Divided Digitally:

Literacy in the 21st Century

Abstract

Socioeconomic inequalities receive much attention in academic literature, but scholars are just beginning to grasp what may amount to one of the most significant disparities of the 21st century: that of technological literacy. As technological skill becomes an increasingly crucial element of everyday life–especially regarding educational and career opportunities–it is becoming apparent that more research is needed on the ‘digital divide.’ Although information and communications technologies are penetrating deeper into society, there remain critical differences in how individuals access, navigate, and benefit from these advancements. Here, we will conceptualize the key concepts of the digital divide and technological literacy and evaluate policy measures designed to combat the digital divide. Then, we analyze results from a survey designed to gauge technological literacy in Madison, Wisconsin to help determine if there exists gaps in technological literacy, and what sort of demographic and socioeconomic factors are linked to such gaps. Additionally, since public schools are a “critical domain within which the digital divide is manifested, reproduced, and sometimes overcome,” we examine disparities in how technology is being taught in primary and secondary schools across Wisconsin. This socio spatial analysis has provided what we believe is substantial evidence of a divide in digital literacy across socioeconomic lines and striking disparities in how technology skills are being taught in public schools. However, given limitations in our ability to collect adequate data on some aspects of the divide and the prescient nature of this understudied field, we recommend future research to fully grasp the scope and impact these forces may have.

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The Digital Divide

The term ‘digital divide’ first started being used during the 1990s, and initially described broad inequalities in access to information and communications technology (hereafter referred to as ICT). More specifically, the digital divide during this period referred to the socio-spatial divide between those with and without access to computers and the Internet, a distinction typically defined by levels of education and income, race, age, and geography. During the rapid expansion of ICT in the 1990’s, addressing the digital divide emerged as a major policy concern. This is evidenced by the Clinton Administration’s Schools and Libraries Program of the Universal Service Fund (informally known as E-Rate), a $2.25 billion initiative designed to subsidize the incorporation of ICT in underprivileged and under-connected public schools and libraries (Warf 2012, 4). E-Rate has been partially credited with the spectacular rise in Internet access in public schools and libraries, where Internet connection rates had reached 99.1 percent by 2012 (Warf 2012, 4,9). Home access has also expanded dramatically in recent years. As of 2013, 70 percent of American adults have home broadband access, compared to just 55 percent that had broadband a mere five years ago in 2008 (Pew Internet Study, 2013). In terms of broadband access, Wisconsin ranks 41st (National Broadband Map, 2013) in the United States, and broadband costs are higher in the state due to comparatively little competition between providers (2013). Despite the rising levels of Internet access in the United States, the digital divide remains present, with the greatest increases in home broadband access among those with college degrees, adults under 50, and those with an annual household income over $50,000 (Smith & Zickuhr, 2013).

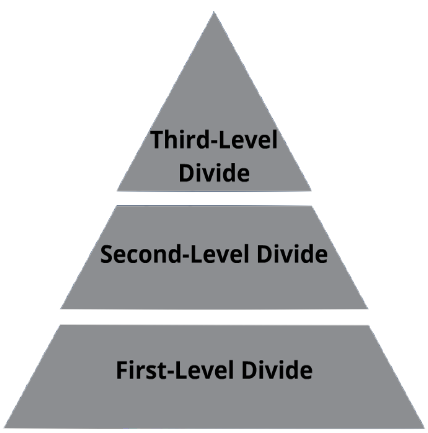
The extent of Internet access in the United States today has led scholars to instead devote their attention toward internet use as opposed to access, resulting in a break between what are now considered the first- and second-level digital divides, the former concerning disparities in access and the second regarding differences in use. In their 2011 article *Does the Digital Divide Matter More?*, Wei & Hindman defend this scholastic shift:

> *"As disparities in actual use patterns of the Internet are more pronounced between social strata than gaps in technological access, the so-called second-level digital divide deserves more scholarly attention and public concern. In comparison to access, the quality and quantity of Internet use is a more critical source of digital inequality as the Internet becomes increasingly widespread." (228-229)*

Despite this shift, there remain significant differences in Internet access, and 'autonomy of use' remains a critical variable in studying the second-level divide (SLDD). 'Autonomy of use' refers to "the freedom to use the technology where and when one wants without restraint," (Hargittai & Hinnant, 606) and is measured through indicators like device ownership, home broadband access, total number of access points, and "the freedom to use the medium for one's preferred activities" (Hargittai 2002; Hargittai & Hinnant 2008, 606; Hargittai 2010, 108). Research (Hargittai & Hinnant 2008; Hargittai 2010) has positively linked greater autonomy of use with sophistication of use, a correlation that will be explored in greater detail during our discussion of the second-level digital divide.

As Wei & Hindman have suggested, most scholars now see the second-level digital divide as a more relevant critical perspective in gauging technological inequalities. The second-level divide is concerned primarily with patterns of ICT use, and especially how tech literacy and habits of individual usage may affect one's capability to benefit from Internet access. As the vast majority of Americans now have Internet access, the decisive factor in which groups will benefit most from the technology is how they interact with it. This is determined in large part by users' levels of technological literacy.

Figure I



We developed this graphic to help conceptualize the digital divide at all of its levels. The first-level represents the digital access divide, the second is the digital consumption divide, and the third is the digital production divide. The pyramid is intended to represent the way that overcoming each level of the divide requires first closing the level beneath, with digital access necessary to even begin addressing the others. Finally, the vertical arrangement of the digital divide pyramid displays the socioeconomic stratum upon which each level is manifested.

Since the concept is inherently difficult to define, there is no single, accepted understanding of technological literacy. Rather, scholars and organizations have proposed various definitions of the term. Some focus on the sophistication of internet use, both assessing how efficiently subjects search the web and what it is they do while searching (van Deursen & van Dijk 2011; Hargittai, 2010). Others define the term in a broader sense, seeing technological literacy as the ability to "use the tools of their society with skill; in an ethical, accurate, and insightful manner to meet the demands of the 21st century workplace," (SETDA 2003, n.p.) paying special attention to "literacy" as an enabler of lifelong learning in a digital medium. David Buckingham is even pushing for tech literacy to focus on culture, arguing digital content is largely absorbed through a cultural lens and the term needs to reflect cultural contexts (2010). Still others understand the term as the ability to apply high-level technical know-how to solve problems. In its most recent publication, Technology and Engineering Literacy Framework, the National Assessment of Educational Progress (NAEP) argues the concept should be intimately related "to national efforts in science, technology, engineering, and mathematics (STEM) fields" (2013). Many suggest the vague nature of the term has plagued the promotion of policy initiatives to address a second-level digital divide, and makes accurate assessment of "technological literacy" on a large scale all but impossible. However, Becker, et al. point out that one major commonality persists across the definitions: technological literacy is multidimensional and complex (2010). In this paper, we refer to technological literacy as the ability to effectively use the information communication technologies, which we take to mean both the Internet and other basic computer functions like word processors and email, necessary to function economically, politically and culturally in the 21st century.

