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ABSTRACT

The Boulder Valley Internet Project (BVIP) was begun as a collaborative venture between the University of Colorado at Boulder and the Boulder Valley School District. The project's organizing aims of integrating Internet-based activities into curriculum and instruction have not been met fully due to the inhibiting characteristics of education reform and the slow pace of connecting 53 schools in the district, a paucity of incentives such as extra pay for teachers, and staff cuts. This study describes the complex system that evolved. Several issues are addressed: (1) the effectiveness of the training component of the project; (2) how the project specifically affected the participants use of technology; (3) the impact of the project on curriculum and instruction; (4) the impact on the school as a whole and the district as a whole; and (5) the possible future uses of this model. The BVIP was found to be a dynamic, evolving program housed within a decentralized educational organization. While change has been slow due to the number of schools involved, a solid base of expertise is being built. (Contains 11 references.) (JLS)

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The Boulder Valley Internet Project: Teachers Mentoring Teachers

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The Boulder Valley Internet Project: Teachers Mentoring Teachers

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Overview

The Boulder Valley Internet Project (BVIP) was a collaborative venture between the University of Colorado at Boulder and the Boulder Valley School District (BVSD), and was funded by the National Science Foundation. The premise of this five-year initiative was that the Internet and the World Wide Web (WWW) could provide a rich variety of tools and resources that could be used to enhance instruction and communication by students, teachers, and administrators. Both the project and the evaluation design evolved significantly as connectivity increased throughout the district, Internet tools became more user-friendly, teachers and students alike acquired Internet knowledge and skills, and telecommunications began to garner popular support. In 1991, however, when the project designers first created their expansive vision for the BVIP, little was known about effective integration of the Internet into a school district—especially a decentralized district like the BVSD that used site-based management for its decision making policies.

The initial efforts of the project directors was to develop a plan that included the development and delivery of comprehensive district-wide Internet training over a three-year period beginning in July 1992. Secondary efforts centered around determining the impact of telecommunications on curriculum and instruction within those schools that were connected to the Internet and whose educators had participated in the training program. The project leaders also envisioned a foundation for shared curriculum implementations that could be used by educators throughout the district.

The *Trainer of Trainers* model was used to create a core group of 26 teachers who then returned to their respective schools to become instructors and resource personnel for their colleagues. The objectives of the training program for this core group, and for later generations of participating teachers, to become proficient in the use of electronic mail (e-mail), to become comfortable investigating Internet resources, and to become experienced at exploring ways to integrate the use of the Internet into the curriculum. The project directors developed a full set of structured classes, unstructured “open lab” workshops, and ancillary materials to support the training program. They elicited feedback from new trainees to continually redesign and improve the training program as the technology evolved. Later, they created a home page on the WWW to access, share, and disseminate information that would be of use to educators throughout the district, and to render

assistance to new users.

Rather than being an isolated effort funded by a single grant, the project was part of a system-wide effort that both impacts and is impacted by the numerous factors in the educational system. As both the project and the Internet itself evolved, so did the model that was used to gather and report data from the evaluation. Teachers moved through various phases of growth, starting from exploration and professional development, through communication and generation of on-line learning communities, to eventual use of Internet activities in the classroom.

Although the grant period has ended, the BVIP is continuing at a rapid pace. The hopes of the project organizers for integration of Internet-based activities into curriculum and instruction have not been fully met due to the inhibiting characteristics of significant educational reform itself, as well as the slow pace of connecting all 53 of the district's schools, paucity of incentives such as release time or extra pay for teachers who have taken on new duties as a result of their Internet expertise, and ongoing cutbacks in FTE and technical support at the building level. Instead of simply being viewed as a teaching tool, the use of the Internet becomes entwined within program development, a much more complex undertaking. This study describes the complex system that has developed from the initial efforts of the BVIP, and is continuing to evolve.

Purpose and Scope of Study

The team from RMC Research Corporation that had been tasked with evaluating the BVIP took a case study approach that was inductive, pragmatic, and highly concrete. They started by building a sound theoretical base, using the *Diffusion of Innovations* model of Everett Rogers (1995), the *Adoption Analysis Tool* of Farquhar and Surry (1994), and the *Engaged Learning* model of Jones and his colleagues (1995). The literature review and development of the model are reported in a separate paper (Sherry, 1997). The scope of the evaluation began as a global inquiry using a survey and interviews, then shifted to a detailed examination with an embedded case study, various artifacts, and a set of focus groups.

