Virtual Teamwork in Education: Implications for Technology Adoption

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Abstract

Over the past five years, the E-Rate program has been instrumental in reducing the digital divide in America's schools: 98 percent of schools in the nation were connected to the Internet by the year 2000. However, the digital divide is only one manifestation of an 'opportunity gap' in the educational system, manifest in wide disparities in the availability of advanced placement classes, special education programs, foreign language instruction, ESL education, and classes for students with limited English proficiency. Online education may provide an opportunity to bridge this 'opportunity divide' provided it can find more substantial funding that it has currently available. We advocate the expansion of the E-Rate program to cover online education. However, there are organizational, technological and pedagogical issues that need to be addresses before online education can be extended policy and funding support. We use a survey of previous research on online learning, the results of a quasi-experiment we conducted comparing online to face-to-face instruction, and our own personal experiences to identify some of these issues and suggest remedies. In conclusion, we argue that expanding the E-Rate program to cover online education is both possible and necessary in the current educational environment.

In November 2002, we will be coming to the fifth year anniversary of the E-Rate program introduced by Congress in the 1996 Telecommunications Act, with the intent to bridge the gaps in telecommunications, technology and internet access between rich and poor communities in the United States. Currently, the E-Rate program channels $2.25 billion annually in discounts for technology and telecommunications access to the nation's schools and libraries located in disadvantaged neighborhoods in both rural and

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urban areas. In light of its stated goals, the E-Rate program has been quite successful: whereas only 35 percent of schools had internet access in 1994, 98 percent in the United States were connected by the year 2000 (National Center for Education Statistics [NCES], 2002). Only 3 percent of instructional classrooms had internet access in 1994; by 2000, it had risen to 77 percent. Telecommunications connectivity had also improved: 77 percent of schools had dedicated high-speed connections such as T1 to connect to the internet. The ratio of students to computers had decreased to 5 to 1, making it easier for all students to have some form of computer exposure every school day.

While there are many federal, state and local programs funding educational technology and telecommunications access, the E-Rate program has to be credited with a substantial share of the credit for helping to bridge the digital divide in the nation's school system. Several other educational technology programs are coordinated by the U.S. Department of Education, among them the Technology Literacy Challenge Fund and the Technology Innovation Challenge Grants. The Technology Literacy Challenge Fund aims to help states fund educational technology initiatives that train teachers to effectively utilize computers and the internet in education, increase computer access in classrooms, expand internet connectivity, and make software and online content available. The Technology Innovation Challenge Grants are available to school districts to promote the innovative use of telecommunications and technology. However, none of these programs are as well funded, or as clearly focused on the digital divide as the E-Rate program is. With its annual outlays of $2.25 billion, the E-Rate program has accounted for a significant share of the estimated $37.9 billion dollars spent on educational technology and internet connectivity in the U.S., over the last 10 years

(Benton Foundation, 2002). And because E-Rate funds are allocated based on the number of students in each school who are eligible for the school lunch program, its benefits have been targeted at the most economically disadvantaged school districts, which are also more likely to serve minority students.

This is not to say that the objectives of the E-Rate program have been fully achieved—gaps in access to telecommunication and computer resources still exist between the richest and poorest school districts. In 2000, only 60 percent of classrooms in schools with the highest concentration of poor students had access to computers with internet access, compared to 82 percent in schools with the lowest concentration of poor students (NCES, 2001). Even in schools with internet connections, there were differences in the type of connectivity by income profile of the student body. Among schools with the lowest concentration of poor students, 72 percent connected to the internet over dedicated lines, and the others over dial-up or other connection types. At the same time, only 50 percent of schools with the highest concentration of poor students had dedicated lines (NCES, 2000). Nevertheless, these gaps too are narrowing over time. It is quite possible, with the continued operation of the E-Rate program, that we could achieve equity in the availability of educational technology and telecommunications services in the nation's schools.

Bridging the 'opportunity divide'

But access to computers and internet is not the only divide affecting educational equity for our children. These gaps are part of a larger educational gap between majority and minority students, rich and poor school districts and rural and urban areas,

comprising access to advanced placement classes, availability of qualified math and science teachers, and overall educational quality. For example, only 3.7 percent of African-American students took Advanced Placement (AP) examinations in 1999, compared to 13.2 percent of white students (Department of Education, 1999). In areas of the country where there are large immigrant populations, there is scarcity of qualified ESL and bilingual teachers as well (Samuels, 2001; Snyder, 2001). These are differences in educational standards that cannot be bridged through better telecommunications or technology access alone—instead, what is required is to make available the same educational content and quality of instruction in poor school districts that is available in the better served parts of the country.