In recent scholarship, researchers have further dissected the second-level digital divide, proposing new typologies of Internet skills and users related to levels of tech literacy. According to Dutch behavioral scientist A.J.A.M. van Deursen, Internet skills range in sophistication from basic operational skills to higher-level strategic skills, which include "the capacity to use the Internet as a means for reaching specific goals and for the general goal of improving one's position in society" (2013). While the basic skills required to use the Internet as a medium are mostly ubiquitous, the means of engaging effectively with online content are lacking for most users (van Deursen 2013).

Other scholars, particularly Petter Bae Brandtzaeg and his colleagues, have proposed a classification for Internet users based on frequency of access, variety of use, and content preferences. Under this typology, Internet users can be categorized as sporadic, entertainment, instrumental, or advanced users. The authors of this study suggest that classifying users in this way can provide “a more nuanced perspective on…unequal Internet usage and participation in an increasingly digital society” (Brandtzaeg et al, 2011).

In both of the aforementioned studies, researchers also identified usage patterns stemming from age in regard to the frequency/reliability of Internet access. According to van Deursen:

> *“With increasing age, the level of medium-related operational and formal [related with basic internet access and navigation] skills decreased. However, although young people performed well on the medium-related Internet skills, they still showed a strikingly low level of information and strategic Internet skills. In fact, it was shown that age has a direct positive effect on content-related skills, meaning that older people perform better on these skills than do young people.” (2011)*

Brandtzaeg et al observed a similar relationship between age and Internet usage patterns, such that younger users had comparatively higher levels of Internet access, but were using the Internet primarily for entertainment purposes. In contrast, older users were ‘Instrumental Users,’ who used the Internet more sparingly but for specific, taskoriented purposes (employing the ‘Information’ and ‘Strategic’ online skills outlined by van Deursen). Interestingly, however, the Brandtzaeg study suggested that the most advanced Internet users also skewed toward the younger end of the age spectrum. These findings seem to suggest that the second-level digital divide is most pronounced amongst young users, and may even be growing. A study by Peters and Valkenburg corroborates this conclusion: “adolescents with greater socioeconomic and cognitive resources used the internet more frequently for information and less often for entertainment than their peers” (2006). In evaluating an under-30 demographic, we hope to investigate this possibility further.

Moreover, other research indicates that there may be a mutually reinforcing relationship between the second-level digital divide and socioeconomic inequality. Web use researcher Eszter Hargittai has observed that those from more privileged backgrounds are especially likely to engage in “capital-enhancing” activities online than their peers (2010). These activities–which include financial transactions, retrieving health information, searching for jobs, and reading the news–are considered more likely to improve one’s socioeconomic status, thereby contributing to further socio-economic disparity. Dewan & Riggins corroborate this claim, arguing, “there is considerable economic surplus being derived by users of sophisticated e-commerce functionalities such as online investing, auctions, recommender services and personalization technology” (2005). In 2005, it was estimated the annual consumer surplus accruing to eBay users was roughly $6.5 billion. Dewan & Riggins warn “those most in need of finding ways to get ahead financially will be less likely to make use of the more powerful and beneficial online commerce features, thus leading to further socio-economic stratification" (2005).

Somewhat surprisingly, this difference in use is entirely unrelated to time spent online. In a 2007 study by Goldfarb & Prince, it was revealed, "high-income, educated people were more likely to adopt the Internet, but they also spend considerably less time online, conditional on adoption" (3, 2007). They attribute this to differences in opportunity cost, implying that high-income users are allocating their time online more efficiently.

Despite the intense (and largely successful) efforts toward closing the first-level digital divide, there is a growing body of scholarship supporting "the pessimistic view that increasing Internet penetration will exacerbate rather than reduce inequalities" (Wei & Hindman 229). This suggests that the second-level digital divide is a more pertinent issue for policymakers seeking to mitigate tech-based–and subsequently real-world–inequality. A cross-national study by Wei et al concluded "in knowledge economies where educational and career tasks are increasingly IT driven, cultivation of CSE [computer self-efficacy; i.e. tech literacy] has taken on added significance" (182, 2011). In our analysis of the second-level digital divide, we hope to develop a richer understanding of the implications that digital usage habits can have on users' socio-economic trajectories, particularly in regard to one's educational and employment opportunities.

In addition to the first- and second-level, scholars have recently theorized the existence of a "third-level" to the digital divide as well. While this is a relatively recent contribution to digital divide literature, we imagine that understanding the implications of the third-level is critical to evaluating the full extent of the digital divide today and in the future. Despite its increasing usage in digital divide literature, the term remains vaguely defined. Wei et al describe the third-level digital divide as the “outcome” divide, referring to divergent educational and career outcomes based on tech literacy (2011). This definition, however, offers little distinction from the second-level divide, which is already understood to encompass both efficacy and related outcomes.

Instead, we qualify the third-level divide as the divergence between those who employ their digital skills to actively contribute to the creation of web-based content and technology applications, versus those who are less advanced. In other words, it can be defined as the difference between consumers and producers of digital content (such as websites, blogs and videos) and software. Jen Schradie describes this phenomenon as the “digital production gap,” referring to the developing disparity between the active creation of original content for public consumption, as opposed to content that is confined to one’s social network, like a Facebook post. Like the first- and second-level digital divides, the third-level digital divide typically reflects inequalities in the real world, especially levels of education (Schradie 2011). While the concepts of the “third-level digital divide” and the “digital production gap” are relatively recent developments in digital divide scholarship, they will be a consideration in our research due to their potentially powerful future implications.

Technology in Education

As awareness of the second-level digital divide has increased, some educational institutions have responded by designing tech literacy curriculums and other initiatives.

In 2004, the International Technology Education Association (ITEA), in partnership with the Gallup Organization, surveyed 800 adults and determined that 98 percent of the respondents believed studying technology should be included in the school curriculum (Rose, Gallup, 2004). Indeed, as Warf concludes, “public schools are a critical domain within which the digital divide is manifested, reproduced, and sometimes overcome” (Warf 2012, 8).