In 1993, after the completion of the first year of the project, Wolf and Black (1993) of the University of Colorado conducted a formative evaluation using a survey and interviews. The data suggested that the initial cohort of 26 peer trainers had been successfully trained. They felt they were more knowledgeable about the use of the Internet as a resource for teaching and learning, and they were beginning to apply their skills and knowledge in their own classrooms. Wolf and Black also identified five barriers that directly impacted teachers' use of the Internet, and that have continued to affect the

level of Internet usage throughout the entire duration of the project: time, access, training, resources, and usability. These results were in consonance with other studies of school districts that were building telecommunications infrastructures to connect their schools (Honey & Henriquez, 1993; Heaviside et al, 1995; Levin, 1995).

In 1994, RMC Research Corporation was engaged to expand upon this formative evaluation. They started by examining the training component to ascertain its value, both in terms of whether the training accomplished the short-term goals of being clear, useful, and engaging, and to determine whether or not the teachers were actually using their newly acquired skills in their classrooms. The team also investigated the influence of the project on the development of new curriculum and teaching strategies and the benefits of participation for the entire school district. Toward the end of 1996, they evaluated the BVIP as a whole to determine whether it may be easily replicable or transportable to other districts, and how it may be improved.

An Integrated Technology Adoption and Diffusion Model emerged from the BVIP evaluation that comprises not only the technological and organizational factors found by Wolf and Black, but also individual and instructional factors that were revealed in the research of Rogers, Farquhar and Surry, and Jones et al. It is somewhat similar to the model recently developed by Lewis and Romiszowski (1996). RMC Research Corporation's integrated model melds three approaches by which one can view the barriers to technological innovations and the factors that either enhance or inhibit the change process by the adopting educational organization. One may view technology adoption from the perspective of access, cost, type and age of available computers and hardware, and the physical aspects of the school network, reliability, and user interface. One may consider the viewpoint of the user, encompassing both user characteristics and the users' perceptions of the innovation. Or, one may focus on the complex needs of the educational institution itself—a school or district situated within a community, which, in turn, is situated within a set of policy-making bodies and the local culture as a whole.

After compiling and reviewing the research on the four strands of variables that impact the adoption and diffusion of a new information technology innovation, and after collecting the initial data via surveys and interviews, the team created a model that targeted the most important variables and applied it to the BVIP. As the data collection proceeded, and as the information was coded and sorted, the model was expanded. Figure 1 presents a summary of all of the factors that influenced the adoption and diffusion of the BVIP throughout the BVSD.

Technological Factors	
Access, reliability, usability, network response time	
Individual Factors	
<i>User characteristics:</i> motivation, need for control, expertise, comfort level, reasons and patterns of use, gender, special needs	<i>Perceived attributes of the innovation:</i> relative advantage, observable benefits, complexity, compatibility with needs and wants, capacity for experimentation on a limited basis
Organizational Factors	
<i>Physical environment:</i> classroom connectivity, network capacity, availability of equipment and supplies, scheduling of labs and computers	<i>Support environment:</i> administrative vision and support, district policies, communication, problem-solving mechanisms, training, availability of support, maintenance, incentives, cooperation with other funding sources
Instructional Factors	
<i>Curriculum:</i> change in content, volume of content, curriculum enhancement, planning and preparation, standards, use and sharing of lesson plans, evaluation and categorization of Internet activities	<i>Engaged learning:</i> teacher and student roles, collaboration, learning context, generative learning, authentic tasks, multidisciplinary studies, authentic assessment

Figure 1. Integrated Technology Adoption and Diffusion Model

Study Methods and Data Sources

Because the purpose of the study was to build an expanded theory base as well as to provide formative and summative evaluation information to the funding agency, the evaluation was conducted as a case study. According to Yin (1994), case studies are generalizable to theoretical propositions, and not to populations or universes. The applicability of the BVIP model to other school districts will depend in large part upon the district's administrative vision and support, and upon the structure of the decision making process, whether site-based or centralized.