Clearly, bridging this 'opportunity divide' is quite beyond the financial capability of cash-strapped school districts and even the federal and state governments in the current budgetary milieu. One cost-effective method of bridging the 'opportunity divide' may be distance education. With growing computer and internet penetration, the usage of the internet to deliver K-12 instruction in the form of online courses is increasing. A recent survey listed more than 100 organizations—including schools, school districts, state education agencies, state-chartered entities, universities, and for-profit consortia—that offer K-12 courses on the internet or the web (Clark, 2001). Several states including Florida, Michigan and Illinois have chartered 'cyber schools' that offer all instruction online. The survey estimated, based on extrapolations from a smaller sample, that as many as 40,000 to 50,000 K-12 students may be enrolled in 2001-02 in the courses offered by these institutions. Online courses are only more popular at the university-level,

with more than 2 million students estimated to be enrolled in internet-based courses in 2002, triple the number from just four years ago (IDC, 2000).

We have in the increasing popularity of online education a unique opportunity to bridge the 'opportunity divide' in elementary and secondary education. By extending online educational initiatives to underserved school districts, student populations there will have the opportunity to benefit from the same teacher quality and educational content to which their richer compatriots are exposed. Online education promises efficiency, by permitting more students and/or a greater number of classroom locations to be served by a single teacher. It also promises wider access to a scarce resource: qualified teachers. A number of federal and state programs have tried to promote internet-based distance education to disadvantaged student groups, most notably the Star Schools initiative. Coordinated by the U.S. Department of Education, this initiative funds distance-learning programs in mathematics, science and foreign languages as well as literacy skills and vocational education, aimed at disadvantaged student groups such as new immigrants, the disabled, the illiterate and those with limited English proficiency. The Department of Education estimates that 1.6 million students have benefited from the program since its inception in 1988. However, the Star Schools program has attracted only limited financial support—a total of $13 to $22 million per year, for a total of $275 million in assistance for 48 projects over 13 years (Office of Educational Research and Improvement [OERI], 2001).

In this context, the success of the E-Rate program in achieving its initially mandated goals presents both a threat and an opportunity. It presents a threat because the very success of the E-Rate program in achieving parity in telecommunications and

internet access in schools will lead to calls for its elimination. Yet, as we discussed above, the 'opportunity divide' in America's schools still exists—even if the stated intent of the E-rate program is being achieved, its underlying premise, namely the equalization of educational opportunity still remains unrealized. Thus, the utilization of E-Rate funds for online education presents a unique opportunity. In spite of the promise of online education, there exists no programmatic support in the E-Rate policy for internet-based course delivery. Indeed, current E-Rate policy makes virtually no reference to the uses of the technology it funds. As Harrington-Leuker (2002) pointed out, it may be easier to build telecommunications networks than to integrate the technology into school curricula in an efficient and cost-effective manner. There can be enormous public policy benefits from wedding the E-Rate to initiatives such as the Star Schools Program.

But before we unequivocally advocate the utilization of E-Rate funds for online education, we need to address questions about the equivalence of online and face-to-face communication. Would encouragement of online education to bridge one type of gap (the 'opportunity divide') lead to the opening up of another type of gap in quality? Previous studies have shown that students in distance education typically have higher drop-out rates than in traditional classrooms (Institute for Higher Education Policy, 1999). What, if anything, can be done to control this in an online environment? Again traditional distance education, from the early mail-based correspondence courses to the 'television classroom' have relied on the one-way flow of information with little student feedback, and almost never in real-time. Can the potential of the web for interactivity, simultaneity and many-to-many communication be harnessed to create a 'virtual classroom' simulating, and exceeding in some respects, the face-to-face environment? What

allowances, if any, do we have to make to individual differences between students and their learning styles to maximize the benefits of online education?

In the following section, we present some pointers based upon previous research comparing student outcomes in online and face-to-face (F2F) environments, as well as the results of a quasi-experiment we conducted comparing the two in a university-level telecommunications management class. Conducting this quasi-experiment involving online course delivery gave us an opportunity to experience firsthand both the challenges and the rewards of using the internet for instruction. After synthesizing the findings of previous research on online vs. F2F learning and the results of our own experiment, we will conclude with implications for educational technology adoption and E-Rate policy.

Is virtual and face-to-face instruction comparable?: Previous research

While online teaching and learning has stimulated a prodigious volume of published scholarship, there is still a lack of empirically validated theoretical models of the online learning process, as pointed out by Wolfe (2000). The field of enquiry is yet to mature into a research agenda, with well-established theories, methods and accepted tenets. Published research ranges from how to/best practices works, to ad hoc/anecdotal studies and more systematic inquiries using both qualitative and quantitative methods.