In one of the first references to technological literacy in a large policy initiative, the No Child Left Behind Act of 2001 (NCLB) states one of its goals is “to assist every student in crossing the digital divide by ensuring that every student is technologically literate by the time the student finishes the eighth grade, regardless of the student’s race, ethnicity, gender, family income, geographic location, or disability” (U.S. Department of Education). However, while the act states achieving technological literacy by the eighth grade as a goal, the law leaves it up to states to independently define the term ‘technologically literate’ as well as develop curriculums to teach and assessments to gauge literacy. Today, only five states require uniform assessment of proficiency at or below the eighth grade. According to Becker, et. al, among those states that have established statewide standards and assessments, variations between them render it very difficult to know if standards are being met or if students are meeting standards by the eighth grade. Thus, despite the language of NCLB, “there has been selective enforcement of the requirement to assess and report on student technological literacy levels” (2010). This “negative leadership”, says Don Knezek, the Chief Executive Officer of International Society for Technology in Education, on the part of state education departments has “cut seriously into 8th graders' tech literacy” (Cech, 2008). Lack of nationwide, standardized testing of technological literacy and consequential lack of reliable data is in stark contrast to highly regarded assessments of other subjects, particularly in the STEM fields.

All education policies and regulations in Wisconsin are mandated on a district level, meaning there is no statewide curriculum for any subject. The state can make recommendations on how to allocate funds they provide, but they have no actual authority or power over the budgeting (Bormett, 2013). Mike Bormett, the Budget and Policy Director at Wisconsin's Schools and Educators Department of Public Instruction (DPI), believes technology education is significantly less addressed than other subjects. Bormett stated, "There's really nothing in education technology. There's very little in statute or regulation in that area." He went on to say that while there is nothing being done at the state level in teaching technology, DPI is concerned about certain districts that lack reliable access to sufficient broadband capacity. [1]

Even though there remains no state or federal top-down involvement in Wisconsin's elementary and secondary schools, the concept of technology education remains widely discussed today, suggesting policy makers still see the issue as relevant. In a very recent example of such interest, the Enhancing Education Through Technology Act of 2013 would, if passed by congress, "award grants to encourage State educational agencies, local educational agencies, and schools to utilize technology to improve student achievement and college and career readiness, the skills of teachers and school leaders, and the efficiency and productivity of education systems

[1] Wisconsin is currently ranked 41st in the country in high speed broadband access.

at all levels."[2] According to Bormette, future prospects for state-level investment in assessment of technology education remain unlikely (Bormette 2013).

Since there are no national or state guidelines on how to teach computing skills, local administrators and teachers are faced with how to effectively incorporate technology education into the curriculum. Although many schools do recognize the necessity to overcome the digital divide, it's a common misconception that the problem can be solved with the purchase of ICT hardware and software. According to an article by University of Kansas geographer Barney Warf, poor schools often lack necessary "software programs, staff or teacher training, or broadband services, all of which are essential for *effective* internet access" (2012, 4) [emphasis added]. For instance, a survey of K-12 schools in the Midwest it found that schools with a higher population of students receiving free and reduced lunch were in fact more likely to have interactive whiteboards in the classroom, yet had comparatively fewer 'technology facilitators' (K12 Study 2011). While modern technologies were present in both settings, the critical difference in the effectiveness of these technologies was the technological expertise of the faculty. These findings show that hardware alone cannot close the digital divide, but rather the implementation of these technologies into the curriculum is the decisive factor in addressing the digital divide.

Analysis of Technology in Wisconsin Schools

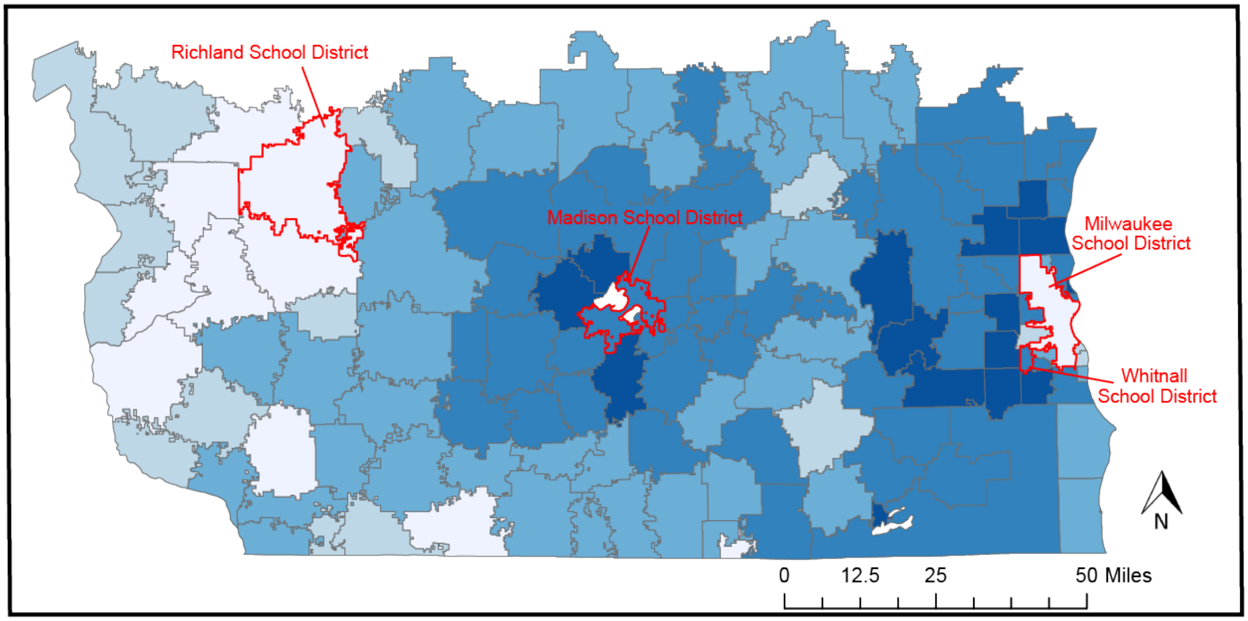
Since no statewide assessment of technology literacy is available for socio-spatial analysis, we conducted interviews with school administrators from four districts

[2] At the time of print, the act was still being considered by a congressional committee.

across southern Wisconsin to better understand differences in how technology is being taught. Our interviews revealed striking disparities in technology use and how teaching computing skills are incorporated into the pedagogy. We choose to look at Milwaukee Public School District’s disadvantaged Bay View Middle and High School, suburban Milwaukee’s Whitnall School District, urban Madison’s school district, and rural Richland School District because they offered an opportunity to evaluate disparities between the role technology and technology literacy plays across geographic space and economic and demographic variance.