Setting

The BVSD is a large, dispersed, partially mountainous district comprising 53 elementary, middle, and high schools, and is situated to the northwest of Denver. The City of Boulder is home to the University of Colorado.

An embedded case study was conducted at Nederland Elementary School, an isolated, rural K-5 school situated in a small mountain town within the BVSD. It is a high-end user school that made good use of the Internet to expand the learning environment beyond the walls of the classrooms and beyond the small community of which it is a part. It is also one of the few schools in the district with schoolwide connectivity.

The evaluation team focused on this school because it provided an opportunity to gather data from teachers and technology resource people who were actually using the Internet as an integral part of teaching and learning. Though connectivity was available to students in all grades, the primary use was by the fourth and fifth graders. Hence, the data do not represent a random sampling across all grades; they reflect the ideas and activities of the teachers and students who were high-end users.

Evaluation Design

After reviewing the relevant research literature and discussing the project with the BVIP project director, five research questions were formulated that underlie the investigations carried out in this case study. Figure 2 summarizes the five research questions and the data collection activities.

Research Questions	District-wide e-mail survey	In-depth inter-views	Focus Groups	Work Group	Embedded Case Study	Documentation Analysis
How effective was the training component of the project?	x	x				
How did the project specifically affect the participants' use of the technology?	x	x			x	x
What was the impact of the project on curriculum and instruction?	x	x	x	x	x	
What was the impact of the project on the school? the district?	x	x			x	x
What are the possible future uses of this model?	x	x	x	x	x	

Figure 2. Data Collection Strategy Matrix

Because the BVSD was a complex system, multiple measures were used to produce converging lines of inquiry. This approach involved both qualitative and quantitative methods, as seen in Figure 2. Throughout the study, strict confidentiality was observed. Quotations gathered from transcripts were coded and then checked by a second team member for inter-rater reliability.

Initial information on the effectiveness of the training component was gathered from a district-wide e-mail survey. The quantitative data were supplemented and enriched by the follow-up interview of teachers who were using the Internet in their classrooms. The documentation analysis involved examining the BVSD system logs, previous project documents and evaluations, newspaper articles, white papers, and other artifacts. More detailed data were obtained through the embedded case study and the curriculum focus group. The Internet activity classification project generated by the work group will be used to assist BVSD teachers in classifying instructional activities and units that use the Internet effectively.

Results

The *Integrated Technology Adoption and Diffusion Model* proved effective for collecting, organizing, and reporting the findings from all phases of the evaluation. The information that was gathered was then used to answer the five research questions. If this model is to be used for creating technology plans for other districts, some restructuring of the instructional and organizational factors may be required.

Research Question 1. How effective was the training component of the project?

Overall, the BVIP was successful in meeting the goals of its training component, namely, to develop and deliver comprehensive district-wide teacher training in the use of the Internet and the BVSD network for educational purposes. The project leaders are still studying the impact of the project on curriculum and instruction. The establishment of a foundation for shared curriculum applications is yet to be achieved, but project participants have made good progress in this direction with the creation of the BVSD home page, several school home pages, and various curriculum implementation strategies that they have shared with their colleagues.

The *Trainer of Trainers* model was an effective strategy in disseminating Internet training throughout the district. It has also been used successfully in similar projects. (See Main, 1996.) Starting with a cohort of 26 teachers, the project team significantly expanded the level of telecommunications expertise and usage throughout the district. As of January 1996, there were 435 regular e-mail users on the BVSD network. The training program's focus on peer training of classroom teachers, and the flexibility of the training in keeping up with the rapid changes in communications technology, were particularly effective strategies.

The barriers encountered by participants were primarily organizational in nature, such as insufficient staff development time, delays between training and access at the school level, and cuts in district funding in a variety of areas. More importantly, since the training was aimed at typical classroom teachers rather than administrators and policy makers, expertise was diffused horizontally at the grassroots level, rather than percolating upwards toward all levels of the educational system.

Research Question 2. How did the project specifically affect the participants' use of the technology?

The most significant influence on the participants' use of technology was the increase in communication with colleagues, experts, and friends within the building, within the district, or outside the district. Originally, the Internet

was envisioned as a tool for communication; over the course of the project, both the communication and the research aspects achieved equal importance. Using e-mail for communication and accessing the WWW for both teacher- and student-initiated research were the most popular uses of the Internet. Teachers who became proficient in Internet use accessed many educational resources that supported their professional growth. Students, too, became proficient at using e-mail to contact their friends, students at other schools, or experts in subject areas that they were researching.