Comparative evaluations of online and face-to-face learning environments have been based on a variety of outcome measures, such as information retention and cognitive skills (as measured in test scores), student participation, team building, and satisfaction, with several studies focusing on more than one of these outcome measures. In two early studies of the trademarked Virtual Classroom™, one from 1986-1988 and the other from

1993-1996, Hiltz & Wellman (1997) found that 1) learning the course material was equal to or superior to learning in the traditional classroom; 2) Virtual Classroom™ students reported higher satisfaction across a variety of dimensions and 3) "…students perceive the experience as 'group learning' rather than individual learning" (p. 47). It should be noted that these studies were conducted when online learning was very new and a novelty effect cannot be ruled out. A more recent study found that students in online sections of a microeconomics course did not fare as well as their face-to-face counterparts in information retention and cognitive ability (Brown & Liedholm, 2002). Using exam scores as the basis for comparison, student performance varied significantly by mode of interaction (live, virtual and hybrid sections). Students in the virtual classes performed worse on exams than the live section students. Moreover, the effect was more distinct when higher cognitive levels like application of concepts was required, compared to lower cognitive levels like simple comprehension. While students were encouraged to collaborate, teamwork was not a core component of the course.

Other studies have specifically looked at communication in a team environment, mediated either face-to-face or virtually. In one study, online teams of students from three different universities who collaborated on a critical thinking exercise without ever meeting face-to-face were found to experience some benefits such as reduced communication inhibition, though not enough to overcome the advantages of face-to-face interaction (Warf, Vincent, Purcell, 1999). Two empirical studies of student teams that used group support systems such as groupware came up with contrasting results about the utility of such software-supported environments: whereas one study found groupware beneficial because it freed up students to focus on the group process by facilitating

planning, participation and record-keeping (Manning & Riordan, 19xx), the other found group development was no different in an experimental group that used groupware, than in a control group that did not (Feather, 1999). In neither of these studies was student interaction confined to an online environment; student teams interacted both face-to-face and online.

Learning outcomes can be difficult to measure and objectively compare when comparisons are made across subject areas, institutions or time. Similarly, communicative intensity is difficult to compare across face-to-face and virtual modes of interaction. One approach to capturing consistent measures of student outcomes is to gauge satisfaction. A study of MBA students in five online courses surveyed their satisfaction with course software and perceived interactivity and found that student satisfaction was more attributable to the flexibility of the online medium, than to its ease of use or the usage level of students (Arbaugh, 2000a). However, team learning and problem-solving were not core learning objectives in the study, though they were certainly elements. Also, there was no comparison to outcomes in face-to-face settings.

Arbaugh addressed this shortcoming in part with a follow up study (2000b) that compared learning outcomes in online and conventional classrooms. Differences in student participation and interaction and exam performance were measured. Students in the online course contributed to discussions significantly more than their classroom counterparts yet reported higher levels of interaction difficulty, a counter-intuitive outcome. Moreover, the study found that the mode of interaction, whether online or in a classroom, makes no significant difference in learning.

Thus, comparative studies of student learning, participation and satisfaction measures in online and F2F environments present a mixed bag of results. While some studies indicated that students in an online environment may not be significantly affected either positively or negatively, others found differences in student participation, learning, test performance, and satisfaction. The inconclusive nature of the research comparing online and F2F instruction calls for further study.

A quasi-experiment

Given the difficulties in measuring learning outcomes noted above, we decided to conduct our own experimental assessment of online vs. face-to-face interaction. While the experiment had other pedagogical and research objectives, one of our main motivations was to find empirical support (or lack thereof) for our hypothesis regarding the equivalence of online and F2F instruction. If such equivalence could be demonstrated, we could build a stronger case for a policy recommendation to utilize E-Rate funds to promote online course delivery. But because we wanted our proposed E-Rate-funded pedagogical model to go beyond the one-way information flow typical of traditional distance education, we were keen to conduct the experiment in a many-to-many, simultaneous, and interactive online environment that simulates the physical classroom experience. We therefore compared outcomes in a team-based, goal-driven instructional situation, when students interacted exclusively F2F or online with both instructors and teammates. We adopted the techniques of the case method and team learning, shown to be effective earlier (Hoag et al, 2001), as our principal teaching methods.

The experiment was conducted in Fall 2000 in a telecommunications management class conducted simultaneously at two large universities. Students in one section (the control group) of this class were assigned to teams to discuss and arrive at solutions to a series of management cases through conventional face-to-face interaction. Students in the other section (the experimental group) were assigned to 'virtual teams' whose membership spanned both universities: they interacted with their team-members and with the instructor in a strictly virtual online mode. As far as possible in a multi-instructor, multi-university experiment, a concerted attempt was made to eliminate or minimize other differences besides the mode of interaction.

