetical at best.

ISSUES IN THE DIGITAL “GENDER GAP”

Some sex differences in digital technology access and use are to be expected, because women and men have different educational and occupational experiences. American women made significant gains in educational and occupational parity in the twentieth century. According to the *Statistical Abstract of the United States* (U.S. Bureau of the Census 2001), women now earn most baccalaureate and master’s college degrees, and over 40 percent of doctorate, law or M.D. degrees. The majority of adult women in a variety of age, marital and parental combinations now hold paid jobs, and the overall distribution by gender in professional and managerial occupations is increasingly similar. In 2000, women were over half of professionals, nearly half of biological or medical scientists, and about one-third of mathematicians, computer scientists, or chemists.

Nevertheless, the discrepancies that remain affect information technology access and use. Men elect more science college courses than women, and more often elect high school physics, chemistry, and advanced math courses. Women far less often major in engineering, architecture or the physical sciences, fields in which sophisticated information technology use is common. In

2000, only 10 percent of engineers and 20 percent of engineering technicians were female, fractions only slightly larger than those in 1983, when the data series in this study begin. One-third of all employed women held a clerical or retail sales job, a rate over four times that for employed men in 2000.

Many clerical workers use computers for data entry or word processing. Increasingly they access email, frequently internal to an organizational server, for communication. Retail sales workers use “smart cash registers” for calculations and credit card transactions. However, these jobs often do not require Internet use. Clerical or retail sales workers typically do not use computers for analyses, syntheses, or information searches the way that professionals and managers do.

Cognitive skills gained using computers or the Internet on the job, e.g., email, online analyses, diagnostics, information collection and simulations, can transfer to home use. If a clerical worker uses email on the job, she will feel comfortable communicating electronically from home. If a nurse practitioner culls the latest Web information on medication interactions, she will more easily employ information searches on the household computer.

WHAT WE KNOW

Most research published in hard copy or online on the gender “Digital Divide” consists of “one shot” studies of students from preschool to college levels. Since many adults take vocational education courses or must “learn on the job,” and instructional systems are now designed for individuals at virtually any age, research that exclusively studies children, youth or young adults is of limited utility. Online surveys, such as the *National Geographic's* (2000), have a large case base, but the data typically solely apply to those with Web access. Like many e-surveys, the *National Geographic* studies an undefined population so that the data represent only those individuals who completed the questionnaire. Since there is good reason to believe that both gender and educational level affect online use, we need more research and multivariate analyses on representative adult probability samples to ascertain changes in access to and use of information technology over time.

National data on the adult general public present mixed results. First, recall that women comprise about 52 percent of American adults. Studies that report that females are 50 percent of information technology users fall short of “gender parity.” For example, the Pew Internet and American Life Project (Lenhart, et al. 2003) found that 50 percent of Web users were female, a figure slightly below parity. Fifty four percent of “non-users” were female, a figure slightly above the adult female proportion. (Sampling error, of course, means that these estimates will vary somewhat.)

The U.S. Department of Commerce's 2000 and 2001 Falling Through the Net surveys (Victory and Cooper 2002) have reported comparable gender Internet use. Since this series is one of the most famous digital divide studies, it

is important to note that other comparable research finds small, but persistent, sex differences. The discrepancies may lie in the Falling Through the Net methodology: interviewers spoke with a person at least 15 years old who “was considered knowledgeable about everyone in the household,” who provided proxy responses for all other members of that household (Victory and Cooper 2002). The data were then weighted up to provide a sample of individuals in households. In other words, data about other dwelling unit residents could be offered by any inhabitant from age 15 to 90-odd without validity checks. All the other studies cited here only report information about the actual respondent.

Norman Nie and Lutz Erbring (2000) mostly attributed the Internet usage gaps they found to labor force participation; their charts do show greater access for the college-educated and less participation among women, Blacks, or Hispanics. Men and the better educated used the Internet more and for more varied activities. Jeffrey Cole’s *UCLA Internet Report: Surveying the Digital Future* (Cole, et al. 2000; Cole, et al. 2002; Cole, et al. 2003) found greater Internet usage among men than among women in 2000 (71 versus 64 percent), 2001 (74 versus 71 percent) and 2002 (73 versus 69 percent).