According to DPI’s annual Report Card, which rates each school’s ability to meet state expectations, suburban Milwaukee’s Whitnall School District “exceeded expectations.” The five schools within the district serve an area that include the Village of Hales Corners, part of Franklin and part of Greenfield, is 95 percent white and has an average household income of $78,926 (U.S. Census, 2010). Recently, the district has made it a priority to equip students and faculty with the latest technology. Yearly spending on technology has more than quadrupled in the district, from roughly $250,000 less than five years ago to $1.1 million today. Beginning in middle school, the district has a one-to-one program, which provides each student with an iPad to help them engage with class material in the home and the classroom. The one-to-one program is expanding to the high school beginning next year, and will expected to eventually reach every student in the district.

Average Household Income for Wisconsin School Districts

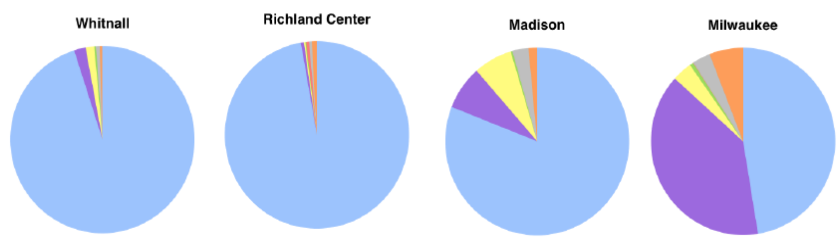


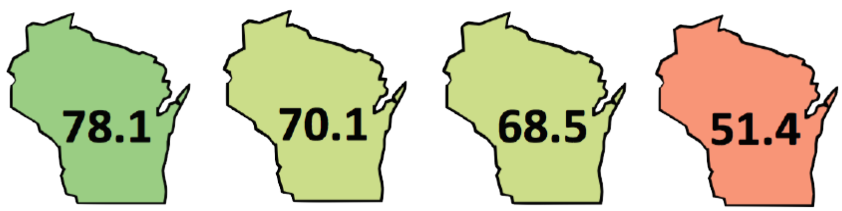
Average Household Income Per School District ($)

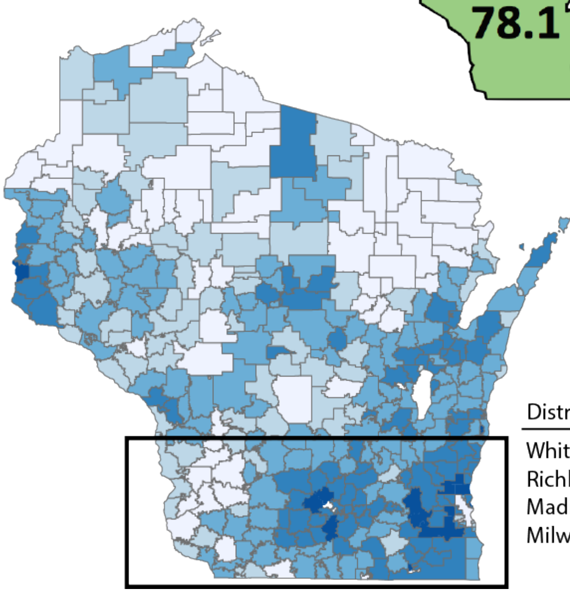
- 41,000 - 52,000
- 52,001 - 57,000
- 57,001 - 68,000
- 68,001 - 93,000
- 93,001 - 148,000
- Districts we focused on

Ethnicity

- W
- B
- A
- AI
- NH
- MR
- O







Overall Accountability Ratings	Score
Significantly Exceeds Expectations	83-100
Exceeds Expectations	73-82.9
Meets Expectations	63-72.9
Meets Few Expectations	53-62.9
Fails to Meet Expectations	0-52.9

*Overall Accountability Score is an average of Priority Area Scores, minus Student Engagement Indicator deductions. Priority Area Scores are scores for the district's priority areas such as student achievement, student growth, closing gaps, and on-track and postsecondary readiness. Student Engagement Indicators are measures outside the four priority areas that affect student success or the soundness of the report card. These include test participation rate, absenteeism rate, and drop out rate.

District	Student Population	Locale	% Economically Disadvantaged
Whitnall	2,332	Suburban	25.5
Richland	1,342	Rural	53.4
Madison	27,112	City	48.6
Milwuakee	78,363	City	82.3

In addition to the one-to-one program, the district has also restructured its staff around technology. In addition to Eric Gran, who serves as the district's Education Technology Director, Whitnall has recently added two Instructional Technology Leaders who help teachers develop their technical skills and integrate technology into the classroom. This is a departure from the "technical support" role that previously defined the duties of the technical staff. During our interview, Gran elaborated on the crucial role these staff members play in Whitnall's overall technical education objectives:

> *"[There was] a science department teacher who wanted to do digital microscopy, but was terrified to do it on her own because (she was) worried about the technology. She set up a meeting a week ahead of time with an ITL* [a member of Whitnall's technology staff]*, and the ITL said she is going to 'go in and teach the tech end of it, so you don't have to think about it, then the second time I'll have you teach it but I'm going to be in the back of the room just in case you have any questions you can't answer, and the third time you're on your own.' And this woman loved it because that resource is right in the classroom when you need it."*

The addition of Instructional Technology Leaders has been so successful that the chair of the science department called it the "best thing that's ever happened to us" in a recent letter to the president of the school board (Gran).

As part of an evolving pedagogy and long-term strategy, Gran outlined the curricular changes the district is making to ensure its students are technologically literate. Technology education at Whitnall begins in Kindergarten, where students learn to communicate with their teachers through email. By First Grade, students start learning word processing and other basic computing skills, like copy and paste. By middle school, the district expects students to have basic productivity skills like spreadsheets, presentations, word processing etc., by the start of high school students have the opportunity to learn how to do basic video editing and audio recording, and at the junior and senior level, all students are expected to have the fundamental skills necessary to incorporate technology into a project or employ it to solve a problem. Gran explains what is expected of high school students at Whitnall:

> *"We hope at (the high school level) they have all the skills to research on the internet, take a camera talk to their friends get their opinions of it, talk to an expert and get their opinions on it and put it all together, narrate and present your point with some visual evidence that maybe you download off the internet. There's a great project, and that's application. Fundamental skills in elementary and middle school, application by high school."*

Currently, the district has a mandated seventh grade class that is designed to explicitly teach basic Microsoft Office programs like Word, Excel, and PowerPoint, but there are plans to get rid of that class and enter into an integrated model, where new skills are taught within the context of other subjects. Departing from this model of "learning in isolation" towards an integrated approach is meant to alleviate learning disconnect and teach students how to apply technical skill to real world problems.

