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After the Wires: Implementation Conditions Related to Teacher Internet Use in Schools with High Internet Connectivity

Jason L. Ravitz
University of California, Irvine

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Abstract

This paper examines implementation conditions related to Internet use by teachers. The focus is on the extent of use by Internet-using teachers in leading-edge schools, i.e., schools that have had multiple high-speed (56Kb+) LAN-based Internet connections for several years. An early 1997 survey completed by 238 teachers in 124 K-12 schools across the United States allows analysis of different patterns of use related to the presence of various supportive conditions, using Ely's (1976; 1990) framework. Multivariate analysis identifies which conditions (or combinations of conditions) are most predictive of overall Internet use, conceptualized as both the extent of "teacher use" and "student use. " Extensive student use of the Internet seems to require systemic changes beyond those required to support teacher use on their own, with implications for current policies that may focus on professional development without adequate attention to these other issues.

After the Wires: Implementation Conditions Related to Teacher Internet Use in Schools with High Internet Connectivity

The history of educational technology is filled with promises of technological innovation being offered as a way to improve teaching and learning. Today we are in the midst of yet another high-stakes, government and industry-sponsored effort to introduce technology to bring about educational change. The federal government, states, and private organizations are spending unprecedented amounts of money for the advancement of Internet use in schools -- offering the hope of more to win, and the risk of more to lose for those who are concerned with educational change and technology.

Many claim that the Internet is a revolutionary technology for teaching and learning because of its ability to provide resources, data sharing, and communication to all who are connected (Fishman & Pea, 1994; Gordin, et al., 1994; Gomez, et al., 1994; Hunter, 1993; Hunter 1995a; Koschmann, et al., 1993; Ravitz, 1995; Riel, 1989; Romiszowski & Ravitz, 1997). Analysis of a representative sample of teachers in the U.S. that focuses on pedagogy and computer use has found that teachers who use the Internet, email and Web browsing, have a substantially different outlook towards student learning and are more likely to embrace a "constructivist-compatible" philosophy than teachers who do not use the Internet. "The most constructivist teachers' average score for Teacher Internet Use was 2 1/2 times as high as the average score for the most traditional teachers" (Becker, 1999). This and other analyses support the plausibility that computer and Internet use can be a catalyst for broader teaching reforms (Becker & Ravitz, 1999). It is instructive to remember, however, that previous claims for the superiority of new technologies for education have often foundered not on the quality of the technologies themselves, but on complex issues related to their implementation in schools (Berman, 1981; Fullan, 1993; Holloway, 1996; McLaughlin, 1990).

The informants for this study are Internet-using teachers in a select group of schools that have already achieved a high level of Internet connectivity.[1] These teachers are perhaps the best informants for what conditions facilitate Internet use by students and teachers, i.e., once a school has already been connected to the Internet and once a teacher has decided to use the Internet for teaching purposes. By examining teachers who are already using the Internet, this paper avoids problems associated with those who have not adopted (Rogers, 1983) or who may be resistant to using these new technologies.

Although it would seem that the participating schools have made institutional-level decisions to adopt the Internet for instructional use, and they have made efforts to support Internet use by teachers, the relative extent of these efforts, the areas of greatest support, and the success of implementation by individual teachers is very much open to examination. While implementation is often discussed at an organizational level, the variables for study are viewed as teacher-level variables with the teacher as the unit of analysis, partly because one might expect different experiences and perceptions reported by teachers in the same school (Becker, 1994a). Thus, this study might be understood as an examination of individual teacher behavior (extent of use) and conditions that may be determinant of greater amounts of use. As more schools obtain Internet connectivity and more teachers become interested in using the Internet, the questions raised in this study may become increasingly important.

Implementing Technology Use in Schools

In general, studies concerning implementation of innovations have often focused on a few independent variables -- fewer than would be required to address the complexities of

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[1] The schools are part of the National School Network (NSN) project organized by researchers at BBN in Cambridge, MA in 1994 with funding the National Science Foundation (Contract # RED-9454769).

implementation (Holloway, 1996; Rogers, 1983). It is increasingly clear that there is no "silver-bullet" that will ensure use of new technologies by teachers. Instead, the reality we see involves a complex mix of issues. Still, there do seem to be some generally consistent findings concerning the importance of training, resources, and a sense of personal involvement by those expected to make a change in their practice (Holloway, 1996). Becker's (1994b) summary for the Office of Technological Assessment found that computer-using teachers worked in schools with strong social support networks for computer use, full time technology coordinators on staff, formal staff development both for using software and integrating it into the curriculum, and a priority placed on students using word processing in their classes. Stuhlmann's (1994) study also found that Internet use requires support from other users, as well as teachers valuing the use of networks, understanding how to use them in the curriculum, and having access at home. Goldman and Laserna's (1998) case studies focused on community-based issues that helped schools support Internet use, including the presence of a visionary, an external sponsoring agency, and some form of community-school partnership.

Other Internet-related studies have identified specific barriers to use. Honey and Henriquez (1993) identified hardware problems -- appearing in this order -- lack of phone lines and peripherals, lack of hardware, poor phone systems, and maintenance problems. They also identified software problems -- too difficult to use, incompatibility with hardware, and lack of availability, and problems with the network -- lack of relevant materials (e.g., databases, curricular materials, student activities), technical difficulties (garbage online, connection problems), non-standard interfaces, system information overload, and interface design. Finally, logistical obstacles included lack of time in the schedule, poor district/school communication about telecommunications, lack of money, poor planning, not enough training, limited access, not enough support from teachers and administrators. Becker's (1995) baseline study of network coordinators in NSN, revealed a similar set of barriers to use including hard to find information,

slow network performance or limited access, information overload, and lack of technical support. These studies and the variety of findings in the literature point to the complexity of the situation, certainly extending beyond a teacher's own preparedness. What seems to be lacking from the above discussion is a conceptual framework for understanding the various findings that exist.

Framework of Analysis

Existing studies demonstrate that many issues influence implementation. "The more factors supporting implementation, the more change in practice will be accomplished" (Fullan, 1991, p. 67). However, research on innovation adoption and implementation has typically lacked an organizing framework and has seldom included multivariate analysis (Gillman, 1988). Ely's (1976; 1990) is one of the few frameworks that is available for studying technology implementation in educational settings.