Most national research on information technology and use is in its infancy. Thus, the UCLA data have one of the longer timelines: three years. Moreover, most of the focus is on the Web, yet individuals who have limited access to computers or other forms of information technology also may be uncomfortable with the Internet.

DATA SOURCES

Probably the longest repeated module about information technology use in the American general public is in the National Science Foundation Surveys of Public Understanding of Science and Technology (the “Surveys,” Miller and Kimmel, 1999), which provide an unprecedented opportunity to trace technological diffusion.¹ Computer items began in 1983 and continued through 1999. Questions about Internet use began in 1995. The NSF Surveys used here comprise 13,626 interviews from seven random-digit-dial (RDD) national telephone surveys (1983, 1985, 1988, 1990, 1995, 1997, and 1999) of adults at least 18. Yearly samples ranged from 1631 (1983) to 2006 (1995); completion rates in contacted households exceeded 65 percent. Actual analytic *ns* vary by topic. For example, only labor force respondents who reported access to a computer on the job were asked about work Internet or email access. The surveys span 16 years in a critical era for computer and Internet access and use.

Because the NSF modules about computer and/or Internet use ended in 1999, this study added comparable data from the 2000 General Social Survey (GSS), which employed a national probability sample of in-person interviews (Davis and Smith 2000). Although the original sample is 2817 adults, this study used only respondents with stated telephone access ($n = 2629$) to make estimates compatible with the RDD NSF Surveys. Experiments with question

wording and topics cause fluctuations in the 2000 case base so the GSS results vary more than the NSF Surveys. For example, GSS estimates of work use of computers or the Internet often employ subsamples as low as 300.

ITEMS

Questions are available about the following: computer, email, and Internet access at home and at work; weekly and estimated annual hours of use; and email use at home and at work. For estimated annual Internet use, this study examined access from any location, including work, home, school or libraries. These variables have the longest time series and are also the most basic.

Background and demographic items specific to both the NSF and the GSS Surveys include the following: gender, marital status, age, labor force status, type of occupation and educational degree level (high school or less, two year college degree, baccalaureate or advanced degree). This education coding is common to all eight surveys. The NSF surveys also contain considerable detail about education: type of degree, major field of study and use of science on the job.

The study's primary analyses use three-way analyses of variance with gender, education, and time as factors. Mean scores or percentages are shown throughout in the charts. However, also summarized are some findings using gender and marital status, and relationships between work and home use of information technology.

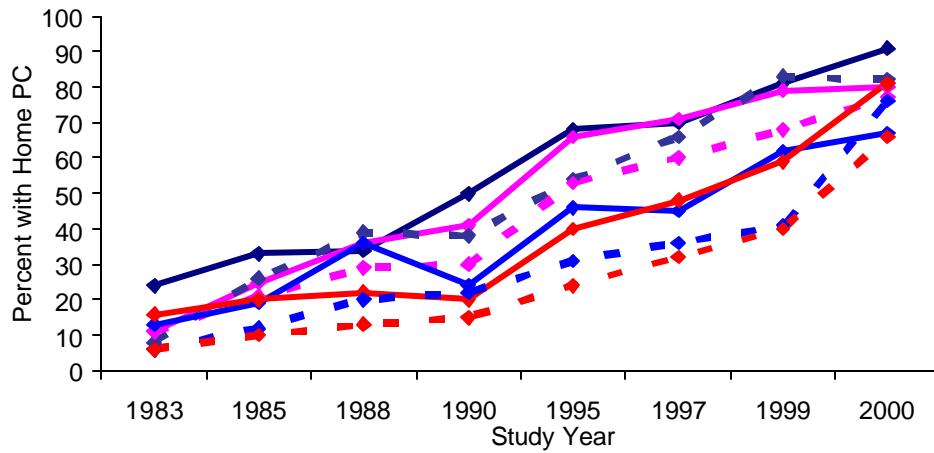
FINDINGS

Computer and Internet Use at Home: Chart 1 shows home computer ownership from 1983 to 2000. Men, the better-educated, and more recent respondents, were more likely to own a home computer. A two-way time-education interaction ($F_{7,14018} = 7.88, p < .001$) indicated that change over time was greatest for the most poorly educated, who lagged in computer ownership in 1983 (6 percent) compared with advanced degree recipients (18 percent). Thus the educational gap in home computer ownership lessened.

