Redefining the Digital Divide: Beyond Access to Computers and the Internet

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This study critiqued the notion that a binary "digital divide" between high and low resource schools describes accurately the technology disparity in U.S society. In this study, we surveyed teachers from six southern California schools. Five of the schools were low resource schools and one school, chosen for comparative purposes, was characterized as a high resource school. We found that high resource school teachers had significantly more physical access to computers and the Internet (C&I), more frequent use of C&I, more creative uses of C&I for instruction, communicated by email more often with students, and engaged more frequently in professional activities such on on-line communication with other teachers. The study lent modest support to previous researchers (Natriello, 2001; Warschauer, 2003a, 2003b, 2003c; Wenglinksy, 1998) who claimed that high resource students are more likely to use C&I for more experimental and creative uses than students from low resource schools. In addition the findings contribute to a broader definition of the "digital divide" that includes social consequences including the impact of social networks and wider use of technology to improve instruction.

While the total number of U.S. residents purchasing computers and connecting to the Internet increases daily, large segments of the population are being passed over in the Information Age. In a recent study NTIA (2002) showed that Whites and Asian Americans have higher rates of both computer and Internet use than Blacks and Latinos. NTIA found computer use to be highest for Asian Americans (71.2 percent) and Whites (70.0 percent), followed by Blacks, (55.7) and Latinos (48.8). Regarding Internet use, 60% of Whites and Asian Americans use the Internet compared to Blacks (39.8 percent) and Latinos (31.6 percent) who use the Internet at much lower rates (NTIA, 2002).

U.S. schools mirror the nation's trends in computer ownership and Internet connectivity. By 2002 over 99% of U.S. schools owned computers and had Internet connections (NCES, 2004).

Despite these findings, there is still evidence of an economic and racial divide among school children and their use of computers and the Internet (C&I). To illustrate, the ratio of students to computers in high poverty schools[1] is much higher than it is in more affluent schools. NCES (2003) estimated that in high poverty schools, the student to computer ratio was 5.5 students per instructional computer compared to 4.6 students to a computer in more affluent schools. In addition, use of the Internet by children from the varying social strata differs markedly. Overall Internet use at home and school for Latino and Black children is 47.8% and 52.3% respectively, compared to Asian American (79.4%) and White children (79.7%) who are far more likely to use the Internet (NTIA, 2002).

Becker and his colleagues (1999) pointed out that teachers are more likely to assign C&I work when their students have ready access to computers. They showed that teachers with ratios of four or fewer students to a computer were three times more likely to assign computer work to students than those teachers with less favorable ratios of six or more students to a computer. Given that higher socioeconomic status (SES) schools are more likely to have low student to computer ratios, they provide a distinct advantage over low SES schools in gaining the experience and practice necessary for using the Internet as an educational resource.

It is evident that computer availability and Internet access have improved over the last several years, however the studies cited above concur that the poor and racial minorities are lagging behind society's dominant groups in terms of computer ownership and Internet connectivity. Rapid advancement in computer availability however, has spurred some commentators to proclaim the closing of the "digital divide" (Simons, 2000; Thierer, 2002). Compaigne (2000) argued against any legislation to ensure universal access because present market forces and government programs currently in place are already achieving that goal. While affirming a digital gap between rich and poor, NTIA's report (2002) indicated a remarkable level of "catching up" among individuals with low family incomes. Martin (2003), in his re-analysis of the NTIA (2002) data, found that while low-income individuals exhibited gains, Internet use was growing more slowly for low-income individuals compared to higher income groups. Martin concluded that in order to compensate for the gap, the lag in technology diffusion between rich and poor should be as brief as possible to ameliorate the current inequality in C&I use.

Others, meanwhile, have argued that declaring the "digital divide" closed based on a wider availability of computers oversimplifies the construct. For example, Bruce (1999) stated that the "digital divide" is not so much that certain groups have less access to the Internet; it is that they have a different kind of access. In other words students from low-income backgrounds often find their access is restricted to computer labs where they are limited to instructional software that emphasizes low-level drill and practice routines. Healy (1998) divided the technological world into the "interacting" and the "interacted." The "interacting" includes those who can take advantage of sophisticated applications and research possibilities available on the Internet, while the "interacted" are those individuals who must settle for the most simplistic offerings designed for lower level users.

