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ABSTRACT

This study examined the presence of Ely's conditions that facilitate innovation, as reported by Internet-using teachers in leading-edge schools. The conditions that make up the framework are: (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. Data were collected from a national survey of teachers (n=238) in approximately half of the 250 schools registered in the National School Network. Preliminary findings are discussed for each of the eight conditions. Tables and graphs present data related to Internet use, including: perception that students would benefit; reasons for use; Internet skills; classroom skills; presence of resource-related conditions; access-related resources; number of simultaneous connections; time available for teacher planning; extrinsic rewards/incentives; extent to which teacher input is sought by decision makers; teacher involvement in other related activities; commitment to planning; level of support; percent of teachers/administrators who use the Internet; leadership; and extraordinary efforts. (Contains 42 references.) (DLS)

Conditions that Facilitate Teachers' Internet Use in Schools with High Internet Connectivity: Preliminary Findings

By:

Jason Ravitz

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Jason Ravitz
GTE Internetworking, Powered by BBN

Abstract

Examines the presence of Ely's (1976, 1990) conditions that facilitate innovation, as reported by Internet-using teachers in leading-edge schools. Descriptive data from a national survey of teachers (N=238) in approximately half of the 250 schools in the National School Network (NSN) are reported, along with analysis of the correlation of the condition measures with teacher and student Internet use. Connections are drawn to other NSN-related studies and plans for further analysis of the covariance of the conditions and interaction effects are described.

Background

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 learners because of its ability to provide resources, data sharing, and communication to all who are connected (Hunter, 1993, 1995a, 1997a). 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 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.[3] 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. As more schools obtain Internet connectivity the issues addressed in this study may become increasingly important.

By examining teachers who are striving to use 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. Finally, 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 for those who are among the strongest Internet users.

Framework of Analysis

Research demonstrates that many issues influence the implementation of educational technology innovations. "The more factors supporting implementation, the more change in practice will be accomplished" (Fullan, 1991, p. 67). This study utilizes a reasonably holistic framework developed by Ely (1976, 1990), one of the few frameworks available in the literature (Holloway, 1996). Ely's claim is that lack of any of these eight conditions can hinder use of an innovation:

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[3] 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).

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, 1990)

This framework appears to be broadly generalizable, readily applied in diverse educational settings, from school districts (Read, 1994), to libraries (Ely, 1976) to universities (Bauder, 1993), in the United States and abroad (Ely, 1990). A series of dissertation studies also support its usefulness for a variety of educational innovations (Bauder, 1993; Jeffrey, 1993; Read, 1994; Riley, 1995; Stein, 1996). Perhaps more importantly, the utility of this framework is 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 and Henriquez, 1993; Sheingold and Hadley, 1990), and so on.[4]

Methods

This study reports data from a national survey of teachers in approximately 250 schools registered in the National School Network (NSN), a project funded by the National Science Foundation since 1994. The schools were required to have had at least 10 simultaneous LAN-based Internet connections for a year prior to joining the project and to be nominated by an intermediary organization involved in Internet-based school reform (Hunter, 1995b). "Internet-using teachers" include teachers, 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.

School-level contacts were mailed a "Teachers Sampling Form" requesting the names of up to 10 of the "strongest Internet-using teachers" in the school.[5] Once these forms were returned (response rate approx. 60%), three teachers in each school were sampled. As in past studies by Becker (1994a), stronger users were over-selected, with probabilities related to their reported extent of use as indicated on the Sampling Form. The assumption here 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.[6] The booklet for the Internet-using teachers had 13 pages containing 54 questions, and approximately 60% were returned -- after data cleaning this resulted in a total sample size of 238 teachers from 124 different schools for this analysis.

[4] Other topics from the literature, such as psychological variables (Marcinkiewicz, 1993; Marcinkiewicz and Regstad, 1996), and leadership *styles* (Hall and Hord, 1987) are not included in the current analysis.

[5] Henry "Hank" Becker at University of California, Irvine, co-authored and supervised the study. Network coordinators, technical coordinators, administrators and teachers not listed among the top ten Internet users were also surveyed. Copies of instruments, descriptive data, and reports are being made available online: http://nsn.bbn.com/
nsn_learnings/survey.html.

[6] Along these lines, data cleaning removed approximately 30 teachers who failed to indicate use with students on a series of screening questions. A sample of "other" teachers suggests that approximately one-third of teachers not identified as among the top Intertnet users in their school would have met the minimum requirements for inclusion in this study had they completed the Internet-Using teachers survey.

Internet Use

This study explores a wide range of Internet uses by teachers and students (Eisenberg and Ely, 1993; Harris, 1994; Honey and 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) such as project-based learning activities (email projects, telementoring, shared investigations, students publishing on the Web, collaborating with other school sites, and participating in live events over the Internet).

While some uses of an innovation may be more sophisticated (Hall and Loucks, 1977) or exemplary (Becker, 1994a) than others, implementation studies using Ely's framework have typically not differentiated between types or quality of use. It is understood that teachers will use the Internet differently. This study employs 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 involve more students and and who participate in a wider range of activities score higher on use.[7]

To identify the extent of Internet use by teachers, this study combines information from seven sets of questions in the teacher survey booklet (comprising approximately 25 different response items):

- 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.
- 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 while doing class preparation work during the school day.
- 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.