Chart 2 examines home Internet access among those with a home computer, thus providing some of our earliest estimates of Web use. By 2000, over 80 percent of persons with home computers were online, compared with 33 percent in 1995. Men, the better-educated and more recent respondents were more likely to be online. (Recall that small case bases in the General Social Survey mean higher standard errors, which makes results from 2000 more variable.) There were no interaction effects; thus gaps that existed in 1995 were still present in 2000.

Chart 3 illustrates the use of home email from 1997 to 2000 for those with home computers. Home email use was significantly more likely in 2000,

CHART 1: PERCENT WITH HOME PERSONAL COMPUTER



Sources All Charts: NSF Surveys of Public Understanding of Science and Technology 1983-1999 General Social Survey 2000

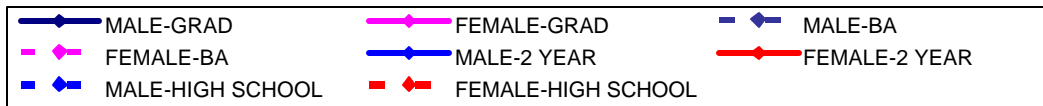


CHART 2: PERCENT HAVING HOME INTERNET ACCESS (FOR THOSE WITH HOME COMPUTERS)

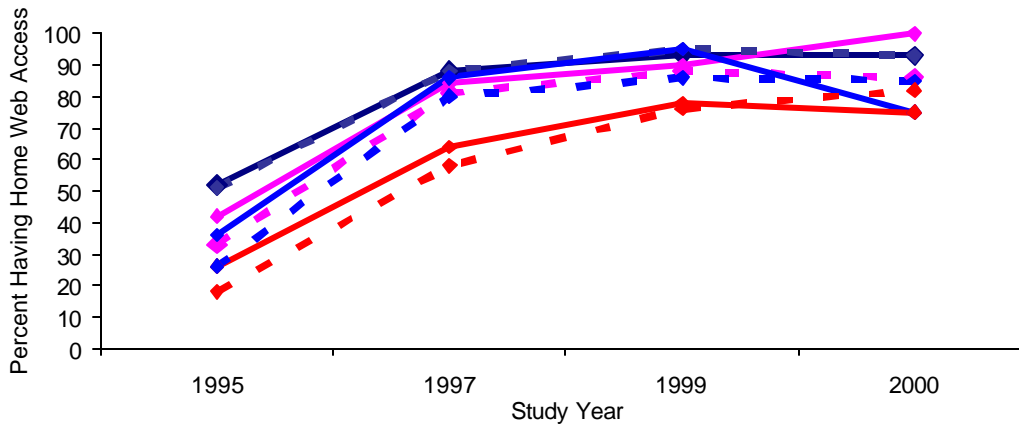
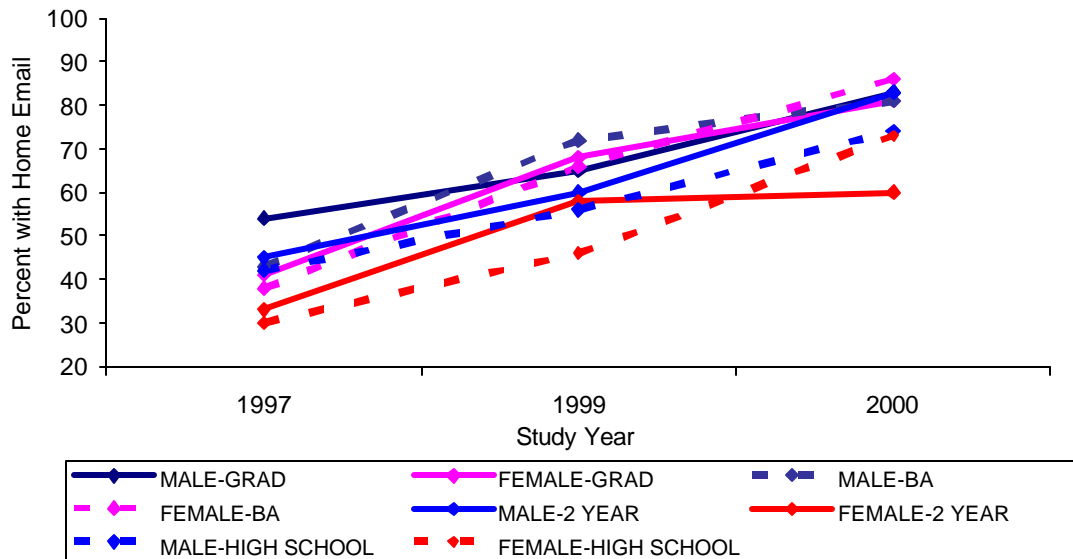