The Richland Center School District also shows dedication to introducing technology into the classroom and making technology education a priority. The district contains four schools and is in a rural area in the Southwestern part of Wisconsin, serving the town of Richland Center and surrounding areas. Average household income here is $51,935 and the population is 97.2 percent white (U.S. Census, 2010). Similar to Whitnall, Richland Center gives its middle school students iPads and has enough computers available for all students. The district has a technology education faculty member that makes sure teaching technology is incorporated into the curriculum and that the teachers have enough training to do so, similar to the role Whitnall's technology facilitators play. Richland Center teaches its elementary students keyboarding, but that is the only class specifically dedicated to a technology skill. Like Whitnall, basic processing skills like spreadsheets, presentations, word processing etc. are incorporated right into the curriculum and students entering middle school are expected to be able to perform such tasks, as well as begin engaging with media technologies. At the high school level, students are expected to integrate these skills.

Richland Center School District Administrator Rachel Schultz said that investment in new technologies and technology education initiatives has increased in recent years, thanks to efforts to divert money from other parts of the budget, grant writing, and a significant amount of money from a lawsuit settlement with Microsoft. Schultz also noted the school does not mandate that any teacher or class use or teach technology, and there remains some teachers that are more interested in incorporating it than others. However, she says that in the last year or two the district has "rounded a corner" when it comes to teachers ability to use and teach technology:

"I think we only have a handful of teachers that just really don't want anything to do with it. Even my high school band teacher got music software that he uses for

composing and things like that, my art teachers have art software that they use, we got a special lab in our IMC where the special software resides on the computers so the kids can go there and work."

While both Whitnall and Richland Center demonstrate a similarly strong commitment to teaching and providing technology to its students, the other two institutions we focused on are less adept at teaching and incorporating technology into the classroom. The Madison School District encompasses the city of Madison and includes 52 schools. Average income within the district is $53,363 and the population is 78.9 percent white (Census, 2010). With an annual technology budget of $1.4 million, the district's chief information officer Andrew Statz explained that Madison's lack of funding is its biggest obstacle when it comes to incorporating technology into the curriculum. The district's school board acknowledges that Madison is behind in technology education and something should be done to improve it, but money is tight and it is not considered a top priority. Statz said that the allocating the districts funds is a highly political process. When faced with budget constraints, funding from the technology department is often cut and redirected into services such as building maintenance or teacher salaries. The district is also lacking technology facilitators on staff, which according to Statz, plays a significant role in the problem:

> *"We need coaches in place. People familiar with using the technology to further offer learning and professional development sessions for staff to make sure that's effectively used. Today we have very little in that area. If you looked at the number of people we should have, its probably 1/10 the number per staff basis."*

Because teachers are not adequately trained on how to use the technological devices in their classrooms, Statz added that many of them view technology as more of a distraction rather than a teaching aid.

At Bay View Middle and High School, which is part of Milwaukee Public School District, the strongest disparities of all four schools were on display. It is important to note that when we interviewed administrators from Whitnall, Richland Center and Madison, it was with officials representing entire districts, while Principal Adam Shapiro of Bay View was only representing his middle and high school within the district. With 158 schools, the district is one of the country's largest, and by far the biggest in the state. Average income within the district is $47,458, and 47.4 percent of the population is white and 39.3 percent is African American. At Bay View, there is a $30,000 annual budget, and Shapiro explained most of that money goes towards providing smart boards. Teachers receive laptops, but students have only a few desktop computers to share among them. Only half of the building that Bay View occupies has wireless Internet access, and budget constraints make 1-to-1 programs like those seen at Whitnall and Richland essentially impossible.

According to Shapiro, even the level of technological literacy among his teachers varies greatly:

> *"Some staff can say 'yeah, I know how to post a grade' and for other staff, even opening an email can be a challenge at times, or doing an attachment can be a challenge."*

While the district does offer some computer literacy training programs to its faculty, they are not mandatory. Shapiro noted that for those teachers who do utilize technology in the classroom have a “much higher level of engagement” than those who do not. Beyond technology as a tool used to engage students in traditional subjects, there is no technology education curriculum in place, nor is there indication of a push to incorporate teaching programs like PowerPoint or Excel into existing curriculums. There is also no faculty dedicated to help teachers incorporate technology education into curriculums.

The little funding spent on technology within the last few years has gone towards smartboard, and without technology facilitators, research shows that they are of little use (K12 study, 2011).

According to Kee-Kwon Wei and others, the most proactive step schools can take to alleviate the digital divide among students is to develop a “school IT culture,” which requires technologically-advanced faculty as well as a positive attitude that encourages students to explore these technologies (2011, 175-176). This is exhibited at Whitnall, which has a relatively high ratio of technology facilitators to students and actively encourages students and staff to integrate technology into their projects and lesson plans. However, this is in stark contrast to the Madison Metropolitan School District, which admits that it has only one-tenth the number of dedicated technology staff as it should district-wide. Additionally, technology appears to be a lower priority in Madison’s already tight budget than concerns like building upkeep and teacher salaries, whereas Richland and Whitnall have shown willingness to trim costs elsewhere in order to support their growing technology programs. At Bay View, there appears neither money nor will to add such staff.

We also learned through the interviews and previous research that while there is no statewide technology literacy assessment, they do provide some curriculums, if outdated, and hold technology education forums (for a fee…) through which educators could learn about the newest in technology in education. The suburban (Whitnall) and rural (Richland) administrators said their schools were up to date and well versed in such resources, and that they took it into their own hands to assess technology literacy even though the state did not. Bay View and Madison, however, did not send anyone to such conferences or pursue any sort of internal technological literacy assessment.

Of course, how much money a district has is directly linked to how much money it can spend on things like technology facilitators and hardware and software upgrades. These monetary disparities are determined primarily by property values within the district and, among our four districts, there are strong disparities in wealth.[3] (map) While there are obvious links between money and a school's ability to provide technology to its students, it is important to note that there shouldn't be an automatic correlation between spending large amounts of much money on technology and a highly tech literate student body, nor should it be assumed tech literacy is only possible when preceded by large investments. For instance, issuing tablets could be, and according to our interviews often is, a financially motivated decision (given high textbook costs and versatility of tablets) as opposed to one solely intended to improve technology teaching.