Teachers recognized that telecommunications is a potentially useful tool for all students and staff. Creative solutions by several innovative teachers who used the WWW for special populations showed great potential to avoid inequities. One interesting example discussed in the focus group concerned a young student with attention deficit disorder who became fascinated with Sea World's on-line resources on manatees. As a result of working with these resources in class, he became more calm, settled, and concentrated as the semester progressed.

Barriers to the use of technology included an increased work load for some new trainees, lack of observable benefits for the additional training involved, and declining morale because of the district funding cuts and the reassignment of in-building technology resource personnel to the classroom.

Research Question 3. What was the impact of the project on curriculum and instruction?

The impact of the project on teaching and learning was strongest when the classrooms had direct access to the Internet and when the teachers' instructional style matched their uses of the Internet. The focus of the curriculum shifted from developing technology skills to enriching instructional content.

Teachers' need for control influenced the ways in which they used the Internet for instructional purposes. Loss of control was due in part to the open framework of the Internet, and in part to the rapid gain in expertise by the students, which sometimes resulted in a novice/expert role reversal between students and teachers. Some teachers were also concerned about if and what subject content would be replaced by Internet-based activities.

Teachers who saw themselves as facilitators were more able to adapt to their role as guide, coach, co-explorer, and co-learner with their students than those with a more traditional pedagogy. Teachers who were able to tap the expertise of their students and use them as assistants in class projects found that their workload was decreased by shifting some of the responsibility of finding suitable resources to their students and using their students as an informal support network. Those who regularly used the Internet for class-related

purposes had a variety of strategies that they used to plan and prepare for their classes, including finding curriculum-related resources in databases on the WWW, participating in mailing lists with colleagues and experts who shared their interests, and sharing information and activities with other teachers and associates throughout the district.

The volume of content on the Internet continues to pose a problem for teachers who need quick and ready access to relevant instructional materials. Teachers who participated in the summer work group designed a classification scheme for organizing Internet resources and relating their content to the curriculum. This classification could be used by the BVIP to develop a foundation for curriculum applications. This will become increasingly important with the current shift by the school board to the adoption of district-wide standards and assessments.

4. What was the impact on the school as a whole? the district as a whole?

Regarding the impact of the project on a whole school, the embedded case study of a rural mountain elementary school revealed a wide range of expertise among the staff. Some teachers had a high level of expertise, whereas the support staff hardly used the network at all. Students and teachers with home access used the Internet more at school than those who lacked home access.

Age had little effect on expertise. Some young students were quite adept at 'Net searching, communication, designing and building home pages, and exploring the Internet for their class projects, whereas some teachers felt intimidated by the Internet and hardly used it at all.

Gender impacted both the amount and type of use, with boys using the Internet more for exploring and girls using it more for communication. Both boys and girls, however, used the WWW regularly for research projects. Some generated their own HTML code for building Web pages and were able to demonstrate their skills to the evaluation team. In particular, a multi-age science class comprised of students from Nederland's elementary and middle school collaborated with Jason Project researchers to create a home page for their class and several products for the Denver Natural History Museum, all focusing on oceanography.

Growth in the use of the Internet throughout the district as a whole was promoted by the students' enthusiasm. As one teacher remarked, the students are pushing the technology. Over the course of this study, however, growth was hampered by the limited connectivity. January 1997 was the target date for full district-wide connectivity. However, classroom connections will be deployed slowly as individual schools raise funds to build their own local area networks.

Two diffusion models were originally proposed but were not implemented. One was a *vertical model* in which middle school students were to mentor elementary school students, and high school students were to mentor middle school students. The vertical model was not used because the middle schools had Internet connections from the beginning of the project, but the elementary and high schools did not get their Internet connections until much later. The other, a *horizontal model* connecting three middle schools, was not pursued because, at the time, it was decided that this innovation entailed changes in curriculum. With the incorporation of standards and the ensuing curriculum revisions that were taking place, this was simply not possible.