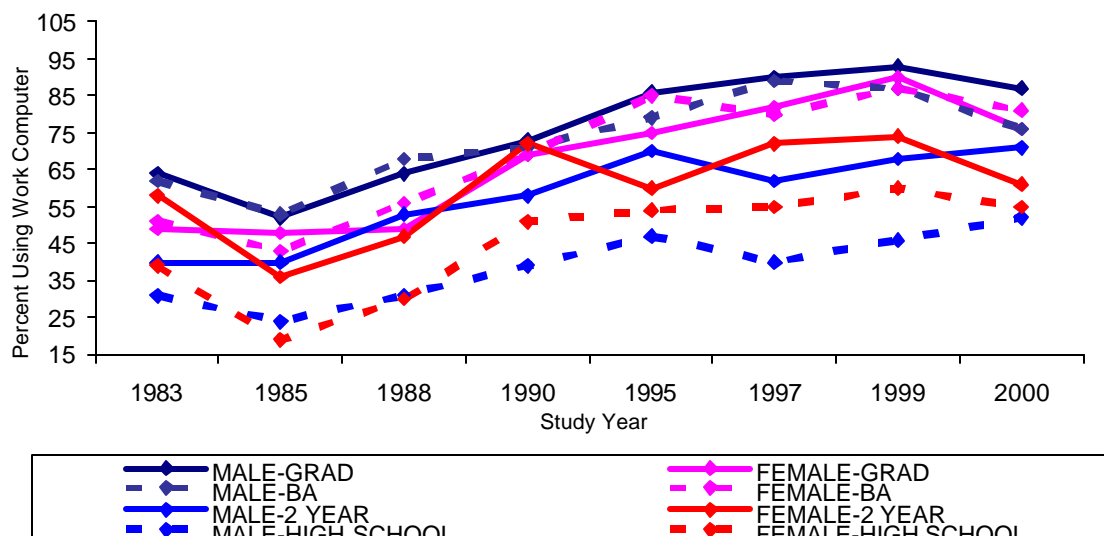
CHART 3: PERCENT WITH HOME EMAIL (FOR THOSE WITH HOME COMPUTERS)

among men, and among the better educated. Again, the lack of interaction effects implies that educational and gender gaps held roughly constant over this short time, and accentuated use did not occur among any particular gender-education combination.

Computer and Internet Use at Work: By 2000 Nie and Erbring felt the greatest difference in Internet use occurred between labor force participants and non-participants. The work environment is particularly important to study because women have extensively used computers for data entry and word processing since the 1960s, activities typically not classified as intellectually stimulating or generally requiring online use. In addition, many workers are introduced to computers or updated computer technology, including the Internet, on the job. Their interest and comfort levels as a result of their work experiences may generalize to home use. Of course, many individuals are now introduced to information technology as children at home, as students, or in libraries or community centers; these data do not address such experiences.