[3] While **map 1** shows household income and not property values, there is a strong link between the two measures.

Therefore, it is unwise to judge how well a school is teaching technology skills solely by the equipment they use in the classroom.

On the flip side, even though we saw little evidence of this happening at the lowest income school we visited, it seems entirely possible that even without investing in large quantities of expensive hardware and software, schools could still effectively teach students how to use technologies to improve their lives. Of course, such a scenario would require teachers that are well versed in the technology or hiring technology facilitators, in addition to investing a minimum amount to provide a medium through which to teach. Of course, this all costs money. But, if done efficiently, we believe it is possible to provide a quality technology education for much less money than it costs to purchase iPads for every student.

While money may not automatically translate into results, a district's investment in technology is both reflective of the resources available to spend on such investments and telling of its overall commitment towards technology education and incorporation. At Whitnall and Richland Center, it seems both the commitment towards providing quality computer education (through technology facilitators on staff) and resources to purchase technologies are present. While their technology budgets have significantly increased in recent years, both Gran and Schultz explained that money is tight across the district, and spending increases on technology simply means less money for other things. This practice of diverting resources from other places into the technology budget to better teach technology suggests a priority shift, one that seems absent in Milwaukee and Madison's public schools.

Survey Methods

We approached our research by both interviewing several education professionals and collecting survey data from an under 30 demographic. As we've seen, the former provided a nuanced, qualitative look into differences in technology education among different school districts and the latter provided quantitative data, analysis of which we were able to identify trends.

We distributed the survey primarily through email, but also distributed a physical copy of the survey in public locations where we expected to find less Internet active demographics and economically disadvantaged people (such as Madison's South Side). In this way, we tried to ensure an accurate sample population (Key Methods 2010).

We chose to only use responses from those under 30 years old because research (Hargittai et al, 2010) suggests people of this younger age group are more likely to be users of ICTs than older generations, meaning we would be more likely to receive data on *how* people use and create technology than *if* people use it. We also made this decision because people under 30 are, for the most part, the only ones who would have been taught how to use technology relevant to today in school or by other means, since the technologies we are examining have only become widespread in the last twenty or so years. Also, time and budget constraints were a limiting factor that did not allow us to examine important differences in age and computer literacy, an issue we will discuss later in the paper. By focusing on this age group, the first level divide was bypassed in preference for an examination of the top two segments of the digital divide pyramid, allowing us a more relevant perspective from which to gauge modern day technological inequalities.

The survey included age, gender and zip code questions. We also asked respondents their highest completed level of education; the highest level their parents completed, household income and their race/ethnicity, all strong measures of socioeconomic standing.

Using existing digital divide literature and suggested technology literacy testing mechanisms as blueprints, we designed three likert scale assessments for the non-demographic portion of the survey. The likert scale enabled us to obtain dynamic, interesting information and effectively analyze the results quantitatively. The first question is designed to measure familiarity with tech-related terms, including: tagging, preference settings, PDF, webblog, proxypod, spyware, advanced search, phishing, filtibly, malware, firewall, podcasting, wiki, JOG, cache, RSS, and tabbed browsing. We modeled this question from a paper published by Eszter Hargittai (a communications professor at Northwestern University), which suggested survey methods for gauging web-use skills (2012). These terms were taken directly from her suggestions. Using the same paper as a guideline, we grouped the terms into different levels of difficulty in order to accurately gauge participant’s understanding relative to each other. The terms classified as requiring low-level understanding are tagging, preference setting, PDF, spyware, tabbed browsing, firewall; the intermediate understanding terms are Wiki, JPG, weblog, podcasting; and the high level terms are cache, malware, phishing, RSS. Included in the list are two placebo terms; proxypod and filtibly. The placebo terms are used in order to get an idea of the respondent’s sincerity or detect a possible level of false confidence (Hargittai et al, 2012). For this likert scale, we chose five levels of familiarity; not at all, somewhat, familiar, very familiar. By using a scale with 5 measures, the participants have the option to remain neutral if they do not feel strongly towards one way, or the other (Key Methods 2010). By asking participants about terms in this way, we were able to assess their familiarity and experience with certain programs without having to actually observe them using a computer.

Then, we asked respondents to rate how often they use the internet for the following activities on a given day: social media; educational activities/research; entertainment; news/current events; business/work; health information; banking; paying bills; information for goods/services; and email. Respondents were asked to rate on a scale from never, rarely, sometimes, often, all of the time or I don't know. In administering this question, we were able to see what respondents were engaged in what we consider to be capital enhancing, more sophisticated activities versus those who were using the Internet for more elementary tasks. Similar to what we did with the Internet terms, we grouped the different uses into three categories: basic (entertainment and social media); intermediate (news, information for goods/services, health information, banking, paying bills, emails); and advanced (educational activities/research and business/work). As discussed above, there is a growing body of scholastic work concerned with the implications of usage patterns that can be seen as capital enhancing and those that are not. In administering this question, we were able to begin addressing the important question of who is using the Internet for what.

Our third likert scale is designed to gauge how comfortable respondents were using various software programs and computer skills, including Excel, Microsoft word, PowerPoint, Java, Google Docs, Adobe Illustrator, Image Editing, HTML, API, and Database Management Systems. Again, we chose programs of a variety of skill levels, which range from Easy to Advanced. The programs are categorized as follows: easy (Microsoft word, PowerPoint); intermediate (Excel, Google Docs, Image Editing); and advanced (HTML, Adobe Illustrator, API, Database Management Systems, and Java). The programs were in a randomized order on the survey, so the participants were not influenced by the level of difficulty, which we suspect made them think more critically about each individual program and answer more honestly. The subsequent survey question asked if participants have ever received formal training for any of the aforementioned program/computer skills, and if so, from where? (Participants could choose from school, work, workshops, and no formal training received) While such information could be implied, little statistical data exists on the whether those who received technology training know more about these software programs than those who didn't. By asking this question we hoped to identify such relationships, or lack there of. We also hoped to identify whether or not they received training outside of a school setting, for instance on the job or other workshops, providing interesting data for cross-analysis.

FInally, we asked the respondents which devices they own: desktop computer, laptop, tablet, smartphone, or other. This question will enable us to accurately assess the respondent's autonomy of use, which literature highlights as an important variable in technology literacy in the context of the digital divide (Hargittai & Hinnant, 2008).