In what follows we develop a framework for redefining the concept of the "digital divide." In particular we propose how a re-envisioning of the "digital divide" concept addresses more accurately how high and low poverty schools differ in terms of access, use, and support of the integration of information technology in teachers' classrooms.

Framing the Study

Popular acceptance and reaction to the concept "digital divide" led to well-meaning but incomplete attempts to solve the technology gap between rich and poor students by simply installing computers and providing access to the Internet in low resource schools (Attewell, 2001; Duran, 2001; Natriello, 2001; Warschauer, 2003a; 2003b; 2003c). California's Digital High School Grants Program (DHSGP) was an example of this effort. DHSGP succeeded in increasing access to computers in resource-poor schools, but California's schools still have not achieved equity in terms of C&I use. Schiff and Solmon (1999) reported that DHSGP offered schools the opportunity to provide students with computer hardware, but did not provide feasible plans to support teachers in integrating technology into their curricula.

In Warschauer's (2003a) view, initiatives such as DHSGP were aimed at closing the computer gap, but failed to address differences in how technology was used in high and low SES schools. Cuban, Kirkpatrick, & Peck's (2001) critique of the technology movement sought to address some of its shortcomings by characterizing schools as too eager to "jump on the technology bandwagon." Cuban et al. (2001) note how schools make use of special funding to purchase equipment, but fail to develop coherent plans for implementation, support, and professional development of teachers to integrate technology into the classroom.

Natriello's (2001) commentary centered on how schools joined in the rush to bridge the divide by connecting to the Internet, but the effort my have inadvertently contributed to patterns that have exacerbated disparities between rich and poor. Natriello argued that schools shaped students' computer activities by purchasing software that supported the school's ongoing pedagogical practices. In other words low SES schools acquired software that promoted drill and practice routines while more affluent schools purchased software for more creative and experimental uses. This is in line with Warschauer's (2003b) warning that computer use in schools could actually worsen inequality by failing to address the key issue regarding the way computers are used rather than merely providing more physical access to technology.

Cuban's (1986) critique was similar. Cuban concluded that teachers take from the computing world what they find immediately useful and jettison the rest, often relying on low-level drill and practice strategies that fit easily within their existing pedagogical approaches. Wenglinsky's (1998) extensive analysis of the National Assessment of Educational Progress data supports to some extent, Natriello's (2001), Warschauer's (2003b) and Cuban's (1986) assertions. Wenglinsky (1998) found that African American students were more likely than White or Asian students to use computers for lower-order activities and were more likely to be taught by teachers who were unprepared to use computers in their classrooms. Other findings, ironically, have shown that economically disadvantaged students are more apt than White or Asian students to use the computer daily, but are also more likely to use it for drill and practice routines (Coley, et al., 1997; NCES, 2003a; 2003b).

Redefining the Digital Divide

This study critiques the notion that a binary "digital divide" between the "haves" and "have nots" describes accurately the technological inequality that exists between high and low-resource schools. The weakness of the "digital divide" framework lies in its overemphasis on the importance of the physical presence of C&I connectivity to the exclusion of other factors that allow students to use computers for meaningful ends (Kling, 1998). DiMaggio et al. (2001) argue that a new view of the "digital divide" must include an attempt to redefine access in social as well as technical terms. Their view was that a social definition encompasses not only the pressing question of who can find access, but also includes what teachers are able to do when they go on-line, including on-line communication and their ability to locate appropriate instructional materials.

Martin (2003) suggested that to overcome the binary definition of the "digital divide" it must be replaced with a multidimensional view of access to C&I. Martin's (2003) model partitions access into three dimensions, including motivation, possession, and skills. Motivation refers to the willingness of individuals to use technology and to include it in their home, work, and educational efforts. Possession describes a more concrete definition of access including physical access to C&I and the ability to use the technology. Skills refer to the ability to use the technology, and the degree of support available to instruct individuals in its use. DiMaggio et al.'s (2001) contribution to a new view of the "divide" emphasizes social aspects including the development of peer networks and the social support necessary to institute innovative uses of the technology. Warschauer's (2003b) critique of the concept "digital divide" calls for a deepening of the concept to include the social consequences of the "divide." Warschauer

(2003a; 2003b) stressed that C&I access signifies social practices leading to the use of technology for building collaboration and cooperation among users. This reconceptualization of the digital divide urges consideration for how people use the Internet for furthering the process of social inclusion including wider participation in democratic societies (Warschauer, 2003a; 2003b).