In conducting this experiment, one of our chief decision-points was the identification of an appropriate outcome measure. Because previous studies had reported difficulties in objectively measuring and comparing learning outcomes and communicative intensity across time and institutions, we decided to look at satisfaction as an outcome measure, as Arbaugh (2000a) did. A factor that may possibly provide insight into satisfaction outcomes is the role of team trust and propensity to enjoy interpersonal interaction. While we found no research of online learning and propensity to enjoy interpersonal contact, a number of studies have examined interpersonal trust in social interactions (for eg., Rotter, 1980) and in virtual work environments (Jarvenpaa, Knoll, & Leidner, 1998). Trust in long-standing teams is built based upon and continually modified by the working relations and experiences of its members. But often, virtual teams do not have the benefit of lengthy interaction with each other: the project typically calls upon members to interact intensively for short periods of time. This is true of the semester-long learning experiment we conducted, as well as of the online courses that we contend

should be supported by E-Rate funds. In such cases, Jarvenpaa Knoll & Leidner (1998) hypothesized that participation (and consequently satisfaction) will be conditioned by an individual's propensity to trust as well as the perception of other members' ability, benevolence and integrity.

In investigating how mode of interaction (virtual vs. face-to-face) influenced the team experience and consequently satisfaction, three specific research questions thus emerged. Given an individual's propensity to enjoy teamwork, how does the technological mode of interaction influence the team experience in a task-based environment? How does mode of interaction influence the evaluation of satisfaction with the learning process, work process and work product in a task-based environment? What implication about the comparative impact of online versus F2F communication on student outcomes can we draw? And in turn, what do these implications suggest for the deployment of E-Rate funds for online education, and the particular communication technologies such funding should support?

Theoretical Model and Hypotheses: A person's propensity to enjoy teamwork is part of their personality and external to the experimental design. An individual with a high propensity to enjoy interpersonal contact may be predisposed to view others as effective team members, and therefore is more likely to have positive team experiences leading to higher levels of satisfaction. However, perceptions of team members will be continually tested and updated as part of the team process as well. An individual who comes to the team experience with high expectations (i.e. high propensity to trust interpersonal contact), but whose experiences do not vindicate those expectations may consequently suffer a disproportionate loss of satisfaction. Conversely an individual with

low expectations of team work may experience high levels of satisfaction if her expectations are exceeded. This line of reasoning has a long pedigree in marketing research under the rubric of 'expectation disconfirmation' (Oliver, 1980). We therefore decided to test a model in which propensity to enjoy interpersonal contact and the experimental condition (virtual or face-to-face (F2F) interaction) are the independent variables, the team experience is the intermediate variable and satisfaction is the outcome (dependent) variable. The theoretical model below depicts the hypothesized relationships.

(Figure 1: Theoretical Model)

Based on this model, the following hypotheses were framed. The first hypothesis is a null hypothesis dealing with the relationship between experimental condition and the team experience. In this paper, we present only the results where team experience is operationalized as the perception of other team members' ability.

H1: *There will be no difference in perceived ability of team members in virtual and F2F environments.*

The second hypothesis states that individuals with high propensity to trust are more likely to have positive team experiences (in terms of perception of team members' ability), irrespective of experimental condition.

H2: *Individuals with higher propensity to trust will be more likely to perceive their team members as having high ability, in both virtual and F2F environments*

The third and fourth hypotheses dealt with expectation disconfirmation. They deal with the interaction between the experimental condition and the team experience, and state that for those with high or low perception to trust, satisfaction will be disproportionately affected by the degree to which their expectations were 'disconfirmed' by the team experience.

H3: *Individuals with weak propensity to enjoy interpersonal contact will experience higher levels of satisfaction, when confronted with high perceived ability of team members*

H4: *Individuals with strong propensity to enjoy interpersonal contact will experience lower levels of satisfaction, when confronted with low perceived ability of team members*

Experimental Design and Methods**:** Our quasi-experiment was conducted using a pretest-posttest control group design (Campbell & Stanley, 1963). A control group (n =37), referred to as the face-to-face (F2F) group received instruction in a conventional classroom setting. The instructor and students met twice per week for 75 minutes. The experimental group, referred to as the virtual group, was comprised of students (n=28) at two geo-graphically-dispersed institutions, about half enrolled from the same university as the control group, and the rest from the other university. Two instructors, one at each institution, taught this section by interacting with students mostly online, but they could meet with their home-institution instructor face-to-face in office hours. It was decided that having one instructor at each institution would more closely simulate the single-instructor environment in the F2F group since students at each university would identify their home-institution instructor as their own. However, teams were strictly inter-university and therefore were forced to 'meet' and collaborate online. After the first week, the virtual class did not 'meet' at an appointed time – interaction was student-initiated. The instructors therefore had to be available for portions of every day (and night, as it turned out).