The expectation is that the lack of any of the identified conditions will hinder implementation of educational technology innovations. The following is viewed as one of the few attempts to identify a variety of generalizable issues that appear to some degree in any setting and which may facilitate the implementation of new practices using technology:

1) dissatisfaction with the status quo

2) existence of knowledge and skills

3) availability of resources

4) availability of time

5) existence of rewards or incentives

6) expectation and encouragement of participation

7) commitment by those who are involved, and

8) evidence of leadership (Ely, 1976; 1990)

While this framework has not yet withstood the tests that would be required to pronounce it as a theory, it can be used with increasing confidence. A series of dissertations suggest that the conditions are broadly generalizable, applicable in diverse educational settings from school districts (Read, 1994), to libraries (Ely, 1976) to universities (Bauder, 1993), in the United States (Riley, 1995; Stein, 1996) and abroad (Ely, 1990). The utility of this framework is also supported by the literature related to computer use in schools, i.e., many of the studies one sees include variables that seem to be consistent with Ely's conditions -- e.g., dissatisfaction (Barker and Taylor, 1993); knowledge and skills (Sheingold, et al., 1981); resources (Becker, 1994b; Office of Educational Technology, 1996); the availability of time (Honey & Henriquez, 1993; Sheingold & Hadley, 1990), and so on.[2] In addition, it seems plausible that the framework can support predictions about implementation outcomes based on the observed presence or absence of the conditions; to the extent that one or more of the conditions is lacking, implementation is likely to be hindered (Ely, 1990).

Purpose of the Study

This examines issues that may affect individual teachers both in their personal efforts to use the Internet, and in their efforts to use the Internet with students. As more schools gain access to the Internet, there is no guarantee that extensive use by teachers will take place, and no guarantee that this use will be substantial for those who do use the Internet at all. The expectation is that there are different levels of implementation by teachers, and that this may partly be attributable to different conditions experienced by teachers within the same school, e.g., as a result of their having developed greater knowledge and skills, or having been provided equipment

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[2] Other topics from the literature, such as social norms (Marcinkiewicz, 1993; Marcinkiewicz & Regstad, 1996), school culture (Becker & Riel, 1999), leadership *styles* (Hall & Hord, 1997) and teaching philosophy (Honey & Moeller, 1990) are not included in the current analysis.

resources prior to others. The general expectation is that teachers who use the Internet to the greatest extent would probably be those who experience more favorable conditions on the whole.

It is also important to consider how the conditions covary and interact with one another. Failure to pay attention to the mix of conditions that are present may oversimplify the situation or fail to generate useful findings. For example, Mitchell, et al. (1987), report that even when extrinsic rewards and incentives are strongly present, another key issue, such as the ability of teachers to clearly visualize their successful use of the innovation, may be critical (p. 16). Therefore, one might hypothesize that the presence of rewards and incentives may only be predictive of greater use when sufficient knowledge and skills are present, i.e., when the teacher clearly understands how the innovation can be implemented in their work setting. This study attempts to empirically address such relationships and the covariance of the conditions in order to develop more useful and valid sets of predictors.

The study examines the extent to which the conditions are present in schools with high Internet connectivity, as reported by Internet using teachers, and how the conditions tend to covary. These are precursors to asking which conditions or combinations of conditions are most predictive of greater or lesser amounts of teacher Internet use. Finally, it provides a test for the framework by exploring the extent to which the variables identified here can account for variance in teacher Internet use. The research questions for Internet-using teachers in schools with high Internet connectivity are as follows:

1. How do the conditions covary?

2. To what extent are each of the eight conditions predictive of use?

3. What set of closely associated conditions are most predictive of use?

4. To what extent do the conditions account for variance in Internet use?

5. What are possible interactions effects between the conditions related to the extent of use?

Methods

The study employs a survey, conducted in early 1997, of teachers in schools known to have established a high level of Internet connectivity. Schools were required to have maintained a Local Area Network (LAN) with 10 or more high-speed (56KB+) simultaneous connections to the Internet, for at least a year. This selection criterion includes schools with one or two networked computer labs, as well as schools with a wider distribution and density of computers. Approximately 250 schools that met this criterion were identified through their participation in the National School Network (NSN) project, a testbed project funded by the National Science Foundation (Hunter, 1995b).

The National School Network was intended to provide a forum for discussion and collaboration among leading-edge organizations involved in Internet and K-12 education reform (Hunter, 1995b). Schools were nominated by intermediary organizations involved in Internet-based school reform, which included museums, universities, regional labs, businesses, and school districts, among others. Each member organization provided a list of schools that were making efforts to implement Internet use that met the criteria for participation in NSN activities, along with the names of school-level contacts. Approximately 100 schools were included in the initial baseline study of network coordinators (Becker, 1995). By the time of the baseline study, most of the schools had far exceeded the minimum connectivity requirements. The remaining 150 schools included in the current study were nominated and accepted to the NSN at a later date, or were schools who had since developed their capacity and met the criteria for participation.

At the start of this study, NSN had 320 schools, but schools were dropped in one city because information was not provided to establish that they had met the minimum connectivity requirements. There were also 3 member organizations with what was thought to be too many schools represented in NSN, and a decision was made to limit them to 20 schools each; schools that were dropped were selected randomly from each group. The final sample size for schools

turned out to be 248 because one school was listed twice under two different names, and another turned out to be a service center for other schools, not a school itself. From these schools, teachers were sampled using the process described below.

This study was undertaken as part of his larger effort that including a baseline and follow-up survey of network coordinators and additional surveys of principals and technology specialists. These were viewed as somewhat tangential to this study; because of the assumption that individual teachers may have very different experiences and perceptions within the same school.[3]

Data Collection

Prior to finalization of the survey instrument, formative evaluation of its content was undertaken. This included open-ended interviews and completion of the instrument by a dozen (12) teachers in seven (7) different schools with high-speed connectivity, in and around Syracuse, NY. Five of these schools were originally in the study's sample population. Participants at this stage included teachers, library/media specialists, and technology coordinators who were most familiar with Internet use in their schools and conditions supporting or hindering that use. In one district, three schools participated, resulting in a mini-case study that identified issues involved in district-level implementation. In this district there were problems of scale associated with providing district-level as opposed to school-level incentives for teachers; extensive use by teachers was most frequently observed outside of traditional subject areas where there seemed to be greater flexibility in the curriculum and testing requirements; and, relief of teaching

[3] Dr. Henry Becker at the University of California, Irvine provided evaluation services to NSN by leading the large-scale survey effort. For more information about other NSN surveys, and access to the various instruments, see a survey dissemination page maintained by the author: http://www.gse.uci.edu/Ravitz/nsn_survey.html

responsibilities was available to support teachers who took responsibility for training others (Ravitz, 1999).

A number of teachers in one school were interviewed in order to determine the extent to which perspectives differed within a school. While fairly consistent understandings of school-wide conditions appeared to be present, reports of individual use and conditions at the teacher level sometimes varied greatly, e.g., concerning individual knowledge and skills or access to computers in the classroom. This seemed to confirm the value of teacher-level interpretation of the conditions for this study. Interviews with two library/media specialists also highlighted their role in implementing instructional use of the Internet and resulted in suggestions for types of use that had not been considered, including large-group use of the World Wide Web in elementary schools.

Once the instrument was finalized, school-level contacts were mailed a "Teachers Sampling
Form" requesting the rostering of two groups of teachers—up to 10 of the "strongest Internet-using teachers" in the school, and 10 "other" teachers, listed alphabetically by last name, beginning with a randomly selected letter of the alphabet. Once these forms were returned (response rate approximately 60%), samples of 3 school-designated "strongest Internet-users" and 2 “other” teachers were selected, each with probabilities related to their reported extent of technology use.