Diffusion of telecommunications throughout the district was successful at the grassroots level because of the empathy between the cadre of peer trainers and their teacher-trainees. Besides the lack of incentives in the way of release time and a lightened workload for teachers who provide inservice training or support for their colleagues, another major barrier to the effective use of the Internet throughout the district is the lack of an on-line, centralized bank of activities and resources, grouped by grade level and content, that are directly related to the district's current and planned curriculum.

Research Question 5. What are the possible future uses of this model?

To answer this question we must focus on the actual successes of the BVIP. First, it was a grassroots effort that successfully diffused horizontally among those classroom teachers who participated in the training sessions. Second, the *Trainer of Trainers* model worked very well because it capitalized on the empathy between change agents and clients. Third, the project itself was successful at first because it had initial buy-in by the superintendent and the school board—the main policy making bodies. It was only after the superintendent and school board were replaced by more conservative individuals that the district support began to falter. And fourth, the project worked successfully with other grants and sources of support such as the Annenberg/CPB Math and Science Project, the district bond funding, and the University of Colorado.

The BVIP proved to be a dynamic, evolving program housed within a decentralized educational organization. The reality of the BVIP was quite different from the theory base of the Rogers *Diffusion of Innovations* model. Change has been slow due to the gradual process of connecting all 53 schools within the district, but it continues due to the solid base of expertise that has been built throughout the project's five year effort. Future plans for the project include access at all schools and greater attention to curriculum content and instructional strategies.

Equity issues, too, were important. The levels of Internet use, comfort, and expertise acquired by those who had home access were generally greater than among those who did not have home computers. Equity is not limited to the BVIP alone, but is an issue that must be dealt with by any district that intends to use Internet-based activities as part of the curriculum.

Other districts that are considering replicating the BVIP efforts should consider their own style of management and decision making processes when designing approaches to the adoption and diffusion of Internet-based classroom activities.

Conclusions and Recommendations for Further Research

Besides providing ongoing information to the district and the project leaders, as well as feedback at the end of the project concerning its degree of success in meeting its objectives, the evaluation produced an expanded theory base and an *Integrated Technology Adoption and Diffusion Model* that can be used for other districts that plan to adopt the use of the Internet in their schools. For this model to be effective as a planning tool, rather than strictly as an evaluation tool, however, some changes must be made in the model. Specifically, it is important to concentrate on the interaction of the teachers' pedagogical styles with learning objectives and the value that can be added to the instructional process through the use of Internet-based activities, and design a staff development plan that addresses the needs of the teachers in the target district.

Moreover, it would be advisable for any planned staff development program to address administrators and policy makers as well as classroom teachers. Since the use of the Internet becomes an integral part of program improvement, it is important for those who are in charge of setting and carrying out district policies - including the school board, the superintendent, parent-teacher organizations, school principals, and school administrators - to be involved in both supporting and participating in the training activities, so that they can create, sustain, and communicate a clear administrative vision throughout the entire educational system.

Student success stories have been instrumental in promoting the use of the Internet within those schools that are already connected, via student-produced home pages. It is important to have policies in place that allow students to use the Internet during their free time, before or after school, especially if they do not have access at home.

It is also important to have policies that encourage schools and classes to place their home pages on a centralized location, that offer support to new users, that steer them to the right people and resources when they encounter

problems with the network, and that provide ongoing maintenance for the system, not only at the district level, but at the local building level as well. In schools where principals and technology resource people provided vision and support for technology, the use of technology flourished.

Although teachers are aware of the many possibilities that the Internet offers for enhancing teaching and learning in the classroom, many need further guidance in strategies for integrating telecommunications into their curriculum and instruction. There are three important areas that need further exploration:

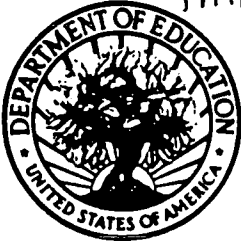
- How can or will teachers use the new technologies?
- How can or will the new technologies fit in with teachers' current teaching styles?
- What value can technology add to the teaching and learning process?

Future research efforts will be devoted to answering these questions and reformulating the *Integrated Technology Adoption and Diffusion Model* into a form suitable for a district technology implementation plan.

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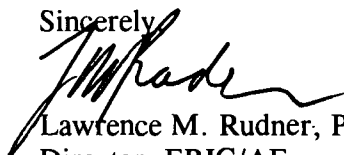
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