At the first class meeting held face-to-face for both experimental groups, students were informed that their interaction and performance were the subject of a research study. In an initial orientation week students in both sections received training on team processes and case method learning; the virtual group also received training on the virtual

learning environment, Blackboard.com's Courseinfo™. In theory, Courseinfo™'s web-based system permits the same kind of interaction found in a conventional classroom – synchronous communication via chats and "whiteboarding" conferences. Beyond that, there are a number of other features: repositories for readings and activities, personalized web sites including photos for each student, private areas for teams (to meet both synchronously and asynchronously, exchange and store information) and a variety of mechanisms for instructor and student to interact. The virtual group condition also included web-based access to a group of telecommunications industry experts who were recruited specifically as online coaches for this course. Students could consult with both the instructor and with the experts when working to solve a case problem.

The students in both sections were telecommunications majors, most upper division. Assignment to an experimental condition was not done by the researchers (who were also the instructors), and therefore did not use any random assignment method: however at the time of enrollment, students did not know whether they were registering for a face-to-face or virtual course. Therefore, there was no reason to expect systematic differences in the two groups. The characteristics of each group were similar as shown in Table 1 and no differences were statistically significant except for the gender ratio, but since both groups were majority male, we concluded they were similar. They were especially similar in the high mean score for perceived importance of teamwork measured at the beginning of the course.

(Table 1: Group Characteristics)

All measures were collected from students at intervals throughout the semester. A pre-test measured students' attitudes regarding teamwork, and demographic data. The

course was divided into five learning activities, each a problem-solving case on which teams collaborated to create solutions and produce reports. After each of the five activities, students filled out surveys gauging perceptions and attitudes. Finally, at the end of the experiment, students were measured post-test on a final round of attitudinal measures. In total, data were collected from students seven times.

Scales were constructed for multiple measures of team orientation, perceptions of team members and satisfaction. In this paper we report the results involving only three of the scale measures: the propensity to enjoy teamwork (*TEAMENJOY)*; perception of team members' ability (*ABILITY*); and satisfaction with the learning process, work process and work product (*SATTEAM*). The *TEAMENJOY* scale is from an unpublished work by J. Mathieu and the *ABILITY* metric was developed by Jarvenpaa, Knoll and Leidner (1998). The team satisfaction scale is self-developed. The *TEAMENJOY* measure was collected as part of the pre-test at the beginning of the semester while the other two, ability and satisfaction, were based on the last round of surveys collected at the end of the sixth instruction module. The scale items with the reliability measures are reported in Table 2.

(Table 2: Scale Measures)

Results of Experiment and Discussion: With the scales reported in the previous section, tests were run for all the hypotheses discussed earlier. The null hypothesis that there will be no difference in the perception of ability between the virtual and face-to-face environments was supported. With a mean *ABILITY* score of 5.21 (SD=1.02; n=37) for the face-to-face section and 5.32 (SD=1.26, n=28) for subjects in the virtual condition, there was no significant difference (t-stat=0.38) between the two modes of interaction. A possible confounding effect is that students may be taking into account

actual ability of their team members that they would have observed as part the team effort over the semester. Tests were run to see if the experimental condition was leading subjects to over- or under-estimate the ability of team members beyond objective measurements of ability (based on GPA scores and instructor evaluations). However, because of the limited sample size, these effects could not be accurately assessed. We have to conclude that there is no evidence that the mode of interaction leads subjects to perceive team members' ability differently.

Hypothesis Two that subjects with higher propensity to trust will be more likely to perceive their team members as having high ability, in both virtual and face-to-face environments was not supported. The Pearson correlation coefficient between propensity to enjoy interpersonal contact (*TEAMENJOY*) and perceived ability of team members (*ABILITY*) was 0.051 (p=0.692; n=63). The results were no different when the correlation was run separately for face-to-face (correl=0.109, n=36) and virtual (correl=-0.001, n=27) conditions. While contrary to our expectations, this result is not surprising because we have reported here only one aspect of the team experience, namely perception of team members' ability. Moreover, it is likely that subjects were able to separate out their propensity to enjoy interpersonal contact from their perception of their team members' ability. This is an aspect that bears further investigation.

Hypotheses three and four, based upon expectation disconfirmation were strongly supported. To estimate the effects of perceived ability of team members on satisfaction for different team orientations, a regression equation was estimated with satisfaction from team work (*SATTEAM*) as the dependent variable and propensity to enjoy team work

(*TEAMENJOY*), perceived ability (*ABILITY*), and an interaction between *TEAMENJOY* and *ABILITY* as the dependent variables. The result is given on the next page.

$$SATTEAM = -1.255 + 0.846 * TEAMENJOY + 1.185 * ABILITY - 0.126 * TEAMENJOY * ABILITY + e$$
$$[-0.66] \quad [2.08]b \quad [3.36]a \quad [-1.69]c$$

N=62; R^2= 0.471; F=17.49;.t-stats in square brackets, a: p<0.01; b: p<0.05;c:p<0.1.