While this study is generally more concerned with an overall use measure, factor analysis seems to confirm that two related factors can be identified. A "student use" factor is based on scores on the first three items listed above. These concern the extent of student classroom use. The last three items listed above load on a different factor called "teacher use". Interestingly, the variety of activities undertaken with students (NNETPROJ) loads with the "teacher use" items, suggesting that the variety of activities undertaken with students is more closely related to a teacher's own exploration or use. As a result, the "teacher use" factor may be interpreted more as reflecting exploratory use by the teacher.[8]

Approximately 75% of the teachers reported that all the students in at least one of their classes had used the Internet, with approximately 20% indicating that they require student use of the Internet on a weekly basis. 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.

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[7] Efforts to obtain a framework for determining "level of use" (Hall and Loucks, 1977) for Internet implementation were not successful prior to development of this study. Partly because the Internet is a relatively new innovation, any use by teachers is considered noteworthy. Becker (1997) begins to examine the impact of Internet use on specific teaching practices, such as having students work on longer projects.

[8] The overall use measure includes all the items (standardized reliability alpha = .81). It is calculated from the sum of the two orthogonal factors ("student" and "teacher" use) which is equivalent (r=1.00) to a single factor solution. Oblique factor analysis reveals the extent to which these factors are, in fact, related to each other (r=.53). Unless indicated otherwise, relationships to "overall" use and oblique factor scores are reported, i.e., not controlling for the other factor. If only overall use is reported, no striking differences were observed between student and teacher use.

Concerning their own use, most teachers (approx. 70%) reported spending at least an hour per week developing their Internet skills or searching the Web for instructional materials. Only one-third reported spending more than one hour per week using the Internet for professional collegiality. About half reported having *ever* posted to newsgroups/listservs or having ever created a Web page. 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 provided by Becker (1997) and Hunter (1998).

Operationalizing 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 and Schmelkin, p. 68). Given the scope of the project, no exhaustive measurement of each condition is possible; instead a few indicators are intended to suggest the extent to which each condition might be present. In a few cases exploratory factor analysis seems to confirm that different elements of a condition are being measured.

Organization of the variables by condition is based on an interpretation of Ely's framework. For example, items related to peer use (Becker, 1994a) are interpreted as belonging to the commitment condition, an indication of support for Internet use by others, while administrator use is viewed as an indicator of leadership.[9] While formative use of the instrument generally focused on whether key issues for teachers were being addressed by the conditions items, perhaps more attention might have been paid to the subjects' view of the framework itself.[10]

Findings

Findings describe the extent to which the conditions seem to be present, and the strength of relationship between the conditions and Internet use measures. Correlations are discussed in terms of the ability to predict the extent of use from knowledge of the conditions measures; this suggests that a relationship exists, but not necessarily a causal one (the findings could just have easily been discussed in terms of predicting the presence of conditions from scores on use). These are preliminary findings because no effort has yet been made to control for the presence of other conditions, to explore the covariance (multi-colinearity) of the conditions, or to examine interactions that might be more predictive of use. Addtional analysis might also seek to control for intervening variables, such as grades and subjects taught, class ability level, or school-wide demographics.[11]

Condition #1: Dissatisfaction with the status quo

Dissatisfaction indicators include the perception that all students would benefit from Internet use, both in general and in terms of learning outcomes. In addition, dissatisfaction with the status quo (in this case, non-Internet use) is indicated by the extent to which the teacher affirms a number of reasons for Internet use, choosing from a list of 13 options (Table 1).

Respondents overwhelmingly agreed that all students would benefit from knowing how to use the Internet, with 80% indicating that they strongly agree. Concerning whether students would enjoy learning more leading to greater effort and accomplishment, the response was more mixed, although still generally positive (Figure 1). Responses on the two items were correlated (r=.28), and the mean response was significantly correlated with overall use (r=.37).[12]

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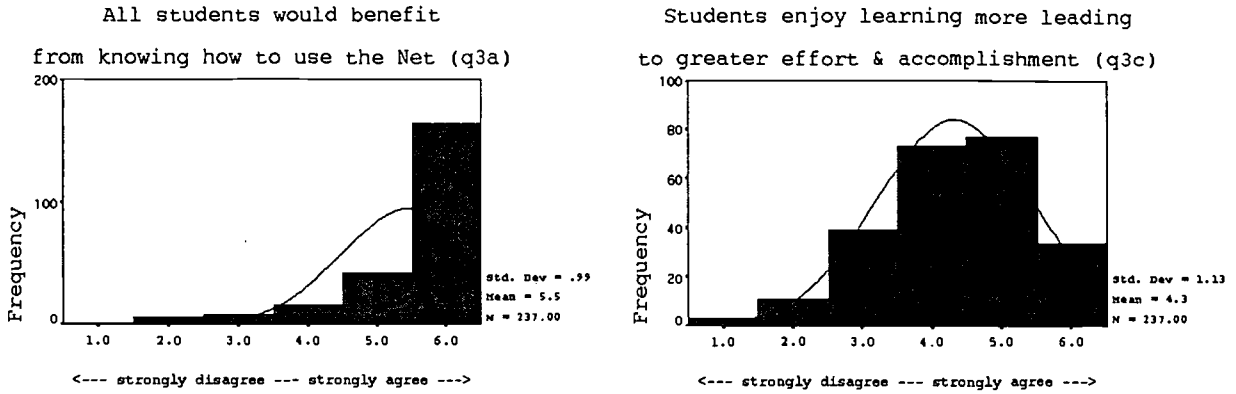
[9] The next stage of analysis may examine the empirical validity of distinctions such as these.

[10] Formative use included completion of the survey by a dozen (12) teachers in seven (7) Syracuse-area schools accompanied by open-ended interviews, site visits, and an unpublished district-level case study.

[11] Becker and Ravitz (1997) found that higher ability classes may be favored with Internet use, particularly in schools with larger traditionally disadvantaged populations, and that subject and grade-level differences may exist as well.