For this study we redefine the notion of the "digital divide" based on the work of Martin (2003), DiMaggio et al. (2001), and Warschauer (2003a; 2003b; 2003c) to understand more fully C&I access in educational settings. Our re-conceptualization of the "divide" is based on four elements re-defining access to C&I: (1) the *physical access* (DiMaggio et al., 2001; Martin, 2003); (2) *C&I use* in the classroom (Martin, 2003); (3) *availability of support* for C&I use (Martin, 2003); and (4) *social consequences* of the use of IT (March, 2001; Warschauer, 2003).

Having a computer and being connected to the Internet define the central characteristics of *Physical Access*. *Physical Access* to C&I is the critical factor for encouraging teachers to integrate C&I in their classroom instruction. Physical Access however, is not a binary concept. *Physical access* can be described as a spectrum in which certain teachers may have computers connected to the Internet in their own classrooms, while other may have less convenient connections or even more remote access in libraries or computer labs.

C&I use expands our definition of "access" by including the amount of time teachers spend using C&I for instructional purposes in school and at home. It includes frequency of email use, creating instructional material, and keeping student records. *C&I use* also implies the frequency teachers use higher order instructional strategies in their classrooms.

Availability of support is defined as the degree of support for teachers to acquire the skills needed to integrate C&I in their classroom teaching. Support may take the form of training made available through state or district funds, or local initiatives to support teacher integration of technology in the classroom. Support is also characterized by teacher perceptions of the level of local and administrative commitment and support to integrate computers and technology into classroom activities.

We include *social consequences* as part of our re-definition of "access" to measure the degree to which teachers are developing and improving their skills as professional educators. *Social consequences* implies that teachers use C&I to communicate and collaborate with colleagues, develop social networks, and that they use technology to improve their communication with students. A *social consequence* of computer access would be the level of formal and informal networks that form to support teacher integration of technology. Our inclusion of this concept follows the work of March (2001) and Warschauer (2003a; 2003b; 2003c) who stressed the importance of teachers being able to use technology to actively participate in communication exchange to improve their practice. We also define the concept of *social consequences* to include teachers' perceptions of how computers and the Internet engage students in higher order learning (i.e., increased motivation and engagement, learning in new ways, deeper understanding).

In summary we agree that the "digital divide" correctly characterizes a technology gap between rich and poor, however the term is much too simplistic to encompass the vast differences in opportunity, experiences, and practices that exist between high and low SES students. A more accurately defined "digital divide" does not simply describe the division between technology "haves" and "have nots" but addresses inequalities in technology and learning. A broader framework that includes a deeper understanding of the "digital divide" involves questioning local, state and federal policies that attempted to solve complex societal issues with simplistic solutions. Providing resources for schools to purchase computers did not address the more important issues regarding poverty, inequality, and differential opportunities made available to low and high SES students.

Our framework complicates the concept "digital divide" by pursuing questions that address the importance of the social aspects of the divide. For instance, we not only ask questions concerning teacher access and use; teachers' instructional practices; and administrative support, but we also seek to understand the social consequences that emerge when teachers have access to computers and the Internet. Specifically our questions are: (1) how does access to C&I differ between high and low resource schools? (2) How does access influence the work that teachers do, including how they teach and what they teach; and (3) What type of support, funding, and administrative support exist in high and low-resource schools and (4) What are the social consequences, including development of social networks, that develop from the use of C&I ?

Method

Procedures

In 1999 State U. formed a partnership with five area high schools with purpose of improving the schools' learning opportunities for their predominantly Latino student bodies. The partnership centered on providing teacher professional development, curricular reform, and technology initiatives. Technology initiatives, supported by the above referenced Digital High School Grants Program and State U. expertise, emphasized professional development for helping teachers to adopt the use of C&I in their classrooms. Our purpose in approaching these schools for this study was to investigate the impact of the technology initiatives.

The schools. Each of the five partner high schools, which we designated low-resource schools, shared similar characteristics[2]. All were located within 80 miles of the State U. and were classified by the California Department of Education (CDE) as "low performing schools." This designation was based on the schools' low API[3] rankings that ranged from 2 to 4. Aside from low API rankings the partner schools exhibited other symptoms of troubled schools including extremely low college-going rates, disciplinary problems, high truancy, and low teacher morale (Casas & Fenstermacher, 2000). As a result of their status as "low performing schools," the partner schools were under a directive to take significant steps to improve their academic standing to avoid sanctions, including possible takeover from CDE.