Chart 4 shows access to a work computer from 1983 to 2000. Because of small case bases, especially for 2000, the data fluctuate around a generally upward trend. All education and gender groups significantly increased their access to a work computer over time. Sex differences overall were small. However, a two-way gender by time interaction ($F_{7,10523} = 5.32, p < .001$) suggested a curvilinear effect: in the 1980s, men were about eight percent more likely than women to have access to a work computer; after 1990, women were about two percent more likely than men to have work computer access. Overall,

CHART 4: PERCENT USING A COMPUTER AT WORK

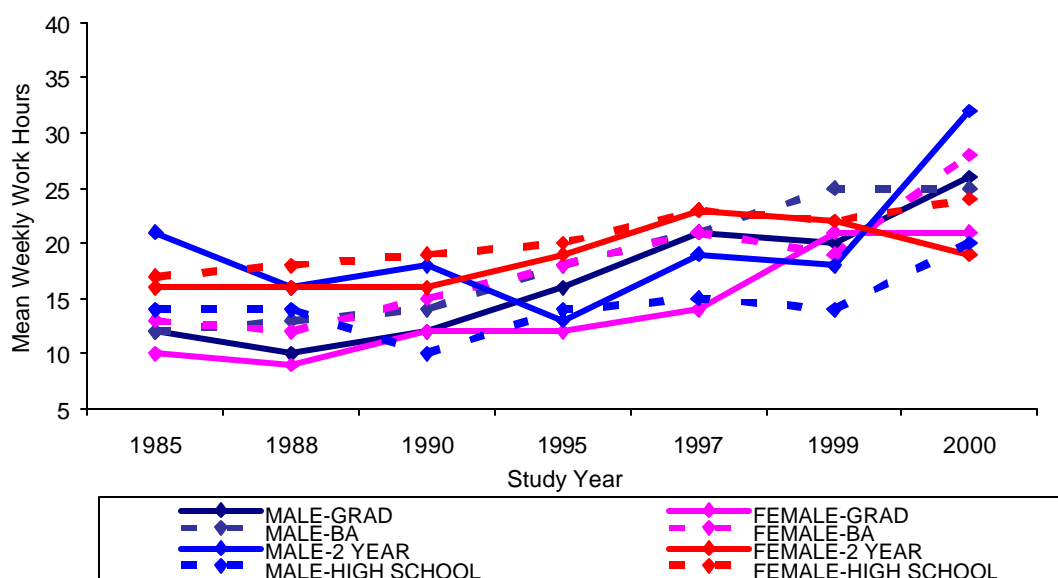


both sexes were 21 percent more likely to use a work computer in 2000 than they were in 1983.

A two-way gender-education interaction ($F_{3,10523} = 13.38$, $p < .001$) indicated that women with high school or junior college degrees used work computers more than comparable men, while men with at least a four year college degree used a computer at work more than did comparable women. This finding is consistent with occupational distributions: women with less than a baccalaureate tend to occupy clerical jobs, which involve data entry and word processing. In contrast, there are greater concentrations of men in technical occupations (e.g., architecture, engineering, or drafting), which use computers for simulations and analyses.

Chart 5 traces the average weekly hours of work computer use, from 1985 to 2000, for women and men with different educations. Results were complex. There were significant ANOVA main effects for gender, time, and education; two-way interactions for degree level by gender, and degree level by time; and a three-way gender-time-education interaction ($F_{18,4897} = 1.76$, $p < .03$).

Detailed results showed that women with high school or junior college degrees initially worked more computer hours than high school educated men or women with graduate degrees. These results are consistent with the heavier concentration of less educated women in clerical jobs, and with the early use of word processors and data entry. Even by 2000, women with graduate degrees logged less weekly work computer hours than women with two-year degrees. However, better-educated men used a work computer for more time than less-

CHART 5: MEAN WEEKLY WORK COMPUTER HOURS (FOR THOSE WITH WORK COMPUTER)

educated men. Many men with two-year degrees hold technical jobs, e.g., drafting, mechanical repair or computer technician; their work computer time increased during the 1990s.