[12] Unless indicated otherwise, all correlations reported in this paper are $p < .001$, two-tailed.

Figure 1. Perception that students would benefit from Internet use



The difference reflected in the above responses may reflect alternative rationales for use (Hawkridge, et al., 1990) such that benefits other than pedagogical ones are perceived. This interpretation is supported by analysis of the reasons given for use. The most prevalent reason among the teachers seemed to concern the pervasiveness of technology in society, a rationale that may not necessarily require learning outcomes.[13]

The distribution of mean responses for the reasons items (reliability alpha =.83) approximated a normal curve and had about the same correlation with overall use (r=.35) as the mean "benefits" score. In the end, an average z-score on both sets of items (reliability alpha = .84) was an even stronger predictor (r=.44) of overall use.

Table 1. Reasons for Internet use ordered by mean response[14]

Q-31 Which of these are reasons for your own use of the Internet at school? How important a reason is it for you?	Mean	Med	Md	S.d.
e) to prepare students for life in an increasingly technological society	2.69	3	3	.57
g) to keep up with new technologies yourself to gain access	2.47	3	3	.72
l) to resources or materials that are not available in textbooks or in the library	2.43	3	3	.76
a) to increase student motivation and participation in their own learning	2.39	3	3	.82
b) to provide opportunities for students who do not have computers at home	2.37	3	3	.86
d) to give students the skills they will need in college	2.22	2	3	.87
f) to help students feel more a part of the global community	2.22	2	3	.93
h) to find out about new teaching practices that you may want to use or adapt	1.93	2	2	.90
j) to reduce your professional isolation through e-mail or collaboration with others	1.49	2	2	1.10
m) to support larger school change efforts by using the Internet as a catalyst	1.49	2	2	1.10
c) to fulfill students' and parents' expectations	1.43	1	1	1.02
*i) to overcome remoteness or geographic isolation in your school or community	1.27	1	0	1.19
*k) to overcome a lack of specialized staff or limited program offerings at your school	.89	1	0	1.01

Key: "Not a Reason"/"NA" = 0; "Very important reason" = 3

*Note. Rural and poor schools are somewhat underrepresented in NSN (Becker and Ravitz, 1997).

[13] Hawkridge's fourth ratonale -- developing workplace-related skills -- was not asked here, however Goldman and Laserna (1996) found this to be an important rationale within the NSN schools they studied. Exploratory factor analysis suggests that reasons related to the pervasiveness of technology in society (items c, d, e, f, g) were related to both student and teacher use. However, reasons related to use of Internet as a catalyst for school improvement (items h, i, j, k, m) only correlated with teacher use (r=.35), while reasons related to other student benefits, only loosely interpreted as a pedagogical rationale (items a, b, i) were associated more with student use (r=.25).

[14] Data in all tables reflect four (4) or fewer missing cases (98% completion) unless indicated otherwise. Measures of central tendency and standard deviations are based on the scoring key shown within or below each table.

Condition #2: Knowledge and skills

Knowledge and skills indicators include self-reported skill levels with respect to 13 different Internet activities. In addition, teachers were asked to what extent they were sufficiently prepared to use the Internet with respect to five skills that may be required for classroom use. The most prevalent of the "Internet skills" included using a search engine and sending email (Table 2); the most prevalent of the "classroom skills" involved finding relevant online information and awareness of what the Internet can do (Table 3).

The mean for all items (reliability alpha=.93) was the best predictor of "teacher use" (r=.70) and was strongly correlated with overall use (r=.54). However, factor analysis created a single factor that combined the "classroom skills" items with two from the "Internet skills" list --- searching the Internet and downloading materials. This factor might still be interpreted as "classroom skills" because the additional items represent among the most frequent kinds of use with students (Becker, 1997). This factor alone was the best predictor of student use (r=.32), an equally strong predictor of overall use, and a reasonably strong predictor of teacher use (r=.48). The two other factors -- one involving Web authoring and IRC/MOO, and the second involving "other" skills (email, ftp) -- might be viewed as more "technical" in nature; these correlated with teacher use, but were not predictive of use with students.

Table 2. Self-reported "Internet skills" for 13 activities ordered by mean response

Q-40 How would you rate your ability to do each of the following things related to the Internet?	Mean	Med	Md	S.d.
c) Use a search-engine like Alta Vista to find information you need	2.52	3	3	.86
b) Send e-mail to groups of people without naming each person each time	2.25	3	3	1.01
a) Send attached files with an e-mail message	2.11	2	3	1.05
i) Download and read file saved in a specific format (e.g., Word, Adobe Acrobat)	1.79	2	3	1.17
e) Subscribe to a Listserv and participate in discussions with others	1.47	1	3	1.19
d) Find a Usenet newsgroup and discuss topics of interest on it	1.40	1	1	1.08
f) Put files on a server for others to access	1.32	1	0	1.19
j) Produce a simple Web page (e.g., containing text and graphics)	1.30	1	0	1.24
h) Translate graphics into a format for placing on the Web	1.10	1	0	1.21
k) Produce a complex Web page (e.g., tables, frames, sounds, animation)	.76	0	0	.98
l) Be a Web Master for a school or district (e.g., design and manage Web sites)	.61	0	0	.95
g) Participate in discussions on IRC, MOO, or MUD	.45	0	0	.79
m) Do programming for Web pages (e.g., CGI, PERL, JAVA, Shockwave)	.42	0	0	.80

Key: "None" = 0; "Low" = 1; "Medium" = 2; "High" = 3; "Don't Know" = 0

Table 3. Self-reported "classroom skills" related to Internet use ordered by mean