We selected an additional school (S6) to provide a contrasting reference point for the five partner high schools. S6, a high resource school, was also located within 80 miles of State U. S6 received an API score of 10 (the highest possible) and was located in an upper middle class (median family income = $77,000) southern California neighborhood. In contrast, the five low resource schools were located in low-income southern California neighborhoods with median family incomes ranging from $37,000 to $39,000 (U.S. Census Bureau, n.d.).

Questionnaire development. We began our data collection by interviewing administrators (principals and vice principals) and one teacher from each of the six schools. A simple protocol was used (how do teachers us computers in your school? How do students use computers? What type of support is available for the use of computers in the classroom?). These interviews provided us with basic phenomenological data regarding C&I use, and informed the development of a 52 item questionnaire to assess teachers' access and use of computers; perceptions of how students use C&I; and level of support for use of C&I and the degree to which teacher approaches to education are being transformed. In addition we reviewed computer access questionnaire items being considered for the Educational Longitudinal Survey of 2002. Those items were based on previous national surveys, including the National Assessment of Educational Progress (2000); National Educational Longitudinal Study of 1988 and the Fast Response Staff Survey (NCES, 2001). Specifically we queried teachers about their (1) access to C&I; (2) frequency of use of computers in school and at home; (3) degree of training and professional development to support classroom use of C&I; and (4) how computers influence teacher conceptions of their role in the classroom (i.e. use of technology to communicate with colleagues and students outside of the classroom)

Sample. We distributed the questionnaire to the teachers at the six schools. Our sample included teachers who taught courses in the State U.'s "a-g categories" that determine eligibility for admission to the university. Students must take courses from each of the six categories: (a) history/social sciences (two years); (b) English (four years); (c) mathematics (minimum of three years); (d) laboratory sciences (two years); (e) foreign language (two years); (f) visual and performing arts (one year); and (g) additional college preparatory electives (one year). We excluded teachers from non a-g subject areas such as physical education, vocational education, or special education. Our rationale for focusing on a-g subject areas was to survey teachers who taught the required courses for entry into State University. We sent 398 questionnaires to the teachers who met these criteria at the six schools. We received 285 usable questionnaires for a return rate of 72%.

Analytic Plan

We obtained multiple measures to construct several dimensions that described how C&I was used at the six schools. We used principal components factor analysis to develop the dimensions and an analysis of variance (ANOVA) to distinguish the six schools along the prescribed factors. Because of the unequal sample sizes in this study, we followed Cohen's (2000) suggestion for using the Brown-Forsythe formula to adjust the F statistic (F_). The Brown-Forsythe formula takes into account the unbalanced ANOVA design and heterogeneity of the sample variances. Additionally, the Brown-Forsythe procedure is appropriate because the samples exhibited a consistent pattern with larger groups having smaller variances than the smaller groups. We followed this analysis with Games-Howell (GH) post hoc comparisons to determine how the schools differed from each other along each dimension. Games & Howell (1976) recommended this approach when the study includes unequal sample sizes and variances.[4]

Measures

We used principal components factor analysis with a promax rotation to analyze C&I use by teachers for the entire sample and extracted the weighted factor scores[5]. This analysis yielded six distinct factors: physical access; barriers to computer use; instructional practices; student engagement; C&I school use; and training. In addition to these factors there was one researcher created composite: school use of C&I. Information on the construction of these composite variables, along with corresponding factor loadings are included in the appendix. We also included estimates of reliability (Cronbach's) for the researcher created composites. In addition to the above composites we selected two variables as proxies for professional activities (*use C&I for on-line conversations with colleagues*) and communication (*use C&I for email communication with students*).

We used these factors to describe the elements of our definition for a newly conceptualized view of the "digital divide." *Physical access* is defined by one factor, *physical access to C&I.* This factor described the number of computers available for teacher use, connections to the Internet, and access to local area networks. *C&I use* was defined by three factors: (1) *school use of C&Is;* (2) *home use of C&I; and* (3) *instructional practices. Instructional practices* included the frequency in which teachers engaged in higher order instructional strategies, including problem solving, data analysis and word processing. *Social Consequences* includes three measures: (1) *professional activities* is a variable that measures the frequency teachers engaged in professional on-line communication with colleagues regarding instructional issues, (2) *communication with students* measures the amount of email communication teachers have with students about homework, and the frequency that they post assignments on the Internet, and (3) the degree of *student engagement* in their learning.