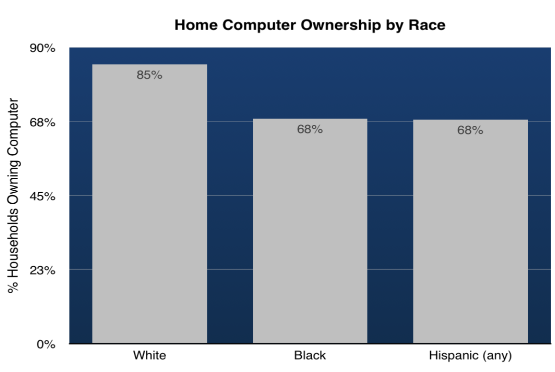
Originally, we planned to distribute a slightly modified version of this survey to teachers from the school district we interviewed to gauge how technologically literate the teachers are relative to teachers from different schools and compared to the general public. However, only one district, Whitnall, provided responses. While we were unable to use this data for cross comparison with other districts, we feel such a comparison could provide valuable insight. We elaborate on this more later in the report.

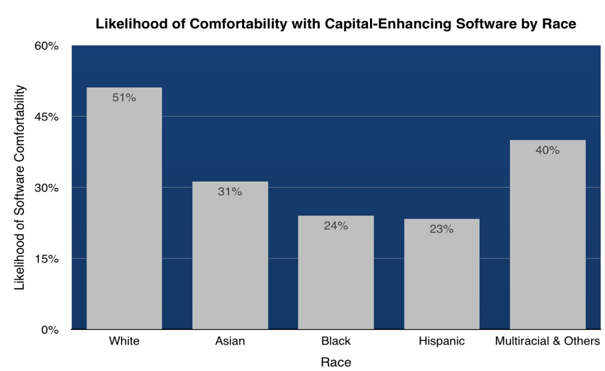
Findings

Just as our analysis of the four school districts exposed huge disparities across socioeconomic lines in how technology is being taught to elementary, middle and high school students, our surveys revealed similar divides in technology literacy among the general public. We found positive relationships between poor levels of technology literacy/sophistication of use and low socioeconomic status, most notably between race, device ownership and software familiarity, advanced ICT usage and parental education, and knowledge of advanced technology terms and the respondent's level of education. Using these findings, we were able to make some logical links back to insights gleaned from our interviews, allowing us to paint a picture of a society that is clearly divided digitally.

Although incorporating technology into the curriculum is a critical factor in developing students' tech literacy, there are indications that conditions at home are equally important in addressing the digital divide. According to research from Ezster Hargittai, who studies the digital divide at Northwestern University, 'autonomy of use' has important implications for technology literacy. Autonomy of use is a variable measure referring to students' ability to access information & communications technologies across time and space, and is closely linked to home device ownership and quality of Internet connection. A number of studies on the digital divide show that students with less autonomy of use are likely to suffer from decreased digital literacy compared to their peers, even if their schools are well-equipped (Wei et al, 2011; Hargittai & Hinnant 2008). The data collected from our interviews and surveys corroborate this body of research, proving that the digital divide is generated both in the classroom and at home.

At Bay View, where 90 percent of the student body qualifies for free or reduced lunch, Shapiro estimates that only about half of the students have access to a computer at home. Similarly, many families in the rural Richland district lack reliable Internet access at home. Although students from these technologically disadvantaged households are increasingly accessing the Internet via smartphone, we argue that the reduced autonomy of use continues to limit these students' technological literacy. According to data from the 2010 U.S. Census, only around ⅔ of black and Hispanic households own at least one computer, compared with 85 percent of their white counterparts. In our survey, we found this to have a severe impact on students' tech literacy; with black and Hispanic respondents only half as likely to feel comfortable using selected capital-enhancing software (Microsoft Office, Adobe Creative, etc.) than their white peers. This suggests that while smartphones may provide Internet access, they fail to close the software divide, which has critical implications for employment.



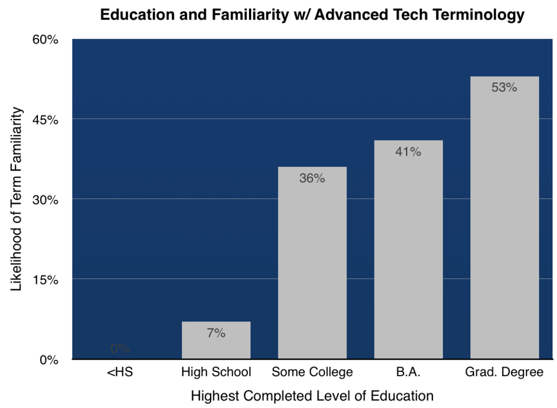


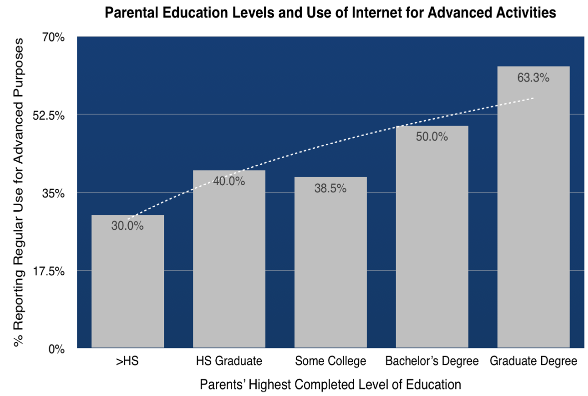
Whitnall School District exemplifies the effect differences in household access have on technological literacy. Although mostly wealthy, white students comprise the district, there are a number of students from disadvantaged areas who attend through open enrollment. While Whitnall has fully implemented technology into the curriculum, Eric Gran reports that the open-enroll students often struggle to use these devices when compared with their peers, most of who have experience with them at home. This reveals that the provision of technology in the school is not in itself sufficient to closing the gap in tech literacy, and that differences in students' home device ownership is a critical element to the digital divide at all levels.

In addition to race and income, we found that the highest education level of the respondent's parents also influenced the ways people use technology. As we previously outlined, the second-level refers to the disparate ways people use ICTs, and how these usage patterns may affect the extent to which users derive benefits from their ICT use. To measure respondents' sophistication of use, our survey included a self-assessment of Internet activity, intended to gauge how they spent their time online. The data revealed that those who used the internet for advanced purposes, which we define as educational, research, or career-oriented, were more likely to have well-educated parents (Hargittai). Respondents whose parents had attained a graduate or professional degree were more than twice as likely to use the Internet for advanced purposes than those whose parents had not completed high school. Given that perhaps a disproportionate number of our respondents were college students (and thus had a similar level of education), this is an especially interesting finding. This seems to indicate that a respondent's upbringing has an effect on the way they use technology.