"Internet-using teachers" were identified as teachers, library/media specialists, or other professional staff who do any of the following:

- Have students in their class use the Internet, either in their classroom or elsewhere at school;
- Supervise students of other teachers in Internet use and are at least partly responsible for the activities the students engage in while using the Internet; and/or
- Use the Internet themselves, either at school or at home, for professional purposes.

As in past studies by Becker (1994a), stronger users were purposively over-selected, with probabilities related to their reported extent of use as indicated on the Sampling Form. The assumption is that the distribution of users has a "long tail" so that only a few users are very strong at each school; a random selection would tend to miss these stronger users. Because reverse weightings were not used, and because of the select group of schools and teachers, the sample is viewed as a convenience sample of Internet using teachers in leading-edge schools.

The UCLA Survey Research Center was contracted to do the data collection, follow-up, receipt, and data entry. Multiple mailings, follow-up phone-call reminders, and a promised gift incentive for Internet-using teachers and schools returning all booklets were included in the data collection design in order to minimize non-respondents. Response rate on the sampling instrument had to be boosted (to about 60%) through extra calling to schools by the researcher and others at UCLA.

Survey booklets were mailed to the designated school-level contact person for distribution to the teachers. The booklet for the Internet-using teachers had 13 pages containing 54 questions. A separate booklet was designated for distribution to "Other" teachers and was approximately 4 pages in length. This shorter survey consisted of the first fifteen questions from the longer survey. These were used to help determine the representativeness of the study sample with respect to the amount of Internet use, as discussed below. The return rate for Internet-using teachers was also approximately 60%, indicating the strong interest of these teachers with its considerable length of 14 pages.

Data Cleaning

The study verified that the sample consisted of Internet-using teachers, not relying solely on their being listed that way on the Sampling Form by a school-level informant. While items identified as representing teacher professional use were viewed as important (they contribute to the overall use measure), teachers who did not also indicate at least some use with students were excluded from the study. These respondents would not have had an opportunity to score high on a total use measure. About five such teachers were removed from the study because, despite considerable experience using the Internet on their own, they indicated a lack of use with students.

Teachers indicated the length of time they had been using telecommunications with students ("none", "a bit", "1-2 years", "3-4 years", "5+ years") and the nature of their personal involvement in students' Internet work (e.g., whether they directly supervise use or not). Those teachers whose students used the Internet for class -- but mainly on their own, or under the supervision of another -- were considered "Internet Users" if any TWO of these additional criteria were met:

a) their teaching practices reportedly had changed as a result of Internet use

b) the Internet was used regularly in class by the teacher or his/her students

c) in at least one class ALL the students had reportedly used the Internet

Comparison of means on the few Internet use items that appeared on both instruments suggests that while the sampling procedure did not work perfectly, many of those who received the "Other" survey could have met the criteria for inclusion (about 44% of "other" teachers), but they would not have scored as high on the Internet use measures. This was considered acceptable because an important goal of sampling was to ensure enough "high-end" users would participate in the study.

Measuring Internet Use

This study explores a wide range of possible Internet uses by teachers and students (Eisenberg & Ely, 1993; Harris, 1994; Honey & Henriquez, 1996). This includes constructivist practices identified in leading-edge schools, e.g., activities highlighted in conferences and newsletters shared across the National School Network project (Hunter, 1997b), including email projects, telementoring, shared investigations, students publishing on the Web, collaborating with other school sites, and participating in live events over the Internet. While these uses may be more sophisticated (Hall, et al, 1975; Hall & Loucks, 1977) or exemplary (Becker, 1994a) than others, studies using Ely's framework have typically not differentiated between types of use. It is understood that teachers will use the Internet differently, however, partly because the Internet is a relatively recent innovation, any use by teachers was considered noteworthy. [4]

The use measures include frequency-based measures (e.g., number of hours, how often), and measures of the breadth of use (e.g., number of students, number of activities) so that those who involved more students and participated in a wider range of activities would score higher on use. This includes information from seven sets of questions in the teacher survey booklet (comprising approximately 25 different response items).

While the focus of the study was on the overall extent of use by teachers on the above measures, there was some interest at the outset in contrasting teacher professional use and the extent of use with students. Empirical analysis confirmed that two related factors could be identified. A "student use" factor was based on scores on the first three items listed below, i.e., those concerning the extent of student classroom use. The last three items listed below loaded on a different factor called “teacher use”. Interestingly, the variety of activities undertaken with students (NNETPROJ) loaded with the teacher use items. As a result, trying different activities

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[4] Efforts to obtain a framework for determining “level of use” (Hall, et al., 1975) for Internet implementation were not successful prior to development of this study.

with students is viewed as an extension of "exploratory" use on the part of the teacher, in contrast to the student use measure that concerns the amount of use by a teacher's students**.**

- MAXUSE: The maximum use a teacher made of the Internet in his/her classes, on a scale from 1 to 4, where 1 represented no use; 2, voluntary student use; 3, occasional use by all students; and 4, use by all students on at least five occasions.
- AVGUSE: The average use a teacher made of the Internet across all his/her classes using the same scale.
- REQDUSE: The frequency with which the teacher *requires* students to use the Internet.
- NNETPROJ: The number of discrete types of network learning activities the teacher has had students participate in during the year (from a list of 17 types including working with scientists, tutoring students by e-mail, doing Web searches, etc.).
- USE4PREP: How frequently the teacher accesses the Internet for class preparation work during school.
- SELFUSE: How frequently the teacher engages in six other Internet-related activities, such as posting a message to a newsgroup or creating or editing a World Wide Web page for their class or school.
- FUNCTION: How many of five functions for using the Internet (e.g., professional collegiality—sharing new ideas, discussing teaching) occupies the teacher for at least an hour per week.

The overall use measure included all the items, which exhibited strong internal consistency (standardized reliability alpha = .81). It was calculated from the sum of the two orthogonal factors which seemed to be mathematically equivalent (r=1.00) to a single factor solution. Oblique factor analysis reproduced the same two factors, but revealed the extent to which they were, in fact, related to each other (r=.53). The question about whether to focus attention on the oblique or orthogonal use measures depends on what the conditions are intended to predict: a) the extent of

each type of use or b) the teacher's own use independent of use with students, and use with students independent of teacher use. The first approach seemed to be more substantively real, even if the resulting measures were more strongly correlated and therefore had more similar predictors. The orthogonal measures are only discussed when interesting differences were found. If no striking differences were observed between student and teacher use, only overall use is reported. However, if findings concerning overall use can be attributed to only one type of use, reporting overall use and not the underlying pattern of use would tend to obscure the findings.