Availability of Support is defined by two factors: (1) teachers' perceptions of the amount of *training* they have received to use C&I, and (2) their views on the existence of administrative and economic *barriers* to integration of C&I into their classrooms.

Results

Physical Access

Our findings show (Table 1) that teachers from the six schools reported differing degrees of *physical access* to C&I, F_ (5, 178.6) = 9.08, $p < .01$. Effect sizes, "eta squared" (_^{2}), describe the proportion of variability in the dependent measure that is attributable to a factor. For example "eta squared" for *access* shows that 14% of the total variance in the dependent measure can be explained by the independent variable (school).

Table 2 displays results from the post hoc analysis showing how teachers from the six schools reported their degree of *physical access* to C&I. S6 teachers indicated they had more computers available for instruction, more computers connected to the Internet, newer computers, and more computers connected to local area networks (LANs) than any of the five low-resource schools. Further analysis shows that there were no significant differences in *physical access* among the low-resource schools.

C&I Use

Teachers reported significant differences, F_ (5, 194.9) = 6.12, $p < .01$, in the amount of *C&I use in school* (Table 1). This highly significant difference indicates a disparity among the schools in the degree that teachers used computers for keeping administrative records, creating instructional materials, and general use of computers in their classroom. Results of the post hoc analysis (Table 3) illustrate that significant mean differences can be detected between S6 and three low-resource schools (S1, S3, S5). From this finding we inferred that S6 teachers used their in-school computers to support instruction more frequently than S1, S3, and S5 teachers. No other differences using the GH approach were detected between S6 and the other schools, nor were there differences among the five low-resource schools. The findings support a relationship between frequent use of in-school computers and the availability of computers in teachers' classrooms. As Becker and his colleagues (1999) reported, when teachers have access to computers and Internet connections, it facilitates their use and their propensity for assigning student work on computers.

Teachers reported significantly different *C&I home* use to support their work, F_ (5, 165.7) = 3.16, $p < .01$ (Table 1). This variable, describing frequency that teachers *use computer at home, and use email at home* to support instruction, produced a somewhat unexpected finding (Table 4). S3 teachers showed more home use of computers than either S4 or S5 teachers, also from low resource schools. A closer examination of these schools showed that S3 (M = 1.70, s = 1.17) had far fewer computers per classroom connected to the Internet than either S4 (M = 2.29, s = .98) or S5 teachers (M = 2.64, s = 1.21). A possible explanation is that because S3 teachers had fewer in-school computers connected to the Internet than any other school in the study, they relied on their home computers to support their classroom work.

How often teachers used various *instructional practices* (Table 1), including problem solving, data analysis, and word processing by students was shown to be significant, F_ (5, 156.8) = 1.9, $p < .10$. Table 5 displays our post hoc analysis for the variable *instructional practices*. We did not detect any significant mean differences between any of the pairs using the GH post hoc analysis. This led us to perform pariwise comparisons for S6 and the five low-resource schools using the Least Significant Difference (LSD) approach. LSD is roughly equivalent to performing all pairwise t-tests, comparing each pair to a critical value based on p = .05 (except that the error term is based on data from all conditions rather than being computed for each pair). This procedure emphasizes sensitivity minimizing Type II errors, but increases the possibility of Type I error. The results of the LSD analysis, therefore, must be interpreted with caution. Nevertheless, Table 5 shows that there were significant mean differences between S6 and the five low resources schools, adding support to the findings of previous researchers (Bruce, 1999; Healy, 1998; Natriello, 2001; Warschauer, 2003a; 2003b; 2003c) who claim that high resource schools use C&I to support higher order activities, while low-resource schools use C&I for much simpler activities such as drill and practice routines.

Social Consequences

Our analysis of *Professional activities* indicated clearly significant differences among the schools F_ (5, 114.1) = 9.08, $p < .01$ (Table 1). We selected this variable to describe how teachers used C&I to engage in professional activity (i.e. how teachers use technology to improve their teaching). We found that S6 teachers engaged more frequently in professional type behavior than teachers from four of the five low-resource schools (Table 6). The largest significant mean differences were between S6 and S1; S6 and S3; and S6 and S5 (Table 6). A smaller mean difference, yet still significant was detected between S6 and S4 (Table 6). Interestingly, we also found that S2 and S4 teachers engaged more frequently in professional type behavior than S3 teachers (Table 6). S3 teachers, again fettered by fewer in-school computers connected to the Internet, engaged less frequently in professional type activity.