Our final metric used to determine technology literacy was based on respondents' familiarity with tech-based terminology. This was drawn largely from an existing study by Hargittai, who contends that familiarity with online terminology is closely linked with students' web-use skill. Our data suggest a strong correlation between education and Internet-savvy. Those with graduate degrees had a 53 percent chance of understanding the more advanced terms, compared with just 7 percent of those with only a high school diploma. Among our few respondents who had not graduated high school, these terms were entirely unknown.

One condition that may affect survey questions, and one which Hargittai noted when evaluating familiarity with tech terms in specific is the possibility of respondents overstating their own ability, intentionally or not. In order to evaluate the extent to which this occurred, we included two meaningless terms, designed to catch those who were answering inaccurately. The results were interesting, as nearly one in five respondents claimed to be familiar with terms like "proxypod" and "filtibly." For these 'placebo' terms, men were much more likely to exaggerate their knowledge–of those claiming familiarity, around three-quarters were male. For this reason, we were hesitant to make any inferences about gender and the digital divide, although it possible (some would argue probable) that such a division may exist.





Limitations & Future Research

While our interview and survey data supported the presence of a multi-level digital divide, there were a number of limitations that affected the depth of our results. First and foremost among these were temporal and financial constraints. We were allotted one semester, approximately three months, to conduct the entirety of our research. This includes not only the data collection phase, but also conceptualizing our research question, evaluating existing research on the digital divide, and organizing our results. Furthermore, we had no financing for our research, and were thus limited in the geographic range of our research as well as the depth of our data collection, particularly when conducting interviews with school administrators. For example, we were interested in examining the role of technology in schools on Indian reservations and those in more-isolated rural areas, but lacked the time and resources to effectively do so. With more time and funding, we would have been able to collect a richer and more complete perspective on the extent of the digital divide in Wisconsin school districts.

On a related note, we were further constrained by poor response rates to our surveys. After distributing the survey, we received only 63 eligible (under 30 years old) responses, the majority of which we obtained by handing out physical copies to the public. We also emailed the survey to students in the UW-Madison geography department. In order to prevent the data from becoming skewed, we closed the online survey after receiving a significant number of responses from the geography students.

While the survey data support the existence of a socioeconomically related digital divide, it is hard to accurately extrapolate from such a limited sample size. Moreover, the survey respondents were disproportionately white college students. For this reason, our data likely understates the actual extent of the digital divide, which existing literature (for more refer to our literature review section) suggests is closely linked to education levels and race.

In addition to our student survey, we also designed and distributed an email-based survey to gauge the technology literacy of teachers in our selected districts. The results likely would have offered insight into the second-level relation between teachers' technology literacy and technology usage in the classroom, and how this might affect student learning outcomes. However our response rate was so poor that we were unable to use the results in our research. Of the four districts, we only received responses from high-achieving Whitnall, and therefore could not gather the comparative data crucial to understanding how educators might shape the digital divide.

While we feel our survey will still provide us with accurate data from which to draw valuable conclusions, there are more precise assessments of technological literacy available. Among these is the iSkill assessment, which combines software with participant observation to gauge literacy with greater precision. Although iSkill or other assessments would likely have provided us with richer data, we were limited by time and resource constraints. Additionally, this type of assessment would have been most effective in evaluating students' technological literacy, which we were prohibited from due to ethical concerns related to researching minors. Such an analysis would have provided data that otherwise does not exist given the lack of any national or statewide assessment standard.

One area of the digital divide into which we recommend further research is the third-level digital divide, which represents the divergence of producers and consumers of digital content and ICT applications. Better understanding of this facet of the digital divide, which is virtually unexamined in existing literature on the subject, is critical due to the documented advantages these highly-advanced users experience in the employment market (see Figure II) and dissemination of ideas. We included questions in our surveys designed to evaluate this level of the digital divide (such as students' ability to code and level of comfort with advanced software), but found that so few the respondents met the requisite criteria that we were unable to draw any definitive conclusions. Rather than proof of nonexistence, we believe this instead suggests the divide at this level is highly pervasive, and may be creating a small group of 'technology elites' with elevated societal status and disproportionate power in disseminating information for mass consumption.

Figure II

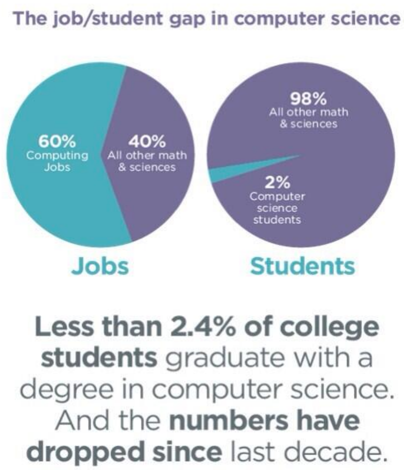


Figure II presents the striking mismatch between student skills and job availability in math and science disciplines. This reveals the desirability of technologically literate applicants for employers, and reflects the critical impact that the third-level divide may have on employment outcomes.

Source: Code.com via @BillGates

Much like the first- and second-levels of the digital divide, there is some evidence to suggest that the third-level divide is linked to educational opportunity, with underlying socioeconomic factors affecting both. Although classes in coding and other advanced computer skills are available to students in many districts, few schools have an advanced computing requirement. Therefore, enrollment in these courses is mostly limited to students that can comprehend the importance of computer skills in today's economy. We suspect such students disproportionately come from highly educated, relatively advantaged households.

Suggesting a growing awareness of disparities and potential implications at this third level, across the country recent efforts have started to incorporate coding and other advanced technology education in specialized high schools, particularly programs geared towards disadvantaged students (Miller, 2013; Wingfield, 2012). However, such efforts remain few and far-between. We expect that until such initiatives gain traction and access to advanced computing education becomes ubiquitous in public education, existing digital divides and consequential socioeconomic disparities will persist, and may even widen.

Conclusion

"If you and your skills are a complement to the computer, your wage and labor market prospects are likely to be cheery. If your skills do not complement the computer, you may want to address that mismatch." (Average is Over, Cowen)

As this paper and previous research has demonstrated, growing access to information and communication technologies is accompanied by growing divisions in how people are using them. The future implications of this second and third level digital divide can only be guessed at, but no one denies the growing importance of technological skill in the 21st century. While the digital divide is an arena in which socioeconomic inequality can be reproduced, it can also serve as an enabler for social mobilization.

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