Operationalizing the Conditions

The conditions are understood to be "global" constructs that are made up of a variety of components. The approach has been to try to "write or select items presumed to be tapping each of the facets" (Pedhazur & Schmelkin, p. 68). The study did make extensive use of rating scales (Sproull, 1988) in which the respondent indicates their position with respect to referent items on a categorical, numerical or graphic scale. This approach is noted for its broad applicability and ease of use (Pedhazur & Schmelkin, 1991). However, unlike previous surveys using Ely's conditions (Bauder, 1993; Riley, 1995), many questions were developed from which one might *infer* the presence of conditions without requiring teachers to make judgments about their relative presence or absence directly. Questions like "my classroom has access to computers when required" were viewed as less substantively useful than knowing the number and type of computers available for Internet use and their location. The drawback to this departure from previous studies is that, while the resulting data may be more meaningful and provide richer descriptive findings, index construction was made more difficult because of lack a commonality that is generally required for creating summated scales (Sproull, 1988).

Factor analysis of conditions items.

While items were originally intended to indicate the presence of one or another of the conditions, final categorization of the items by condition was based on a combination of empirical

and logical (face validity) analysis. There was no clear guide for identifying the components for each of Ely's conditions, and one contribution of this study may be to begin to define sets of items that serve as components of each condition. The process was to determine what groups of items were empirically related via factor analysis, and then to decide if conceptually the items should or should not be viewed as representing the same condition. In a few cases, empirical patterns emerged that seemed to justify a reconceptualization of how the item was used. Most notably, one set of items was intended to reflect the strong intrinsic motivation teachers derive from observing their students doing well (Mitchell, et. al., 1987). The strength of covariance with Dissatisfaction items, however, suggested that forcing these items into separate measures would have been counterproductive. As a result, "Dissatisfaction" was reconceptualized as including perceived student benefits.[5] The measure of Rewards & Incentives was then limited to the "extrinsic" items, e.g., paid release time, an approach also taken by Bauder (1993). These items were dichotomous measures that loaded together, and a single count measure was created.

It was encouraging to see how many items loaded together as had been expected. For each of the following conditions all the anticipated items loaded together on a single factor:

- Dissatisfaction with the Status Quo
- Knowledge & Skills
- Participation

[5] Upon further reflection these indicators may be weak indicators of dissatisfaction but strong indicators of a related construct, i.e., a belief in the utility of the Internet. In the future, Dissatisfaction might be better measured by questions like "we really aren't preparing students for the future very well" or "without computers I don't know how a teacher is supposed to teach."

Factor analysis demonstrated the strong internal consistency of items for each of these three conditions. It also highlighted a degree of covariance or "overlap" between Knowledge & Skills and Participation items. Even though the items loaded separately, many also had strong loadings on the other factor. Ultimately, to avoid problems of excessive collinearity, these two sets of conditions were aggregated into a single "Expertise" measure. Item-level analysis adds richness to the findings concerning the covariation of these two conditions -- i.e., it was participation in the form of helping other teachers that most strongly correlated with Knowledge & Skills indicators, suggesting that helping others is a strong sign of expertise.

Items for the remaining conditions, those that did not emerge as separate factors -- Resources, Time, Commitment, and Leadership -- tended to group together. Initially, a decision was made to argue for a conceptual (face validity) distinction between these. For example, a strong empirical relationship between time and leadership items was viewed as a potential finding, not a reason to discard the distinction. This approach provided greater opportunity for each of these conditions to demonstrate covariance with other conditions and to be examined as predictors of use on their own. Later, to avoid problems associated with excessive collinearity, these measures were combined into a single "Supportive Environment" measure, which included a count of the number of Rewards & Incentives that were provided. These seemed to fit together conceptually, representing more environmental-level perceptions when contrasted with the Knowledge & Skills, Participation (combined as "Expertise), and Dissatisfaction ("perceived utility") conditions.

More often than not, unanticipated items within a factor had weaker loadings (below or much below .4) than the intended items, supporting treating the items separately from those that loaded more strongly. Face validity also tended to support these decisions. The one exception concerned the number of teachers with whom a teacher reported having discussed the Internet. This was initially viewed as a "commitment" indicator -- an indication of the size of the teacher's

peer group who might be involved in using the Internet. However, the item consistently loaded with participation indicators. This was critical because the literature points to the importance of "user-density" (Becker, 1994a), and the item did correlate with the proportion of teachers reportedly using the Internet. In the end, the measure was re-interpreted as a participation indicator. In order to develop a "user-density" measure, a decision was made to employ the final set of unexpected pairings based on a strong correlation (r=.57) between the estimated proportion of administrator users and the estimated proportion of teacher users, to provide an overall measure of "staff" commitment. These had originally been viewed as representing leadership and commitment respectively, but seemed to provide an overall indication of staff use. The final categorization of items into indicators for each condition is summarized in Appendix A. Full factor analysis results are available from the author (Ravitz, 1999).

Index construction.

The strategy for constructing conditions indices (an overall measure of each condition) was to compute the average z-score using each set of related items, recognizing that this step required some subjective judgments. There were some items that were viewed as important conceptually that nonetheless tended to reduce index reliability, e.g., including the amount of RAM memory on the teacher's computer with the other resource variables. In such cases there seemed to be a clear trade-off between measurement reliability and covering substantive areas that were considered important. RAM was used as a separate indicator that contributed toward the overall resources index. In this way, empirical findings helped to guide the construction of aggregate measures without being overly deterministic.

Each indicator (e.g., support resources) was calculated using the mean z-score on the items. Each condition measure (e.g., Resources) was then computed using the mean z-score on the indicators for that condition. Mean replacement for missing items was performed prior to index

construction. Case that answered less than 2/3 of the items in a given index were treated as missing cases for that index, rather than computing a score based on insufficient data.

Findings

Of the variety of networking activities listed, by far the most frequently reported uses with students were looking at World Wide Web sites and searching for information online (both reported by over 90% of teachers). The next most common activities for students, creating Web sites or participating in email exchanges, were only reported by about 30% of teachers. Most of the teachers (75%) reported that all the students in at least one of their classes had used the Internet, however, only about 20% indicated that they require student use of the Internet on a weekly basis.

Concerning their own Internet activities, most teachers (approx. 70%) reported spending at least an hour per week developing their own Internet skills or searching the Web for instructional materials. About half reported having ever posted to newsgroups/listservs or created a Web page, and only one-third reported use for professional collegiality for more than one hour per week. Fewer than 20% reported that they had ever participated in real-time events via the Internet, such as text-based chats or videoconferencing. Additional descriptive analysis of use by students and teachers within NSN schools is available elsewhere (Becker, 1997a; Hunter, 1998; Ravitz, 1999)

Concerning the distribution of use scores by school level, Bauder (1993) found that elementary school teachers are more frequent users of computers and report more favorable conditions. There are a number of possible reasons for this, including greater flexibility in self-contained classes and given extended periods of time with the same students there is greater opportunity to provide more students with opportunities to use computers, even if there are only a few available in the classroom.