Q-41 To what extent are you sufficiently prepared to use the Internet? *Do you have sufficient...*	Mean	Med	Md	S.d.
b) Ability to seek and find relevant online information	2.40	3	3	.70
a) Awareness of what the Internet can do	2.37	2	3	.72
d) Knowledge of how to use the Internet in the curriculum	2.03	2	2	.79
e) Classroom management skills related to Internet use	2.00	2	2	.86
c) Ability to manage large amounts of electronic information	1.93	2	2	.92

Key: "Seriously lacking" = 0; "Somewhat lacking" = 1; "Generally present" = 2; "Very present" = 3

Condition #3: Resources

Two sets of resource indicators include support resources -- technical, training and curriculum support -- and hardware resources (e.g., computers and connectivity). Of the support resources, teachers generally reported that technical support and training opportunities were sufficiently present (Table 4). However, resources for Internet use in the curriculum and help for integrating online activities into the curriculum were most often reported as being insufficiently present. The mean score on these four items (reliability alpha = .80), was correlated with

overall use (r=.17, p<.01), but the mean of the two curriculum-related items (correlated, r=.58) was a stronger predictor (r=.22).

Table 4. Resource-related conditions reported as being sufficiently present ordered by mean

Q-35 To what extent are the following conditions sufficiently present to support Internet use by you and your students? Sufficiently present...	Mean	Med	Mode	S.d.
e) Technical support is available when you need it	4.05	4	5	1.56
k) Training opportunities are offered to develop your Internet skills	3.84	4	5	1.62
f) Curriculum resources for Internet use are available	3.41	3	2	1.49
l) Help is available for integrating online activities into the curriculum (e.g., workshops or meetings to help teachers plan activities)	3.10	3	2	1.54

Key: "Strongly disagree" = 1; "Strongly agree" = 6. (9-12 missing cases, includes "Don't Know"/"DK" responses)

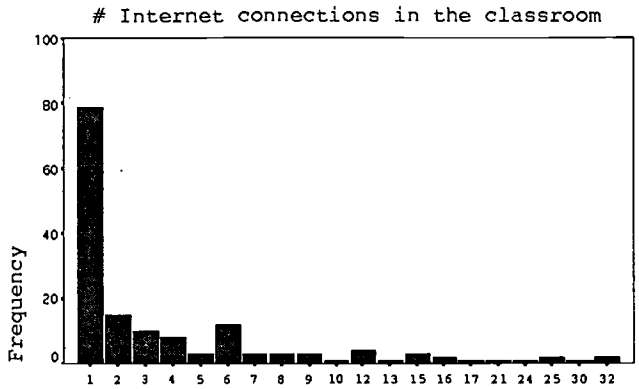
Concerning hardware resources, teachers were asked whether or not better Internet access in the future would increase their use (Table 5). A majority indicated that classroom Internet access and simultaneous access for 20-30 computers would increase their use "a lot". Surprisingly, those who scored higher on use were more likely to report that improved access would help "a lot" -- this suggests that less frequent users may not perceive access as being a critical issue, while more frequent users might take greater advantage of improved access if it were provided. As a result, an indicator score from these items (reliability alpha = .87) was not at all predictive of use (r= -.03).

Table 5. Access-related resources would increase use ordered by percent indicating "a lot"

Q-1 Which of the following features of the Internet or conditions for accessing it would make you likely to use the Internet more?	% "A lot"	% "A little"	% "Not at all"/"NA"
a) Internet access in your own classroom rather than elsewhere in your school	61	5	34
c) Simultaneous Internet access for 20-30 computers in a computer lab	57	14	29
d) Access to the World Wide Web	55	6	39
b) High-speed Internet connection rather than modems	52	11	37
e) Electronic mail to/from anyone in the world with an Internet e-mail address	44	14	42

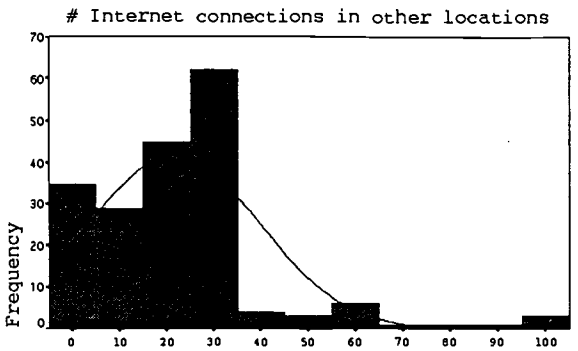
Next, teachers were asked to indicate the number of simultaneous Internet connections in the location where students most frequently use the Internet -- inside the classroom, outside the classroom, or both. 60% indicated that the classroom is a location where students most often use the Internet, and 80% indicated that students most often use the Internet in another location -- with 45% providing data on both locations. The highest number of simultaneous connections reported in the classroom was 32, but a full half reported only one Internet-connected computer (Figure 2). The mean response for the number of simultaneous connections in a location outside the classroom was 21, however some reported up to 100 (Figure 3); these latter cases indicated that they were reporting for multiple locations (e.g., "in other classrooms" or "labs").