These results indicate that both *TEAMENJOY* and *ABILITY*, independently as well as through their interaction, significantly affect satisfaction from team work. The signs on the coefficients indicate that the effects of team orientation as well as perceived ability are positive on satisfaction. Interpretation of the interaction term is easier if we input specific values for the dependent variables into the regression equation. For an individual with very low propensity to enjoy interpersonal contact (say *TEAMENJOY*=0), a 10% increase in perceived ability of team members will lead to a 11.8% increase in satisfaction scores. This supports Hypothesis Three. For an individual with very high propensity to enjoy interpersonal contact (say *TEAMENJOY*=7), a 10% *decrease* in perceived ability of team members will lead to a 10.6% decrease in satisfaction scores. The loss of satisfaction when the expectation of good team experiences is disconfirmed is less, but still supports Hypothesis Four.

Another approach to these results is to treat team orientation not as a continuous variable, but as a dummy variable that takes the value of zero for low propensity to enjoy interpersonal contact individuals and one for high propensity. A new variable *TEAMDUM* was defined, which takes a value of zero if *TEAMENJOY* is less than its median value (=4.3), and one if it is more. A new regression equation was estimated as follows with this new variable.

$$SATTEAM = 1.374 + 1.911 * TEAMDUM + 0.803 * ABILITY - 0.298 * TEAMDUM * ABILITY + e$$
[1.84]c [1.90]c [5.79]a [-1.60]

N=64; R^2= 0.460; F=17.31;.t-stats in square brackets, a: p<0.01;c:p<0.1

This model essentially confirms the results of the pervious regression equation, but additionally indicates that the slope of the *ABILITY* term is not be significantly different for high and low team orientation individuals. The positive and significant coefficient on the team orientation dummy indicate that individuals with high propensity to enjoy interpersonal contact consistently experience higher satisfaction for all levels of perceived ability of team members.

Finally, one of the motivations of this experiment was to investigate how satisfaction scores (and the influences on it) differed across modes of interaction (virtual vs. face-to-face). Interaction terms were defined for all the independent variables in the two regression equations above with the treatment dummy (*COND*=0 for face-to-face, =1 for virtual interaction). New regression equations were estimated with all the original variables and the new interaction variables, and a joint hypothesis was tested setting the coefficients of all the interaction variables simultaneously equal to zero. The resulting *F*-statistic was not significant at any acceptable level, indicating that there was no significant difference in the models between the virtual or F2F interaction modes. The results of this analysis are not reported here in the interests of word economy.

The findings in the experiment confirm the consensus of previous research that there is no significant difference between online and F2F interaction in terms of their impact on student satisfaction. Qualitative feedback we received from participants in the study confirms the results of the quantitative analysis. Subjects were positive about the team experience in the online and F2F settings, but the online environment seemed to

offer some additional advantages: such as avoidance of the need for scheduling meetings and keeping records of communications.

However, there are differences in the way low team orientation and high team orientation individuals interact with their team members: individuals with low propensity to enjoy interpersonal contact seem to be equally burdened online as well as F2F, though they quickly overcome this disadvantage if the quality of the team experience is positive. It has been suggested that the relative anonymity of the online environment may help individuals open up more readily in a virtual team setting, and thus further leaning goals. The results of our experiment suggested that low team orientation individuals will work under a disadvantage even online, at least in terms of the satisfaction they derive from team activities. In designing online learning environments and while adopting technology for service delivery, this aspect needs to be kept in mind.

Implications for funding online education using the E-Rate

Since its inception about five years, ago the E-Rate program has contributed substantially to narrowing the digital divide in America's schools. Almost all schools are connected to the internet today, and a substantial percentage of instructional classrooms have computers connected to the internet. A majority of schools also have high-speed connectivity through dedicated connections such as T1. Though there are still gaps in telecommunications, computer and internet access between the schools with the highest concentration of poor students and those with the lowest concentration, these gaps are being progressively narrowed.

However, we argued in this paper that the 'digital divide' is only one manifestation of a broader 'opportunity divide' that places substantially fewer resources at the disposal of the poorest school districts perpetuating a disparity in education. Though the E-Rate program has quite successfully narrowed the digital divide, the need for such programs is no less today than it was five years ago. We proposed that one way of tackling the 'opportunity divide' might be to expand the E-Rate program to include online delivery of course content and skill development material. The rising popularity of online education at both the K-12 level as well as the university level, and the potential to realize substantial economies in educational delivery indicate that online education is the way of the future.

But before we could unequivocally advocate the use of E-Rate funds in support of online education, we needed to investigate the advantages and disadvantages of online instruction versus the traditional classroom. We did this both by consulting the substantial and growing body of literature on online learning, and by conducting a quasi-experiment of our own comparing online and F2F instruction. Our personal experiences with the online component of this quasi-experiment sensitized us to both the potentialities as well as the problems of using the internet in an educational setting. These multiple perspectives confirmed our initial expectation that there may be no significant difference in the way individuals perceive online or F2F team interaction in a task-based environment. E-Rate funds could indeed be utilized in support of online educational delivery, without significantly affecting educational quality.