Across the current sample, high school teachers tended to report the greatest amount of student Internet use, but scored the lowest on teacher use. This is probably due to differences in how computers are used (as in the Bauder study) contrasted with how the Internet is being used in schools. Perhaps elementary teachers feel a greater burden to assure the age-appropriateness of materials prior to sharing them with students, while there is pressure on teachers of high school students to develop their technical proficiencies for entry into college or the workplace. This would encourage teachers to find ways to support student use, without necessarily providing opportunities for teacher use on their own. Because the differences in extremes were quite large, middle school teachers actually scored highest on overall use.

When the conditions scores were disaggregated by grade level, middle school teachers tended to report higher scores on the supportive environment measures, notably time, leadership, resources, and commitment, particularly when compared to high school teachers. Middle school teachers also scored higher on knowledge & skills. Elementary school teachers (who reported the greatest amount of professional use) scored lowest on dissatisfaction, suggesting that this condition is more closely related to use with students. In short, middle school teachers in NSN appear to be a particularly strong group with respect to the conditions being present, while high school teachers report the conditions as being less present overall. The only condition that high school teachers scored higher than the mean on was dissatisfaction. Given that they scored higher on student use than teachers at the other levels, and that this is the only condition on which they scored higher than the mean, this condition seems to be more closely related to use with students.

Despite their school's having had Internet connectivity for some time, indicators of some of the conditions seemed to be lacking. A review of the marginal distributions by Ravitz (1997, 1998, 1999) suggests that indicators that were most present included items related to dissatisfaction (or perceived utility), technical and training "support" resources, organizational commitment, and leadership. Those that seem to be most lacking involved time for planning and curriculum use,

and curriculum-related resources. The presence of the condition, of course, cannot be taken as a sign of its importance. For example, a severe lack of time reported by teachers suggests that this may, in fact, be one of the most important conditions.

Covariance of the Eight Conditions

In the end, despite attempts to define the conditions both conceptually and empirically, each of the conditions scores were correlated to a considerable extent. As might be expected, after viewing the factor analysis, there was a large amount of covariance between the Knowledge & Skills and Participation scores (r=.49). Dissatisfaction with the Status Quo (after including "observed student benefits") had the greatest independence from the other conditions. The extent of collinearity between most of the remaining conditions -- time, commitment, leadership, and resources -- was apparent; each of these had at least one very high intercorrelation (r >.5). Rewards & Incentives also seemed to covary with this group, despite being correlated with Participation as well.

Overall there seemed to be three sets of closely related conditions. The first two groups are interpreted as involving conditions that might be viewed as being somewhat internal to the thinking and activities of the teacher -- Dissatisfaction being the first, and "Expertise", a combination of Knowledge & Skills with Participation, being the second. The third grouping involves the remaining conditions that might be viewed as being more external to the teacher's own thinking and activities, i.e., supportive environment measures. Factor analysis using these eight measures as inputs confirmed the utility of these three separate measures (Table 1). Dissatisfaction emerged as separate factor when three factors were produced, while a second factor reflected the stronger collinearity between Knowledge & Skills and Participation. While there were only two factors produced with eigenvalues > 1.0, a factor scree plot suggested the presence of a potentially useful third factor, separating Dissatisfaction items from Knowledge & Skills and Participation items. These combined groupings of conditions seemed to be most defensible empirically, and seemed to be most useful conceptually.

Table 1

Varimax Rotated Factor Matrix (3-factors, Principal Components) Identifying Sets of Related Conditions (N=238)

Variable	Factor 1 "Supportive Environment"	Factor 2 "Expertise"	Factor 3 "Dissatisfaction"
Commitment	**.82**	.08	.21
Leadership	**.81**	-.09	.01
Time	**.68**	.30	-.04
Resources	**.67**	.39	-.02
Rewards & Incentives	**.59**	.14	.09
Knowledge & Skills	-.01	**.86**	.20
Participation	.34	**.78**	.01
Dissatisfaction	.11	.15	**.97**

Final Statistics:

Variable	Communality	Factor	Eigenvalue	Pct of Var	Cum Pct
Rewards & Incentives	.38	1	3.23	40.30	40.30
Time	.55	2	1.27	15.80	56.20
Participation	.72	3	.88	11.00	67.20
Commitment	.72				
Dissatisfaction	.97				
Knowledge & Skills	.78				
Leadership	.66				
Resources	.60				

Note. Varimax converged in 5 iterations, Kaiser Normalization. Pairwise skipping. Mean replacement.

Eight conditions related to Internet Use

Multiple regression is used to indicate the strength of each of the eight conditions as a unique predictor of Internet use. All of the conditions were correlated with use, but in order to determine the unique contribution of each one, it is necessary to remove the effect of the other conditions.

Overall, the conditions were much more predictive of teacher professional or exploratory use (R^2=.60) than of student use (R^2 = .25). Dissatisfaction and Knowledge & Skills were the strongest predictors of overall use. (Table 2). Dissatisfaction was the only condition that was a strong unique predictor of both teacher and student use, suggesting that in either case it is necessary for teachers to perceive the utility of using the technology for themselves and their students (Table 3). While Knowledge & Skills and Participation were significant predictors of overall use they were not significant predictors of student use.

Table 2

Summary of Regression Analysis for Eight Conditions Predicting Use (N = 238)

Conditions Variable	Zero Order	B	SE B	Beta
Dissatisfaction	.51	.78	.11	.37***
Knowledge & Skills	.54	.53	.09	.34***
Resources	.30	.02	.12	.01
Time	.32	.07	.03	.13*
Rewards/Incentives	.22	.20	.21	.05
Participation	.45	.26	.11	.14*
Commitment	.27	.00	.13	.00
Leadership	.13	-.04	.12	-.02

Note. $R^2 = .49$

*p < .10 **p < .01 ***p < .001

This suggests that "personal" readiness on the part of the teacher does not always translate into greater use with students. Similarly, Time was predictive of overall use, but particularly of use with students and not so much of teacher use. It seems that the time requirements for teachers to use the Internet with students is more significant than for use on their own. Time was the condition that was most severely lacking according to teachers, and was one of two "supportive environment" conditions that were significant predictors of student use.

The other "environment" measures that were predictive of student use involved Resources, both the availability of curriculum support and access to the Internet for large numbers of students. Other types of resources were somewhat predictive of student use, but only after removing the effect of teacher use (using orthogonal use measures).[6] In other words, of those teachers who use the Internet on their own to a similar extent, the ones who use it more with students are the ones who have the most access to computing and curriculum support resources.

Commitment was predictive of teacher use only, while Leadership and Rewards & Incentives measures were not unique predictors of use, although they were correlated. These conditions may be indirectly related to use, e.g., through their relationship to other conditions, such as Knowledge & Skills or Resources.