Figure 2. Number of simultaneous Internet connections in the classroom (if classroom is a location where students most often use the Internet)



Mean = 4.4; Med = 1; S.d.= 6.2 (n=142, 60%)

Figure 3. Number of simultaneous Internet connections in other locations (if students most often use the Internet outside the classroom)



Mean = 21.6; Med = 20; S.d.= 17.97 (n=190, 80%)
Note: midpoints shown, first bar represents < 5

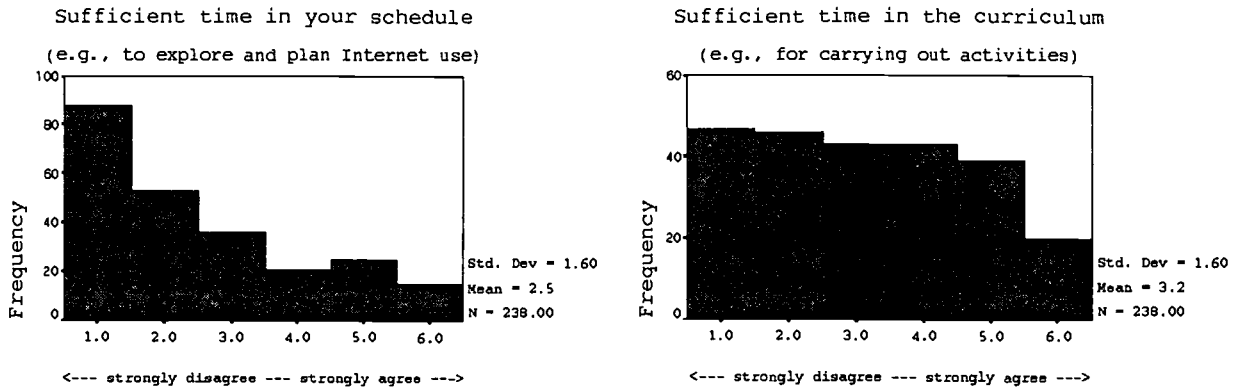
The number of simultaneous Internet connections *in the classroom* was correlated with overall Internet use (r=.26), predictive of use by teachers *and* students. When limiting the analysis to those who answered 50 or fewer (n=178), the number of simultaneous Internet connections *outside of the classroom* was only significantly correlated with *student* Internet use (r=.28), particularly when controlling for teacher use (r=.39). Because more than half of the teachers did not answer one of these items, a more useful indicator is the maximum z-score on the two items (the two z-scores were correlated, r=.29) -- i.e., whether or not a teacher reports a larger number of connections than other teachers in *either* location. This indicator was also predictive of overall use (r=.22).

Finally, teachers were asked about the amount of RAM memory on the computer they use most frequently at school. A little over 10% reported having 32MB or more. About half reported having 16MB; one-quarter reported 8MB, and fewer than 15% reported any less than that. When the amount of RAM was converted to an interval (as opposed to ratio) variable, it was moderately correlated with overall use (r=.19, $p < .10$).

Condition #4: Time

When asked whether there is sufficient time to support Internet use -- in the teacher's work schedule and in the curriculum -- there was strong disagreement on both items (Figure 4). The response concerning time in the curriculum was a better predictor of Internet use, even though teachers were more likely to disagree that there was sufficient time in the schedule. Time in the schedule was correlated with overall use (r=.21), but not as strongly as time in the curriculum (r=.35). The two items were correlated (r=.55), and the mean response was also predictive of overall use (r=.32).

Figure 4. Insufficient time available for teacher Internet planning and use in the curriculum



Teachers were also asked to report the actual amount of in-school preparation time they are given each week as part of their work schedule. Approximately 20% reported 1 hour or less per week. The most frequent response was 5 hours, with an average of about 4 hours. This included a few teachers who reported more preparation time, i.e., a cluster of about 10% who reported 6 or more hours/week, even up to 10 hours.

The amount of reported preparation time was, surprisingly, not correlated with the above items related to the perception of time availability, nor did the amount of actual preparation time correlate with any of the Internet use measures. A possible explanation is that teachers do not necessarily have access to the Internet during their in-school preparation time. This might be an example of a resource variable "access" interacting with a time variable "preparation time", a relationship that might be explored further. Although not a time variable per se, those who reported using the Internet more frequently during their class preparation time (USE4PREP) also scored significantly higher on student use (r=.33) even when teacher use was held constant (r=.11, p<.10).

Condition #5: Rewards & Incentives

Rewards and incentives indicators include two sets of items -- the first involves the perceived level of benefit for students with whom the teacher has used the Internet. While this variable may be more a result of use, not a cause, students benefiting is viewed as an important intrinsic motivation for continued, ongoing use, i.e., after some initial attempts have been made. The intention was to have some indication of a perceived reward concerning the teacher's relationship with students (Mitchell, et al., 1987). This item is different from the more hypothetical dissatisfaction measure concerning whether all students would benefit.

Teachers reported that most of their students had benefited greatly from their use of the Internet (Table 6). Approximately 15% of the teachers reported that *all* of the students with whom they had used the Internet had benefited greatly; nearly all (92%) reported that more than half had benefited at least "somewhat". Finally, negative experiences were rarely reported, most (62%) indciated that *none* of their students had a negative experience overall. The percent of students reported as having "greatly benefited" was significantly correlated with overall use (r=.38).

Table 6. Mean percent of students reported as having benefited at each levels

Q-25	**Of your students who have used the Internet, estimate the percent of them in each category:**		
Negative experience overall	Benefited very little	Somewhat benefited	Greatly benefited
3.3	10.2	29.7	56.7

The primary educational value that was reported involved access to a huge variety of curriculum information. Approximately half of the teachers reported that students were applying themselves for longer periods of time, taking more responsibility for their own learning and showing greater interest in world events and foreign cultures as a result of Internet use. About half also reported a more equal distribution of expertise among students and that average students were communicating at 'gifted' levels. Fewer (less than 1/3) indicated benefits in terms of

students having a deeper understanding of the ideas the encounter, and having experiences with or increased interest in the adult world.[15]

The second set of indicators concern the availability of various "extrinsic" rewards or incentives that might be provided to teachers by the school or district (Table 7). Of the items listed, those that were reported as being generally available involved the provision of computers, equipment or modems to teachers who are interested in the Internet. In addition, release time, reimbursement for inservice courses, and public recognition were reported in about half (40-50%) of the cases. For the remaining items a majority indicated that the reward or incentive was "not available".