However, our research and experience indicated some of the problems educationists are likely to encounter as they develop and deploy online courses. Policy-

makers and school administrators will need to be cognizant of these issues as the debate an expansion of the E-Rate program.

Will online instruction be more efficient? An early promise of online education was that it will facilitate efficiencies in educational delivery by enabling more students at multiple locations to be served by the same teacher. Perhaps this promise may be fulfilled if lessons can be standardized, and feedback and assessment can be automated. However, teaching and learning is essentially an interactive, personalized endeavor. Labor efficiency in online teaching has proven elusive. Early on in the study of online learning networks, teachers reported that online teaching required more of their time than teaching in F2F settings (Harasim et al, 1995, p. 223). This was certainly borne out in our study. In the virtual condition, teams collaborated according to their own schedules and learning style preferences. This was desirable, it was a planned benefit compared to the less flexible classroom condition. However, it meant that never would two teams ask the same questions at the same time. Interaction with the teacher had to be individualized and on-demand. There was a great deal more "electronic hand-holding" as well as students seemed to need reassurance and feedback during the time they spent working on the case problems, not just at the end when they submitted work for final evaluation. The instructor in the online condition estimated that she spent more than double the time, compared to that spent by the instructor of the face-to-face course.

Though teaching this course in the online condition may have been more labor-intensive, it consumed fewer other resources overall. There was no classroom, no teaching supplies and few technology demands above what students and teachers in a face-to-face institutional setting would require. The needed infrastructure is already

available in most schools because of the past support from the E-Rate program. There were some instructional design expenses estimated at US $5,000. The virtual environment was based on a commercial product developed by Blackboard.com. However, all of the capabilities of that product could be replicated with email, simple html and free Internet chat and bulletin board software. From a policy perspective, the cost of building and maintaining classrooms greatly exceeds the costs of online education. In funding online education, policy-makers and administrators will need to be aware of both the steep learning curve and the initial labor-intensiveness of course development, as well as the potential for substantial cost-savings down the line.

How will online education change the notion of the traditional classroom? Traditional classroom instruction is based upon the role of the teacher as authority figure, coordinator, expert and evaluator. One of the opportunities in online instruction is that the traditional classroom can be expanded to wider virtual learning community, by recruiting subject experts—scientists, researchers, working professionals, community leaders etc.—to supplement the efforts of the teacher. In the quasi-experiment we conducted, the virtual teams had web-based access to a group of telecommunications industry experts who were recruited specifically as online coaches for this course. Students could consult with both the instructor and with the experts when working to solve a case problem. The online experts became full members of the learning community as alternative coaches. In many respects the experts could teach the students better than the teacher herself because of their particular expertise. In survey results, students reported high satisfaction with the experts (5.0 on a 7 point scale) and a high perceived value of having access to the experts (5.1 on a 7 point scale). Student comments were even more encouraging, “Being able to

talk to experts and work on 'real life' cases was an excellent way to learn the material," "[I liked to] be closer to industry experts and their experiences," and "[The experts online system] mimics a corporate communication setting" were typical comments. We believe the availability of experts actually served as a kind of intervention on the shy and low trust students. They may have been reluctant to ask the instructor a question but the experts, who were not in a position to judge and evaluate their ideas, provided a socially comfortable means of interacting.

Because it was not the goal of the study to test means of improving labor efficiency, only some of the teaching burden was shifted to the experts. It was successful however and so we would recommend its wider consideration because it will be a marked improvement over face-to-face courses, where students learn in relative isolation. They do not have easy, interactive access to their instructors and certainly not on-demand. With the online experts, the students had easy access to more than 20 "teachers."

What inter-institutional issues are likely to be raised by online education? In our quasi-experiment, the online group was made up of students from two universities. The research objective of this design was to see whether the traditional notion of team learning could be successful. Compared to the F2F group of single institution teams, there were no differences in learning or satisfaction outcomes. In qualitative comments, a few of the online condition students noted that it was interesting to work with students at another university where they may think or do things a bit differently. The experience of these students suggests that geographically-dispersed demand for highly specialized courses—even when the course design calls for team learning and active learning pedagogies—can be met by offering it in a virtual learning environment.