Our analysis of the variable *communication with students* showed modest differences in teacher use of email for communicating with students outside of class, $F (5, 142.8) = 2.69, p < .05$ (Table 1). Although the results are not substantial (_^{2} = .059), they are indications that teachers from high resource schools may be taking advantage of available technology to integrate innovative approaches to teaching and learning in their classrooms. Table 7 shows that S6 teachers were more likely than S1 and S4 teachers to use email with students to discuss school work than teachers from the two low resource schools (using the GH approach). Table 7 also shows mean differences (using the LSD approach) between S6 and three remaining low-resource schools (S2, S3, S5) indicating more frequent use of C&I by S6 teachers for communicating with students. Finding significance using the LSD approach (because of increased chance of Type I error) tempers our findings, but our results lend cautious support to previous research attesting that high resource schools use innovative teaching strategies more frequently than low-resource schools (Natriello, 2001; Wenglinsky, 1998).

In a somewhat unexpected finding, teachers reported no significant differences in their perceptions of increased *student engagement* due to use of C&I (Table 1). The lack of significance regarding student engagement shows more agreement than disagreement among teachers and their beliefs concerning how computers affect student learning.

Available Support

Two factors that we identified as proxies for available support were found not to be significant: *Barriers* to implementation; and presence of *training* to support C&I for classroom instruction (Table 1). Because of the amount of statewide funding and local administrative commitment for implementing the use of computers in the classroom, it was not surprising to find relatively small mean differences (not displayed here) between high and low resource school teachers and their views regarding *barriers and training.*

Conclusions

Our goal was to redefine the notion of the "digital divide" to provide a more accurate framework for analyzing the technology gap between high and low resource schools. We derived a framework from the work of Warschauer (2003a; 2003b; 2003c), March (2001), Martin (2003), and DiMaggio, et al. (2001) to introduce a multidimensional view of the "divide" that broadens the concept of "access" to include not only whether teachers have physical access to C&I , but what they do when they are on-line. This view of C&I access describes how teachers use computers to support instruction, and social consequences of Internet use, including skill development, communication, and building social networks.

Evidence from our study re-affirms a "divide" between high and low resource schools. We showed that S6, a high resource school, had more computers per classroom, more connections to the Internet, and more access to local area networks than any of the low-resource schools. Further examination however begins to unveil a more complex view of the "divide." S6 with its greater access to C&I than low-resource schools, had more teachers using C&I to support instructional activities. In addition to more frequent use, we presented modest findings that S6 teachers were more likely to engage in C&I practices that encouraged creative and critical thinking in their students. These results comply with Becker and his colleague's (1999) report that teachers with more access to C&I used computers more frequently and assigned computer work to students more often than teachers with less access. Additionally, we added cautious support to Natriello (2001) and Wenglinsky's (1998) assertions that high resource schools are more likely to involve students in higher order learning processes such as problem solving and data analysis.

Our expanded view of the "divide" addresses the social consequences attributed to the range of access to C&I. We agree with DiMaggio et al. (2001), that differential access to C&I found in schools points to inequality in teachers' opportunities to develop knowledge and technical skills in ways that enhance their professional practice and social life. To illustrate, S6 teachers consulted more frequently with on-line colleagues regarding instructional issues than their lower resource counterparts. A consequence of this communication disparity is that high resource teachers are more likely than low-resource teachers to be exposed to opportunities leading to the skill development and knowledge acquisition through the construction of social networks. As Hargittai (2001) explained, social networks expose teachers to technological innovation and a more expansive instructional repertoire than teachers with less exposure.

Our redefinition of the "divide" accounts for a more sweeping condition than previously described in the popular literature. A newly defined "divide" encompassing the social consequences attributed to C&I use addresses the vast differences in teachers' skills, knowledge, and professional practices characterizing high and low resource schools. In addition, a new "divide" explains further how our stratified educational system provides more opportunities for innovation, experimentation, and creativity for society's more privileged socioeconomic groups.