The mean response for each teacher on all these "extrinsic" items (reliability alpha =.70) was correlated with overall use (r=.22). For those items that showed a relationship with use (a, c, d, f, g and h), the mean score was only slightly more predictive of use (r=.25).[16] There seemed to be no relationship between the percent of students having greatly benefited and the availability of extrinsic rewards or incentives.

Table 7. Extrinsic rewards or incentives "somewhat" or "generally" available ordered by sample mean

Q-50 To what extent are each of the following rewards and incentives available at your school to encourage teachers' use of the Internet?	Mean	Med	Md	S.d	% available "at all"
a) Teachers who show they are interested are provided with computers/equipment	2.08	2	3	.82	80
b) Computers or modems are loaned to teachers for use at home	1.79	2	1	.77	58
e) Cost of in-service/graduate credits for Internet workshops/courses is reimbursed	1.69	1	1	.78	50
c) Release time (substitutes) are provided for Internet development activities	1.53	1	1	.67	44
f) Public recognition given for leadership, helping other teachers/staff use Internet	1.53	1	1	.69	42
d) Paid time provided for after school hours spent on Internet-related activities	1.33	1	1	.59	26
h) District/school has contests rewarding innovative technology-using teachers	1.19	1	1	.50	14
g) Career-ladder opportunities for telecommunications-using teachers	1.17	1	1	.42	16

Key: "Not available" = 1; "Somewhat available" = 2; "Generally available" = 3. (13 missing cases)

Condition #6: Participation

Participation indicators include the extent of a teacher's involvement in setting the course for Internet implementation in their school or district -- contact with decision makers concerning Internet-related issues and the extent of involvement in various other activities supporting implementation. Concerning direct involvement in decision making, respondents were most likely to report having a trusted colleague to whom they can voice their concerns. While they generally reported having an opportunity to voice concerns, fewer reported having their input directly sought by decision makers, e.g., before decisions are made (Table 8).

[15] Network coordinator data actually show a decrease in some of these benefits being reported since 1995, including students having greater interest in world events and foreign cultures, a deeper understanding of ideas they encounter, and greater interest in the adult world (Becker, 1997).

[16] Of course, selecting only those items that "work" as predictors of use may capitalize on chance; the utility of these particular items as opposed to others would have to be confirmed in follow-up studies.

Table 8. Extent to which teacher input is sought by decision makers ordered by sample mean

Q-32 To what extent is your input sought by decision makers in your school or district concerning Internet-related issues?	Mean	Med	S.d.	% never (=1)	% sometimes (=2)	% often (=3)	% always (=4)
b) There's a trusted colleague to whom I can voice concerns	3.18	3	.89	5	16	34	45
a) I have opportunity to voice concerns to decision makers	2.72	3	.86	6	37	37	20
d) I am given updates and asked for feedback	2.51	2	.85	11	40	37	12
c) My opinions are sought before decisions are made	2.28	2	.86	17	47	26	10

Note. Percent of valid responses shown, rounded. Key included in table. (9-12 missing)

Of the various other types of activities in which a teacher might participate, those reported most frequently included selection of hardware and software, providing support to other teachers, and working on curriculum integration (Table 9). Regarding other activities, half or more reported that they were not involved "at all".

Table 9. Teacher involvement in various other activities ordered by mean response

Q-36 To what extent have you been involved in any of the following activities?	Mean	Med	S.d.	% Not at all (= 1)	% Slightly (= 2)	% Generally (= 3)	% Very (= 4)
a) Reviewing, selecting, purchasing hardware/software products	2.67	3	1.08	18	27	26	29
b) Providing services to other teachers, training /tech support	2.65	3	1.16	23	22	22	33
f) Developing ways of integrating Internet into the curriculum	2.32	2	1.10	31	25	25	19
e) Serving on Internet-planning committee, school or district	2.06	2	1.20	48	19	12	21
c) Developing products for others, e.g., software or guidelines	1.97	2	1.07	47	22	20	12
d) Developing school or district-wide policies for Internet use	1.93	1	1.11	50	21	15	14
h) Meeting with parents/community members re: Internet use	1.52	1	.81	65	21	11	3
g) Attending school board meetings to discuss Internet issues	1.36	1	.73	76	15	6	3

Note. Percent of valid responses shown. May not total to 100% due to rounding. Key included in table.

In addition, teachers were asked if regular meetings to discuss Internet issues were sufficiently present. Most (75%) respondents tended to disagree that Internet-related meetings were sufficiently present, many (36%) disagreed strongly; this was among the least sufficiently present of the items reported by Ravitz (1997). While this may indicate a desire for more involvement in decision-making, the wording of the question was not specific enough to determine this, i.e., responses could also indicate a desire to have others types of Internet-related meetings, e.g., with peers regarding curriculum uses.

Overall, teachers who use the Internet more were more likely to participate in decision making and planning activities. A combined z-score using the items from all three questions (reliability alpha =.88) correlated with overall use (r=.35). Dropping the last item, which provided less value in terms of predicting overall use (r=.17, $p<.01$), the mean score on the two sets of items was more predictive of teacher use (r=.52) and overall use (r=.42), than it was of student use (r=.24); in general, this condition seems to be more closely associated with teacher use.