Workers increasingly access the Web to locate information or communicate with colleagues. Chart 6 shows how workers with graduate degrees had greater Web access (77 percent overall) than those with a high school education (35 percent). Work Internet access for those with computer access at work rose from 41 percent in 1997 to 67 percent in 2000. Work Web access was higher for men than for women (58 versus 45 percent). The absence of two or three-way interaction effects indicated that gender or education gaps remained constant from 1997 to 2000.

Work email can conveniently relay instructions, schedule appointments, send documents, or foster collegial networking. Chart 7 shows that men who had office computers more often had work email than comparable women. Overall, 55 percent of men had work email compared with 47 percent of women. Work email access rose from 32 percent among the high school educated to 73 percent among advanced degree recipients, and from 46 percent in 1997 to 60 percent in 2000 for those with work computer access. As Chart 7 and the two-way gender-education interaction effect shows ($F_{3,2071} = 3.71$, $p = .01$), email use was especially pronounced for men with any type of college degree. For example, 78 percent of men with advanced degrees and office computers had work email compared to 64 percent of very well-educated women with office computers. Again, some of the differences may stem from the types of jobs held by women

CHART 6: PERCENT WITH WEB ACCESS AT WORK (OF THOSE WITH WORK COMPUTERS)

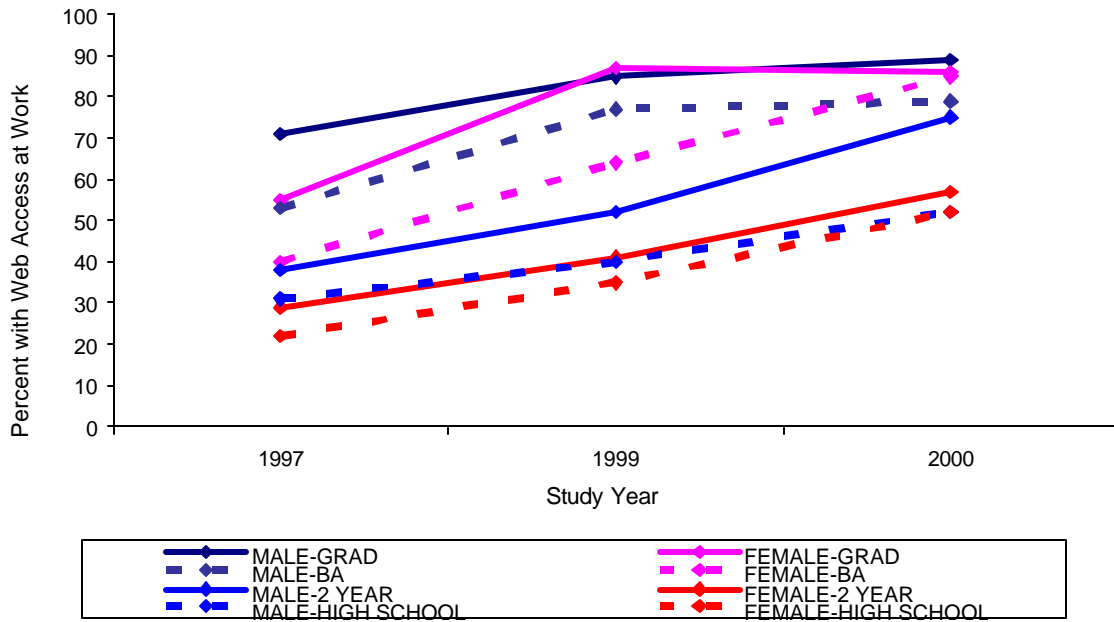
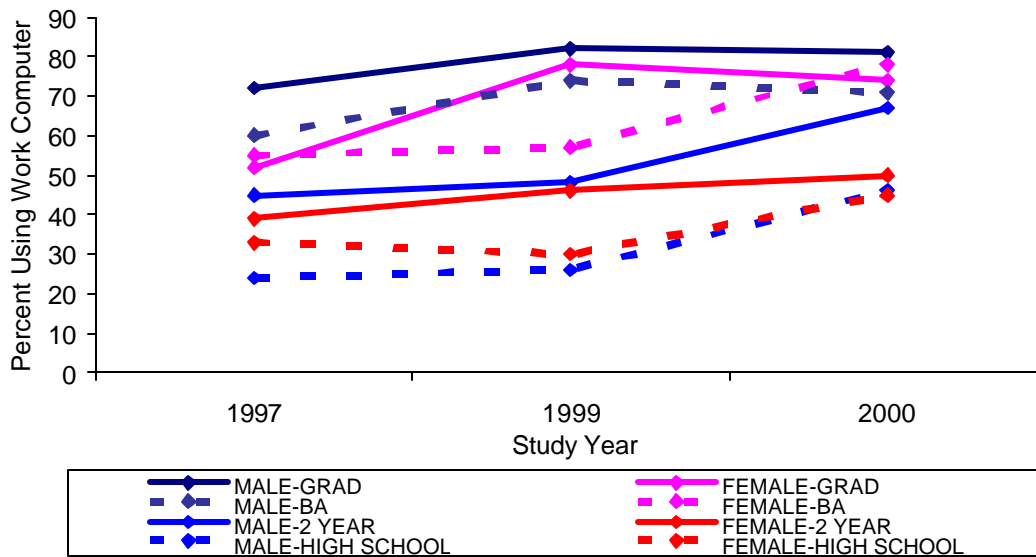