Individual survey items that seemed to be particularly strong correlates with *overall use* included the number of other teachers in the school with whom a teacher has discussed the Internet, the number of students reported as having "greatly benefited", and a teacher's self-reported knowledge and skills. Time was observed to be one of the strongest correlates of use with students, as was "classroom" related knowledge and skills. The latter measure combined

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[6] A table of correlations for all indicators and use measures is available (Ravitz, 1999).

"classroom skills" items with two from the “Internet skills” list --- searching the Internet and downloading materials. These represented among the most frequent kinds of instructional use with students and loaded together in exploratory factor analyses. Two other factors involving Web

Table 3

Summary of Regression Analysis for Eight Conditions Predicting Student and Teacher Use (N = 238)

	Student Use, Oblique				Teacher Use, Oblique			
Conditions Variable	Zero Order	B	SE B	Beta	Zero Order	B	SE B	Beta
Dissatisfaction	.41	.48	.09	.35***	.44	.33	.06	.24***
Knowledge & Skills	.27	.10	.07	.10	.70	.52	.05	.53***
Resources	.27	.10	.09	.08	.26	-.08	.07	-.07
Time	.29	.05	.02	.16*	.26	.02	.02	.05
Rewards/Incentives	.17	.05	.17	.02	.21	.11	.12	.05
Participation	.28	.09	.09	.08	.52	.22	.06	.19***
Commitment	.21	-.07	.10	-.06	.28	.12	.07	.10*
Leadership	.16	.05	.10	.04	.10	-.07	.07	-.06
	Student Use, Orthogonal				Teacher Use, Orthogonal			
Dissatisfaction	.37	.55	.10	.36***	.36	.23	.07	.16***
Knowledge & Skills	.08	-.08	.08	-.07	.69	.61	.06	.56***
Resources	.21	.17	.10	.13*	.21	-.15	.08	-.11*
Time	.25	.07	.03	.19**	.20	.00	.02	.00
Rewards/Incentives	.13	.04	.18	.01	.19	.16	.14	.06
Participation	.14	.02	.10	.01	.50	.24	.07	.19***
Commitment	.13	-.20	.11	-.15*	.25	.19	.08	.14*
Leadership	.13	.08	.11	.06	.06	-.12	.08	-.08

Note. R^2 for Student Use, Oblique= .25; R^2 for Teacher Use, Oblique = .60

Note. R^2 for Student Use, Orthogonal = .19; R^2 for Teacher Use, Orthogonal = .56

*p < .10 **p < .01 ***p < .001

authoring and IRC/MOO, and "other" skills (email, ftp) -- were viewed as more "technical" in nature and were associated only with the teacher use measure.

Looking at individual items within the conditions, some appeared to be more closely related to one or another type of use. Those that appeared to be more closely associated with student use than teacher use included pedagogical reasons for Internet use, observed student benefits, connectivity resources, and time in the curriculum. Items that seemed to be more closely associated with teacher use than student use included knowledge & skills items as a whole, participation items, and an "organizational" commitment item concerning the presence of a long range plan being in place

In general, analysis of orthogonal relationships produced little difference in the findings. In a few cases, correlations with student use seemed to be lower when teacher use was held constant. This suggests that the relationship with student use was, to some extent, a function of teacher use on their own. When their own use was controlled, the relationship between knowledge and skills with student use, for example, decreased. Greater use on their own probably plays a strong role in supporting teachers' development of strategies for student use. In contrast, the number of connections outside the classroom was more strongly correlated with student use when teacher use was held constant, suggesting, not surprisingly, that outside classroom Internet connections supports student use, independent of teacher use.

Sets of "closely associated conditions" predictive of use

While it seemed useful to keep the conditions separate for the initial analysis, the covariance of the conditions eventually required their being combined into groups of "closely associated conditions", as had been anticipated in the design of the study. Multiple regression analysis substituted the sets of closely associated conditions that were identified previously. To

produce these new variables, each of the condition scores was standardized and a mean was computed:

DISSATISFACTION (including "intrinsic" rewards & incentives, perceived utility)

EXPERTISE (Knowledge & Skills / Participation)

ENVIRONMENT (Resources / Time / Leadership / Commitment / Rewards & Incentives)

While these new measures remain significantly correlated the amount of collinearity was reduced. The eight conditions included correlations of up to .5 or .6, with over half of the pairs of conditions showing correlations of $r > .45$. After combining the most closely associated conditions, the new level of correlation among predictors was viewed as more acceptable ($.21 < r < .39$).

Not surprisingly, Dissatisfaction and Expertise were most predictive of overall use, with the former being more predictive of student use and the latter of teacher use. The Supportive Environment measure was predictive only of student use (Table 3).

The analysis of the three sets of "closely associated conditions" does not produce particularly surprising findings, given the observed relationships for all eight conditions. However, it highlights the extent to which supportive environment measures were related to student use, and not particularly useful in predicting the extent of a teacher's use on her own. This suggests that more systemic issues may be required to allow teachers to use the Internet with students than are required for teachers' use on their own.

Multiplicative Effects on Internet Use

Exploratory analysis focused on potential multiplicative effects between the conditions. This was intended to address potentially more complex relationships between the conditions and use, for example if the predictiveness of one condition were dependent on the presence of another. Hypothesized multiplicative effects were added to the prediction equation to see if the multiplicative term contributed either to the overall predictiveness of the equation, or accounted for unique variance as contrasted with the main terms. In order to reduce the likelihood of capitalizing on chance, only those combinations that seemed most plausible were selected for

testing. Moderate beta scores (between .07 and .18) were observed for several of the proposed terms.

Table 3

Sets of Related Conditions as Predictors of Internet Use (N=238)

	Overall Use			
Groups of Conditions	Zero Order	B	SE B	Beta
Dissatisfaction	.51	.80	.10	.38***
Expertise	.57	.73	.09	.44***
Supportive Environment	.34	.17	.10	.09*

	Student Use, Oblique				Teacher Use, Oblique			
Groups of Conditions	Zero Order	B	SE B	Beta	Zero Order	B	SE B	Beta
Dissatisfaction	.41	.47	.08	.34***	.44	.37	.06	.27***
Expertise	.32	.18	.07	.17***	.71	.66	.05	.64***
Supportive Environment	.30	.21	.08	.16***	.30	-.01	.06	.00

	Student Use, Orthogonal				Teacher Use, Orthogonal			
Groups of Conditions	Zero Order	B	SE B	Beta	Zero Order	B	SE B	Beta
Dissatisfaction	.37	.51	.09	.34***	.36	.30	.07	.20***

Expertise	.12	-.03	.08	-.03	.69	.76	.06	.66***
Supportive Environment	.23	.23	.09	.17**	.25	-.07	.07	-.05

Note. R^2 for Student Use, Oblique= .24; R^2 for Teacher Use, Oblique = .57

Note. R^2 for Student Use, Orthogonal = .16; R^2 for Teacher Use, Orthogonal = .51

*p < .10 **p < .01 ***p < .001

The first set of exploratory analyses examined plausible interactions involving the Supportive Environment measure. This measure demonstrated a relatively weak relationship with the use measures, however it was thought that it might interact in important ways with "teacher readiness" measures -- i.e., Expertise or Dissatisfaction. It was felt that the presence of a supportive environment might magnify the effect of a teacher's own readiness, or frustrate even the most willing and capable teacher. An important interaction effects was observed concerning the prediction of "student use". While Expertise itself was not predictive of student use, when it was used as a multiplicative term with Supportive Environment the result was a significant unique predictor (beta = .10).