Condition #7: Commitment

Indicators of commitment include the extent to which there is sufficient organizational-level commitment for Internet use and to which various stakeholder groups have been supportive of Internet use over the past two years. Additional indicators include the number of other teachers in the school with whom the teacher regularly converses about the Internet, and the number of others who are estimated to be using the Internet. Finally, teachers were asked about the overall supportiveness of people in different stakeholder groups.

The "organizational-level" commitment indicators (Table 10) were reported as being generally present, this included the existence of a long range plan, a substantial budget being in place or assured, and Internet use as a priority in school improvement plans. Approximately 70% tended to agree that each was sufficiently present, with

most respondents agreeing strongly. Responses to these three items were correlated with each other (r >.56) and the mean response on all three was predictive of overall use (r=.23). The perception that Internet use is a priority was more closely associated with increased use (r=.24), while the existence of a substantial budget was a slightly less powerful predictor, although still statistically significant (r=.16, p<.02).

Table 10. Commitment items concerning planning for Internet use are present

Q-35 To what extent are the following conditions sufficiently present to support Internet use by you and your students?	Mean	Med	Md	S.d.
a) A long range plan for Internet development and use is in place	4.26	5	6	1.55
b) A substantial budget has already been approved, or is assured	4.05	4	6	1.60
c) Internet use is a priority in existing school improvement plans	4.36	5	6	1.49

Key: "Strongly disagree" = 1; "Strongly agree" = 6. (9-12 missing values)

Concerning the supportiveness of various stakeholder groups (Table 11), responses generally indicated support for Internet use from each of the listed groups. Vendor or corporate sponsorship (item h) was the only of these items that had a significant correlation with overall use on its own (r=.22, p<.02). The mean of all these items (reliability alpha = .86) was also predictive of overall use (r=.17, p<.02).

Table 11. Level of reported support by groups of stakeholders

Q-33 Over the past two years, how supportive have people in the following positions been in promoting the school's Internet use?	Mean	Med	Md	S.d.	Missing
b) Teachers (e.g., on committees, talking to others, demonstrating uses)	3.28	3	3	.69	5
c) District-wide committee or task-force (e.g., district-level planning)	3.21	3	4	.85	20
f) District technical support (e.g., install/maintain computers/ networks)	3.21	3	4	.94	15
e) District administration (e.g., policies, hiring people, seeking grants)	3.10	3	3	.88	25
d) School board or decision making body (e.g., budgets, dev. policies)	2.98	3	3	.90	20
a) Parents (e.g., asking for Internet, bond issues, attending meetings)	2.91	3	3	.92	28
i) District or school curriculum supervisors (e.g., ideas/materials for use)	2.73	3	3	1.0	23
g) Local community members (e.g., voting funds, interest, activities)	2.52	3	3	.90	54
h) Vendors or corporate sponsors (e.g., hardware, software, telecom corps)	2.45	2	2	.95	51
j) Local businesses (e.g., partnerships, instructional/technical support, interest)	2.18	2	2	.90	65

Key: "Unsupportive" = 1; "Strongly Supportive" = 4. "Don't Know" responses treated as missing.

Concerning the number of other teachers in the school with whom a teacher has discussed the Internet in the past month, most (80%) reported speaking with 10 or fewer teachers, however approximately 10% reported speaking with over 25 in the last month. This was a relatively strong predictor of overall use (r=.37), especially after a square-root transformation created a more normal distribution and one positive outlier was removed (r=.46). Finally, the estimated proportion of other teachers at the school perceived to be Internet users (Table 12) was also significantly correlated with overall use (r=.27).

Table 12. Estimated proportion of teachers and administrators who use the Internet

Q-42 Approximately how many of the teachers and administrators at your school do you think use the Internet? Cirle one...		
	Teachers (Q-42a)	Administrators (Q-42b)
"A few"	24%	35%
"About half"	39%	17%
"Most"	19%	17%
"Nearly all"	14%	21%
"Don't Know"	2%	9%
	Mean=2.2; Med=2, S.d.=1.0; Missing=8	Mean=2.3; Med=2; S.d.=1.2; Missing=23

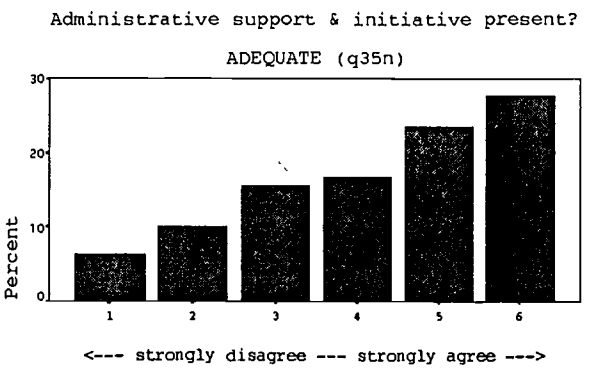
Key: "A few" = 1; "About half" = 2; "Most" = 3; "Nearly All" = 4; "Don't know" = Missing.

Condition #8: Leadership

The last condition involves the extent to which administrators and school principals are seen as advancing use of the Internet. This includes the estimated number of administrators who use the Internet themselves, the perception that administrative support is sufficiently present, and the overall stance taken by administrators with respect to Internet use. An additional form of leadership that was explored concerned a teacher's awareness of other individuals who may have made extraordinary efforts to bring about school Internet use.