CHART 7: PERCENT HAVING WORK EMAIL (OF THOSE WITH WORK COMPUTERS)



and men. Many primary or secondary level teachers, social workers or lower level bank managers (most of whom are female) still lack work Web access or even email.

Finally, Chart 8 estimates annual online hours from 1995 to 2000 from any source. Online use literally “exploded” over this period. However, each year, men spent significantly more hours online than women. By 2000, men averaged 260 annual online hours compared with 190 for women. Online use had a significant monotonic relationship to education: the best educated averaged 450 online hours in 2000, compared with 147 annual hours for high school graduates.

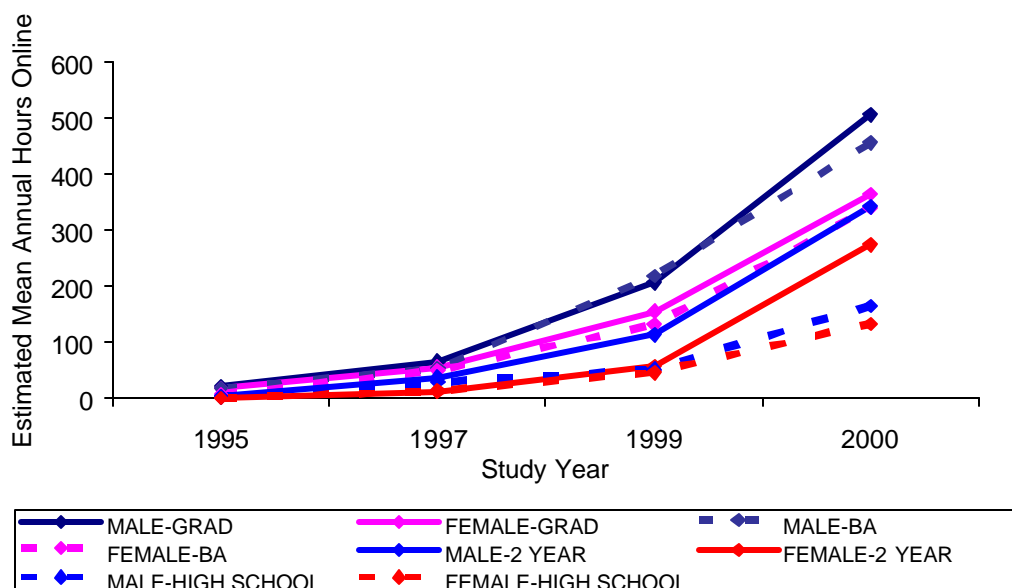
A two-way interaction ($F_{9,8130} = 26.02, p < .001$), indicated that online use increased more over time for the best educated. Annual hours online grew from 20 to 450 for this group, but from only 2 to 147 hours for the high school educated, indicating that the educational gap widened to a chasm. Although both sexes increased online use, the two-way interaction effect here ($F_{3,8130} = 4.75, p = .003$) indicates that men increased their time more. Male annual online hours increased by 251 hours between 1997 and 2000, compared with a 187 hour increase for women. More education contributed to more online use for men (a 114 hour increase from those with the least to the most education) than it did for comparable women (a 72 hour increase) ($F_{3,8130} = 2.86, p = .04$).