From a policy perspective it remains a high priority to close the "hardware gap" between high and low resource schools. Although as Warschauer (2003a) reminds us, the divide is not "binary" and there is no single overriding factor for determining or closing such a divide. Overcoming this divide means furthering the process of social inclusion including policies directing state and local districts to address the knowledge, skill, and social gap characterizing teachers from high and low resource schools. Low resource school teachers are in need of professional development to acquire skills to integrate C&I into their instructional practices. In addition, structures need to be developed to assemble teachers into school, district, and national networks to support C&I use in their classroom.

Finally there are social justice concerns regarding the "divide" between high and low resource schools. In addition to plugging the hardware gap, education policy makers must address issues related to the impoverished communities in which the schools are located. It is one thing to provide in-school computers, but it is also essential for students to have C&I access at home, including up-to-date computers, software, and high speed Internet connections. It is only through social policies, grant initiatives, and programs to provide C&I connections that students from low-resource schools will approach the technology standards existing in more privileged communities.

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Appendix: Measures

Variables from Teacher Technology Survey and factor scores in parentheses.

Physical access to C&I is the degree to which teachers have access to computers and the Internet in the classroom. Variables include: *number of computers available for instruction,* .887; *number of computers with access to the internet,* .947; *number of computers less than 3 years old,* .775; *number of computers connected to local area network,* .904. Variables coded 1 = one; 2 = two; 3 = three; and 4 = four or more.

Barriers are the structural or administrative barriers to instructors using computers and the Internet in their classrooms. Variable include: *outdated computers,* .485; *lack of good software,* .638; *inadequate training;* .880; *lack of release time,* .795; *lack of administrative support* (.850); *lack of funding* (.704). Variables coded 1 = not a barrier; 2 = small barrier; 3= moderate barrier; and 4 = great barrier.

Instructional practices describes variables showing how teachers used the computers and the Internet in their classroom: *use computers to solve problems* (.874); *use computers to analyze data* (.670); *instruct word processing* (.437). Variables coded 1 = never/very rarely; 2 = 1-2 times per month; 3 = 1-2 times per week; 4 = almost every day; 5 = every day.

C&I school use shows how teachers use computer and the Internet in their classrooms. The variables are: *how often do you use a computer in school* (.777); *how often do you create instructional materials* (.629); *how often do you use the computer for administrative records* (.750). Variables coded 1 = every day; 2 = almost every day; 3 = a few times a week; 4 = between once a week and once a month; 5 = never.

Student engagement is the degree to which students are engaged in the classroom. Variable included are: *students are more engaged and motivated when computers are used* (.655); *computers allow students to learn in ways not possible with traditional techniques* (.793); *computers help students reach deeper understanding* (.885). Variables coded 1 = strongly agree; 2 = agree; 3 = disagree; 4 = strongly disagree.

Training. Variables include: *how helpful was college preparing you to use computers* (.521); *how helpful are formal classes to use computers* (.758); Variables coded 1 = very unprepared; 2 = somewhat prepared; 3 = adequately prepared; 4 = well prepared; 5 = very well prepared; *how many hours of professional development for using computers and the Internet have you had* (.791). Variables coded 1 = 1-4 hours; 2 = 5-8 hours; 3 = 9-12 hours; 4 = 13-16 hours; 5 = 17-24 hours; 6 = 25 hours or more.

Researcher created composite variable with Cronbach's alpha in parentheses.

C&I home use (_ = .872). *Use computer at home; Use email at home.* Variables coded 1 = every day; 2 = almost every day; 3 = a few times a week; 4 = between once a week and once a month; 5 = never.

Individual variables selected

Professional practices: Use C&I for on-line discussion with collegues; Variable coded 1 = every day; 2 = almost every day; 3 = a few times a week; 4 = between once a week and once a month; 5 = never.

Communication with students: Use C&I for email communication with students; Variable coded 1 = every day; 2 = almost every day; 3 = a few times a week; 4 = between once a week and once a month; 5 = never.

Endnotes

1 NCES defined high poverty schools as schools in which at least 71% of the students received a free or reduced price lunch. Low poverty schools are those schools with less than 35% of the students receiving free or reduced price lunch).

2 We used several indicators to distinguish low (S1-S5) from high resource (S6) schools: (1) the percentage of students receiving a free or reduced price lunch (FRPL), S1's FRPL was 42%; S2 = 42%; S3 = 42%; S4 = 42%; S5 = 42 %; and S6 = 8%; (2) Percentage of parents with high school diplomas: S1 = 60%, S2 = 64%, S3 = 76%, S4 = 57%, S5 = 58%, S6 = 97%; and Percentage of parents with college degrees: S1 = 11%, S2 = 10%, S3 = 18%, S4 = 19%, S5 = 15%, and S6 = 38%.