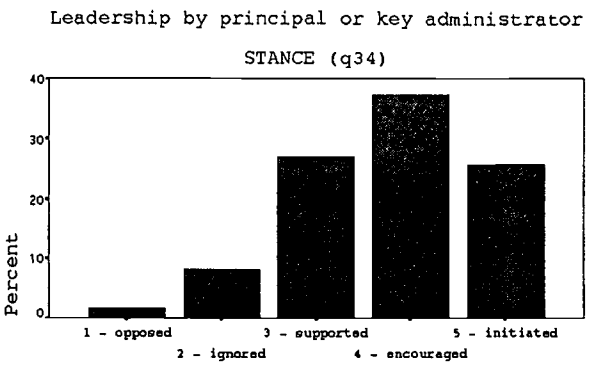
The estimated proportion of administrators who are Internet users (Table 11, above) was moderately correlated with overall use (r=.15, p<.05). Generally, administrative support for Internet use was reported as being "sufficiently present" (Figure 6); responses on this item correlated with *overall use* (r=.14, p<.05). Concerning the overall leadership stance, approximately 90% indicated that the principal or key administrators had at least been generally supportive (Figure 7); however, this was not a useful predictor. The mean z-score on these last two items was predictive of *teacher use* (r=.14, p<.05), but not student use -- the perception of administrative support seems to be more closely associated with teacher use than student use, possibly because of additional conditions required to support use with students. Still, the mean z-score on all three items, including the proportion of administrators using the Internet (reliability alpha =.68) was predictive of *overall* use (r=.15, p<.02).

Figure 6. Administrative support is sufficiently present to support Internet use?



Mean 4.2; Med= 5; S.d.=1.56 Missing= 4

Figure 7. Leadership stance taken by principal or key administrator



Mean= 3.8; Med=4; S.d.=.98 Missing=9

Concerning others in the community making extraordinary efforts to bring about Internet use (Table 13), the most frequently mentioned types of individuals tended to be those who work in the school (principal, technology coordinator/media specialist, teachers) or a district-level specialist. None of the other types of individuals were mentioned in more than 10% of the cases. Incidentally, of those who wrote in "other" responses (n=15), three respondents chose to highlight extraordinary efforts made by the school board or a school board member.

Based on a comparison of means (ANOVA), those teachers who reported extraordinary efforts by a university liaison were significantly more likely to score higher on use measures.[17] Other important leadership roles, by this criterion, included that provided by a principal or school administrator, and that provided by vendors of network software, educational content or computers.

Table 13. Extraordinary efforts by individuals in various groups and relationship to Internet use ordered by reported frequency

Q-51 Is there someone who has made extraordinary efforts to bring to reality a vision of tele-communications use in your school--someone who has made a substantial contribution that would not have been made by other individuals in that same role? *Circle as many as apply, but be "tough."*	#	%	Mean diff. in overall use
b) School computer or technology coordinator or media specialist	60	25	.02
c) A teacher	54	23	.09
d) District-level technology specialist or other district administrator	40	17	.15
a) Principal or other school administrator	31	13	.37**
e) Specific parent(s)	8	3	.07
h) University faculty member or students or network-based project liaison	8	3	.81***
i) A provider of network software, educational content or computer retailer	7	3	.47*
f) Local business person, corporate sponsor or professional person in your community	7	3	-.12
g) Government official	0	0	.00

*p < .20 **p < .06 ***p < .02

Interestingly, those who reported extraordinary efforts by a local business person or community member scored slightly lower on overall use, however this was not a statistically significant finding. The total number of items selected was moderately predictive of use (r=.12, p<.05), while the number of the three significant items that were indicated was a somewhat better predictor (r=.19, p<.005). Of these three items, 60% of all respondents (n=141) reported none, 35% (n=82) indicated at least one, and only 5% (n=12) responded that individuals in two of these roles had made extraordinary efforts -- all but one indicated the principal or school administrator, paired seven times with a provider, and four times with a university liaison.

The number of people reported as making extraordinary efforts was correlated with the mean z-score on the other leadership items. The mean z-score on all four leadership indicators (reliability alpha=.63) was a better predictor of overall use (r=.20, p<.005) than any single leadership indicator.

Summary

For each of Ely's conditions (1976, 1990) several survey items were developed based on a review of the literature. Descriptive data reported here suggest which conditions seem to be most present or lacking as reported by Internet-using teachers in leading-edge schools. For example, it seems that technical and training resources, administrative support and organizational commitment are among the most present; conditions that seem to be lacking include time for planning and curriculum use and the availability of curriculum-related help and resources.

In general, indicators for each condition are significantly correlated with use measures, including both teacher and student use. Within each condition certain indicators are stronger predictors than others. Some that appear to be more predictive of *student use* include classroom-related knowledge and skills, and curriculum resources; those that seem more predictive of *teacher use* include more "technical" Internet knowledge and skills, the extent of participation in decision making and other implementation-related activities, and the perception of support for Internet use by principals and administrators. The conditions that seem to be most predictive of use overall, based on measures developed here, include knowledge and skills and dissatisfaction with the status quo. In addition, a few individual indicators from other conditions seem to be strong predictors -- the number of other teachers in the school with whom a teacher discusses the Internet, and the number of students reported as having benefited greatly.

[17] Goldman and Laserna (1996) provide case studies of NSN schools involved in university-school partnerships.

The next stage of analysis will focus on the covariance of indicators across the conditions, possible interaction effects, and exploration of new factors that may cut across the framework --- such as all the items related to curriculum integration. A regression model will determine the extent to which the conditions as a whole can account for differences in the extent of teacher Internet use. In conclusion, the framework may help shed light on the complex interplay of conditions, all of which seem to be related to teacher implementation of the Internet, the latest in a long line of educational technology innovations.

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