It should be noted that some work use spills over to home use. Overall, 48 percent of those with computer access at work also owned a home computer, but only 20 percent of those did who lacked work access. Even by 2000, when this gap narrowed substantially, 78 percent of those with work computers ($n = 287$) also had a home computer compared with 65 percent of the 159 respondents, including those without a job, who did not have work access (corrected $X^2 = 7.76, p = .004$). However, if respondents in 2000 did own a home computer, they had equal home access to email or the Internet, regardless of their use of a computer at work.

DISCUSSION

What are we to make of the “digital divide” over time by gender or education—or both? The answers from these nationally representative surveys of adults are mixed. From the 1980s forward, women and men show comparable computer use at work, although the type of use varies. Men with any level of college experience (including junior college or technical training), and women with four-year or advanced degrees by 2000 had achieved rough parity in work Internet or email access. However, women with high school or junior college degrees and men with high school degrees lagged behind.

Partly this reflects the different kinds of jobs women and men hold. Although women with baccalaureates or more advanced degrees have opportunities for jobs that use computers and the Internet for syntheses, simulations, diagnostics and information searches, women who lack a four-year

CHART 8: ESTIMATED AVERAGE ANNUAL TOTAL ONLINE HOURS

degree generally continue in the far less interesting “pink collar ghetto” of word processing or data entry. Thus, it is not surprising that, in the NSF Surveys from 1985 to 2001, men agreed more often than women that “science and technology make work more interesting.”

In general, college-educated men more often had computers, Web access or email at home than women baccalaureates. Women with graduate degrees and home computers had home Internet access comparable to men with graduate degrees. A further factor that complicates home computer ownership and access to the Web is marital status. By 2000, over 80 percent of married men or women reported owning a home computer. However, 72 percent of non-married men and only 62 percent of non-married women did so, resulting in a significant gender-marital interaction. Partly these differences reflect age (many “single” women are older widows.)

However, the marital-gender gap also can reflect finances. Of the four gender-marital groups, single women are generally the least affluent. Married women are often in two-income families and thus can more easily afford computer ownership or an Internet service subscription.

With the exception of home computer ownership, gaps between the sexes and among educational groups continue; in some cases, they widen rather than narrow over time. The largest disparities are in the amount of online use. Coupled with the results from other studies, we also know that there are qualitative differences. Men explore the Internet for more diverse and potentially personally enriching uses than women, including information

searches and entertainment. Far less is known about differences among educational groups.

One vision of information technology is that it is the “great leveler,” bringing updated information and opportunities to women, many ethnic minorities and the poor. To some extent, these groups now do have increased access to computers and the Internet. However, men or the well-educated often have increased their access and use disproportionately more than women or the less-educated. These are sobering findings for those who hope that information technology will foster greater societal equality. Only with the kind of historical, cross-time research employed in these analyses can we begin to understand the seriousness of disparities across American social groups and, hopefully, take steps to eliminate them.

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ⁱ The NSF Surveys currently can be obtained through site license from the National Science Foundation-Science Resources Statistics program (<http://www.nsf.gov>). Several hundred variables, including the ones in this report, will be available in an online Public Use File now under construction.