Looking more closely at the components of these broad measures, the strongest interaction effect that was observed concerning Knowledge & Skills x Time. The former was not a significant predictor of student use by itself (beta = .09), but the interaction term was (beta = .18). It appears that teachers with higher knowledge and skills may require available time before they are able to implement substantial amounts of student use. Table 4 shows the result of dividing the sample into four groups based on their z-scores on Time and Knowledge & Skills.

The interaction effect for teacher use was not particularly strong. Those with high Knowledge & Skills scores scored high on teacher use even if they did not score high on Time. However, for student use, only those teachers with high scores on both conditions scored any higher than the average.

Another plausible interaction effect involved a relationship between Expertise (or Knowledge & Skills) and Dissatisfaction. Given that both were important predictors on their own, it was thought that the presence of both might lead to a "super-ready" teacher. This was not confirmed, as there was no observed interaction effect for student or teacher use (Table 5). It was also imagined that because Dissatisfaction, like Expertise, was perhaps a more "personal" condition, this variable might interact in the same way with the Supportive Environment measure. Only a very slight effect was observed between Time and Dissatisfaction for teacher use and overall use, but not student use as had been the case with Knowledge & Skills.

Table 4

Interaction of Knowledge & Skills x Time on Student Use

Scores on K&S and Time	n	Student Use	Teacher Use
Both Low	62		
M		-.30	-.61
SD		.90	.72
Low K&S / High Time	56		
M		-.23	-.45
SD		.88	.79
Low Time / High K&S	49		
M		**.02**	**.47**
SD		.96	.74
Both High	71		
M		**.43**	**.57**
SD		.84	.65

Note. Only z-scores greater than zero were categorized as "high"; the remaining cases were categorized as "low" on each condition.

A summary of results appears in Table 5. In short, it appears that while Supportive Environment was a relatively weak predictor on its own, it does interact with the other measures in a way that indicates its potential importance. The most significant interactions seem to involve the “student use” measures, not the “teacher use” measures.

Table 5

Summary of exploratory analysis using multiplicative terms

Hypothesized Multiplicative Terms	Result
Environment * Expertise	Significant interaction with Student Use, orthogonal Beta = .10; p <. 10
Environment * Knowledge & Skills	Significant interaction with Student Use Beta = .12; p < .05, orthogonal Beta = .10; p < .10, oblique
Time * Knowledge & Skills	Significant interaction with Student Use & Overall (beta=.11) Beta = .15; p < .01, oblique student use Beta = .11; p < .02, overall use
Dissatisfaction * Expertise (or * K&S)	No interaction effect
Dissatisfaction * Environment	Slight interaction effect with Overall Use Beta = .08; p < .11
Dissatisfaction * Time	Slight interaction with Overall Use Beta = .07; p < .17

Note. The hypothesized terms are indented to show sub-components of the broader measure, i.e., Knowledge & Skills is a sub-component of Expertise, and Time is a sub-component of Supportive Environment.

Discussion

Perhaps the most important implication of these findings is that professional development initiatives that focus exclusively on teachers' knowledge and skills may help bring about greater teacher use of the Internet, but often without accompanying use by students, at least not substantial

use by students. The strongest predictors of teacher professional or exploratory use seemed to be the more personal ones -- Knowledge & Skills and "Dissatisfaction" (i.e., belief in the utility of the Internet). It seems that a motivated and skilled staff will find ways to use the Internet on their own, perhaps including "exploration" of use in their classes. However, the extent of use with students -- requiring use or involving a large proportion of students -- may require more systemic or environmental supports, including time, curriculum support and resources. Supportive Environment was a unique predictor of student use (beta = .16), but not teacher use (beta = .00).

Exploratory analysis suggests that the extent of Internet use with students, even among teachers who possess greater knowledge and skills, may be a function of time availability, as well as the availability of curriculum support and access to the Internet for large numbers of students. Formative use of the instrument also pointed to the importance of curriculum resources. A math department head, for example, revealed that he was very adept at Internet use on his own, and wanted to use the Internet with students, but had not yet been able to find appropriate curriculum materials. Of course, curriculum integration can be viewed as an issue the cuts across many of the conditions -- time, knowledge and skills and resources.

Reflecting on why the “supportive environment” measures were not more predictive of teacher use, one imagines that perhaps these variables do not have powerful direct effects, i.e., providing resources may increase knowledge and skills and belief in the utility of the Internet, and then through those conditions affect teacher use on his or her own. In addition, it seems clear that lack of some resources, e.g., curriculum integration resources, access to numerous computers, would not prevent teacher use on his or her own, but would hinder efforts to use the Internet with students.

It is worth noting that one of the only other multivariate studies of Ely’s conditions (Bauder, 1993) supports the hypothesized interaction between Knowledge & Skills and Resources, stating that without access to resources, it may be difficult to develop the necessary knowledge and

skills for effective use of technology. An alternative explanation offered here might be that limited resources reduce the impact of knowledge and skills, even when they are present. Bauder (1993) also tends to support the findings concerning how the conditions covary, finding a close association between Knowledge & Skills and Participation (Expertise), and between Rewards & Incentives, Time, and Leadership. Coupled with findings from this study, this raises concerns about the distinction between these conditions and their conceptualization in future studies.

Clearly, the failure of some of the conditions to be unique predictors may be due to weak operationalization. The effort to create empirically (and logically) distinct measures for each of the "environmental" conditions has been problematic. "Interrelationships among the conditions make measurement of individual conditions and their effects more difficult" (Bauder, p. 84). Of the Commitment and Leadership indicators only two items, one from each condition, were significant unique predictors (excluding the other conditions from the multiple regression equation) -- the estimated proportion of teacher users within the school, and the reported presence of sufficient administrative support.

Efforts to explain the remaining variance, might include attention to other issues within the "supportive environment" conditions. For example, teacher home access to the Internet would seem to be an important resource variable that preliminary analysis suggests is related to both teacher and student use. Another analysis that would be worth undertaking would control for intervening variables, such as grade-level and number of years teaching, as there are differences in Internet use among NSN teachers according to subjects taught and class ability levels (Becker & Ravitz, 1998). Greater attention to teacher background including teaching philosophy, experience with technology, and training received might also be worth considering. Building any of these into the analysis might help improve our understandings. In addition, taking into account these various circumstances also might help argue for the generalizability of the findings, confirming that the study results are indeed applicable across different contexts, an important assumption of this study.