There were the inevitable differences in administrative policies and technology standards between the two universities especially because neither institution had a current inter-institutional cooperation program. However, and perhaps surprisingly, they were easy for the instructors to overcome. From the administrators' point of view, our project held the promise of a means to expand their curricula for a modest price and so the instructors got the needed cooperation. In terms of technology, the virtual environment was Web-based and so uniformly accessible to all. On the other hand, the instructors for this course had more freedom because of the universities' support of academic freedom—they were free to develop their own course content and define the learning objectives. In the K-12 situation, where courses have to conform more closely to state-mandated curricula and learning objectives, inter-institutional cooperation may present more challenges. More attention to standards issues may be warranted if online education needs to be widely deployed.

What role will individual differences between students play in receptivity to online instruction? One overview of the body of literature on the efficacy of distance education had pointed out that little attention has been paid in previous research to individual differences between students (Institute for Higher Education Policy, 1999). Our quasi-experiment was in part intended to investigate the issue of individual differences further. We found that though both low trust and high trust individuals were positively affected by the team experience in terms of their satisfaction scores, low trust individuals had lower levels of satisfaction at all levels of the team experience than their high trust counterparts. This finding was counter to the intuitive expectation that the anonymity of the online medium may encourage low trust individuals to communicate more openly

without fear of social disapproval. Low social trust individuals are already at higher risk of isolating themselves from social intercourse and the added anonymity of the online medium, lacking as it does the opportunities for interaction with classmates and teacher, may reinforce their tendency to discontinue receiving instruction. This may partly explain the higher drop-out rates that other observers have noted in distance education.

Individual differences were manifest in other ways too in our quasi-experiment. We noted that students who were more likely to contact the experts with a question were also more likely to be pro-active in other ways. In other words, the frequency of contacting the experts is a proxy measure for a kind of propensity to be socially active online. There is anecdotal evidence that some of the same students who often consulted experts were also more likely to initiate team discussions online and more likely to consult the instructor online. Those who never consulted an expert were more likely to try to solve problems in isolation and/or only joined the team process when prodded by another teammate. In case learning, as in other active learning pedagogies, the hands-on, social aspects are thought to catalyze learning. In a face-to-face classroom situation, even those low-trust or shy students loath to participate in discussions might feel social pressure to contribute. In theory, the benefit of such participation is better learning. However, in a virtual environment, a student can maintain a background position, even though it is against his/her interests, at least for learning and grades. We view this aspect of virtual learning environments as a threat to learning for this kind of student. Contrary to some of the hyperbole surrounding the active learning potential of the Internet, our e-classroom model of virtual learning seems to reveal a tendency for differences in learning

styles to become magnified, their effects exacerbating learning disadvantages that were mitigated by the face-to-face classroom experience.

The importance of 'electronic hand-holding' has already been noted to accommodate some of these individual differences in personality and learning styles. Teachers and curriculum designers may need to put in place specific mechanisms to monitor and encourage participation, and to intervene with at-risk students. Policy makers and administrators may need to put in place appropriate technology, record-keeping software, and institutional mechanisms to accommodate 'electronic hand-holding.'

In conclusion, despite the finding of no-significant difference in both the prior literature and our own quasi-experiment, our personal experiences indicate that there are many organizational, technological and pedagogical issues that need to be ironed out before a full-fledged commitment to online education can be made. But none of these issues detract from our basic argument that the mandate for the E-Rate program needs to be expanded to include online education. The 'digital divide' in American schools may be bridged in the near future, but an 'opportunity divide' still exists. The equalization of educational opportunity for all children in America is a pressing need, and only the E-Rate program among current educational technology initiatives has the financial muscle to accomplish it.

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Table 1: Characteristics of students

	F2F		Virtual	
Characteristic	Mean	Std. Dev.	Mean	Std. Dev.
GPA	2.97	.352	2.85	.463
Class standing	4.23	.777	4.36	.895
Age	21.6	1.648	22.5	3.097
Expected grade	1.4 (between A & A-)	.900	1.27 (between A & A-)	.761
Perceived importance of teamwork	5.75	1.104	5.75	1.119
% male	68.3%		80.0%	

Table 2: Scale measures

Comfort/enjoyment (7 items, alpha = .9241) (Mathieu, unpublished)
- I'm more comfortable working by myself than with others (reversed).
- If given a coice, I'd choose to work ina team rather than by myself.
- I generally prefer to work alone than with others (reversed).
- I really enjoy working in groups.
- I dread working in groups (reversed).
- I like working in groups.
- I usually get more out of a project by working alone, rather than with others (reversed).

Team Ability (5 items, alpha = .9492) (Jarvenpaa, Knoll & Leider, 1998)
- I feel very confident about team members' skills.
- Team members have much knowledge about the work that needs to be done.
- Team members are well qualified.
- Team members are very capable of performing their tasks.
- Team members seem to be successful in the activities they undertake.

Satisfaction with team (3 items, alpha = .8629) (self-developed)
"Considering the entire semester, how satisfied are you with each of the following?"
- Team's overall effort
- Process of working together as a team.
- Quality of the products produced.

Figure 1: Theoretical Model