3 The API rankings receive by the schools were based on the results of various indicators (i.e., statewide assessments) including the Standardized Testing and Reporting (STAR) program and California Standards Tests. To rank the schools, the California Department of Education divides API scores into deciles. Schools are numbered from 1 to 10 (highest rank). Schools with rankings of 4 or less are designated underperforming schools. In this study, S1 had a ranking of 4; S2 = 3; S3 = 3; S4 = 3; S5= 4; and S6 = 10.

4 To test for equality of variances we use Levene's test for homogeneity of variances (SPSS 13.0 for Windows).

5 A promax rotation is used rather than a varimax rotation because of the theoretical interconnectedness of the concepts. Varimax rotation would have forced no correlation between the various factors when in fact the theoretical operationalization would indicate systematic covariance between the factors.

Source	df1	df2	F_	_^{2}
Physical Access				
Physical Access to C&I	5	178.6	9.08***	.140
C&I Use				
School use of C&I	5	194.9	6.12***	.096
Home use of C&I	5	165.7	3.16***	.055
Instructional practices	5	156.8	1.87*	.032
Social consequences				
Professional activities	5	114.1	9.08***	.167
Communication with students	5	142.8	2.69**	.047
Student Engagement	5	191.4	1.68	.027
Training				
Barriers	5	180.2	1.71	.029
Training	5	133.1	.610	.010

*p < .10
**p < .05
***p < .01

Table 1. Analysis of Variance for Teacher C&I Use (F'= Brown-Forsythe Statistic)

	S1	S2	S3	S4	S5	S6
S1	—-	-.026	.401	.267	.053	-1.148***
S2	—-	—-	.427	.293	.079	-1.122***
S3			—-	-.134	-.348	-1.549***
S4				—-	-.214	-1.415***
S5					—-	-1.201***
S6						—-

***p < .01

Table 2. Post Hoc Comparisons (Games-Howell) of Mean Differences for Physical Access to C&I by School (S1-S6)

	S1	S2	S3	S4	S5	S6
S1	—-	.803	.239	.688	.251	1.310***
S2		—-	-.563	-.115	-.551	.508
S3			—-	.449	-.013	1.072***
S4				—-	-.437	.622
S5					—-	1.059***
S6						—-

***p < .01

Table 3. Post Hoc Comparisons (Games-Howell) of Mean Differences for School use of C&I by School (S1-S6)

	S1	S2	S3	S4	S5	S6
S1	—-	.379	.653	-.109	.011	.683
S2		—-	.273	-.489	-.368	.304
S3			—-	-762**	-.641**	.030
S4				—-	.121	.794
S5					—-	.672
S6						—-

** p < .05

Table 4. Post Hoc Comparisons(Games-Howell) of Mean Differences for Home Use of C&I by School (S1-S6)

	S1	S2	S3	S4	S5	S6
S1	—-	-.092	-.160	-.027	-215	-.536**
S2		—-	-.068	.065	-.123	-.444**
S3			—-	.133	-.054	-.375**
S4				—-	-.188	-.509***
S5					—-	-.321*
S6						—-

*p < .10
** p < .05
***p < .01

Table 5. Post Hoc Comparisons (LSD) of Mean Differences for Instructional Practices by School (S1-S6)

	S1	S2	S3	S4	S5	S6
S1	—-	.402	-.209	.354	-.040	1.305***
S2		—-	-.611**	-.047	-.441	.903
S3			—-	.563***	.167	1.514***
S4				—-	-.115	.950**
S5					—-	1.345**
S6						—-

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

Table 6. Post Hoc Comparisons (Games-Howell) of Mean Differences for Professional Activities by School (S1-S6)

	S1	S2	S3	S4	S5	S6
S1	—-	.411	.277	.122	.277	.938**
S2		—-	-.134	-.288	-.133	.527†††
S3			—-	-.154	.001	.662††
S4				—-	.155	.817**
S5					—-	.661†††
S6						—-

** $p < .05$
†† $p < .05$
††† $p < .05$

Table 7. Post Hoc Comparisons(Games-Howell* and LSDÜ) of Mean Differences for Communication with Students by School (S1-S6)