Finally, future studies must do a better job at addressing the possibility that some of the conditions could be outcomes of use. This study has assumed that if anything there may be more of a cyclical effect, e.g., expected benefits may lead to use, followed by observed benefits, and subsequently even greater amounts of use. Similarly, basic knowledge and skills may lead to use that engenders more sophisticated knowledge and skills. Still, in the future it would be helpful to measure the presence of the conditions prior to teachers being introduced to Internet use, so that the effect of providing more favorable conditions at the start of a project could be examined. Efforts to test the predictive validity of the conditions are underway, employing selected measure from this study prior to Internet implementation and only later measuring progress towards Internet-related goals. The result of this effort could be a unique and validated instrument that might be broadly useful in planning and assessing Internet implementation.[7]

Finally, while the literature on school Internet use describes many exciting projects (e.g., Hunter, 1997b), findings from this study suggest that somewhat more limited use generally prevails, even among top computer-using teachers in leading-edge schools! Analysis of whether the conditions can predict not only the amount but also the quality of use by teachers, and especially the quality of their use with students, have not been considered.

Conclusion

In conclusion, this study has demonstrated the utility of one of the few generalizable frameworks available in the literature for examining issues related to implementation of new technologies in schools. The results of this study generally support what have found. Implementation requires a complex set of conditions -- knowledgeable and motivated teachers who are given sufficient time and resources, opportunities to interact with peers, and opportunities to be involved in decisions. The conditions may change as more and more teachers adopt Internet

[7] The author has received a grant to develop an instrument to assess readiness for technology-related reforms in collaboration with other researchers . See URL: http://www.gse.uci.edu/Ravitz/cilt_project/overview.html

use into their practice. It seems reasonable to expect that later adopters (Rogers, 1983) may be less innovative, and therefore less dissatisfied with the status quo (non-use). These teachers may require more external supports, even to establish use on their own. On the other hand, later-adopting teachers and schools that may benefit from better technologies, improved access to resources, and more effective ways of acquiring knowledge and skills established by pioneering teachers and schools.

Given the rapidly changing technological landscape, we are reminded that new innovations will always be forthcoming, and these days they will have arrived before we know it. Moreover, there will always be some schools that gain access to new technologies sooner, and some teachers within these schools will be pioneers in incorporating these into their teaching. The findings from this study may not generalize to all teachers and schools as the Internet becomes more widely available. However, the questions and concepts will continue to be useful for examining factors related to later adopters, and for understanding the implementation of the next generation of educational technology innovations as well.

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Author Notes

Jason Ravitz is a Research Specialist at University of California, Irvine in the Center for Research on Information Technology in Organizations. He has worked on two national surveys of teachers and schools and their instructional use of computers and the Internet. He is maintaining online archives of National School Network findings. His current work is on the Teaching, Learning & Computing: 1998 survey, jointly funded by NSF and OERI. This study examines constructivist practices of U.S. teachers and the relationship of these practices to computer and Internet use, and includes representative data from 2000 teachers in grades 4-12, and a purposive sample of 2000 teachers in high-technology and reform-oriented programs. He received his doctorate from Syracuse University in Instructional Design, Development and Evaluation (1999), and worked at BBN Educational Technologies in Cambridge, MA from 1994-1998.

For additional information or discussion, please contact:

Jason Ravitz <jravitz@uci.edu>

University of California, Irvine

2001 Berkeley Place Building

Irvine, CA 92697-5500

(949) 842-5850: voice

http://www.gse.uci.edu/Ravitz/home.html

APPENDIX

List of Indicators by Condition

Indicator	Condition
	Dissatisfaction with the Status Quo / Perceived Utility
ALL_BENE	The belief that all students would benefit from knowing how to use the Internet.
STU_BENE	The belief that students enjoy learning and accomplish more when using Internet.
REASONS	The number of reasons a teacher indicates as being important justifications for his or her Internet use. Total sum of scores on 13 items using a 1-4 scale where 1 represents "Not a Reason" and 4 represents a "Very Important Reason".
OBS_BENE	Percent of students who the teacher has observed having used the Internet and who have greatly benefited.
OBS_BEN2	Number of student benefits a teacher has observed as selected from a list of ten items, e.g., communicating better, taking greater responsibility for or greater interest in learning.
	Knowledge & Skills
OWNSKILL	The teacher's self-rated skills related to Internet use (on 13 specific skills).
OWNPREP	The teacher's judgment about their own current possession of five broad Internet-related competencies, including, for example, "awareness of what the Internet can do."

	Resources
SUPPORT	Degree to which support resources are available on a 1-6 scale ranging from "strongly disagree" to "strongly agree", including technical support, training opportunities, curriculum resources and help with curriculum integration.
CONNECT	Maximum number of simultaneous Internet connections reported in teachers' classroom or in school location where students most often use the Internet combined with the extent to which there is "reliable and sufficient access" to the Internet.
RAM	Quality of computer teacher uses most frequently in school as indicated by the highest amount of RAM reported for that computer.
	Time
SCHEDULE	Degree to which time is provided in the schedule to explore and plan Internet use as indicated on 1-6 scale.
TIMECURR	Degree to which time is available in the curriculum to carry out Internet activities as indicated on 1-6 scale.
	Rewards and Incentives
RI_EXTRN	The availability of a variety of eight different potential "extrinsic" rewards and incentives for using the Internet as reported on a 1-3 scale where 1 represents "Not Available", 2 represents "Somewhat available" and 3 represents "Generally available.".

	Participation
PARTIC	The extent to which a teacher reports being involved in decision-making activities related to Internet use, including voicing concerns to decision makers directly or through a trusted colleague, having their opinions sought, and being provided with updates and asked for feedback. Mean score on 4 items scored on a 0-3 scale ranging from “never” to “always”.
INVOLVED	Teacher participates in a variety activities related to planning and implementation of Internet use. Sum score on 8 items with 0-3 scale.
DISCUSS	The number of other teachers with whom the teacher has personally discussed Internet issues on "several occasions" in the last month.
	Commitment
ORG_COMM	The extent to which Internet use is included in the long-term plans, budget or priorities at the school, i.e., whether Internet use over time is perceived as a priority in existing plans or implementation is seen as a "sure thing" over time by the teacher.
STAKEHLDR	The extent to which a variety of groups have been supportive of Internet use including parents, community members, district-level efforts, and so on.
STAFF	Estimate of the proportion of teachers and administrators who use the Internet at the school.

	Leadership
STANCE	Overall stance taken by key administrators, e.g., principal, toward Internet use based on a selection from five items ranging from "active opposition" to "taking initiative."
ADEQUATE	Extent that administrative support and initiative is perceived as being "sufficiently present" or "adequate" on a 1-6 scale ranging from "strongly disagree" to "strongly agree."
LEAD_X	The number of school or district-level individuals reported as having made extraordinary efforts to support Internet use.