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ABSTRACT

Over the past 5 years parents, industry leaders, and policy makers have called repeatedly for the improvement of mathematics and science education in urban schools and for measures to insure that all students are "technologically literate." Various efforts at the national, state, and local levels have emerged in response to these calls, with projects ranging from software development to teacher training and from student skill development to business, school, and university partnerships. This report is a description of a collaborative project. One of the primary goals of the report is to share the experience of this project in a manner that will both guide and inform colleagues. The report has been organized along the four themes of the project: (1) the use of new technologies for mathematics, science, and computing education; (2) student motivation and achievement training; (3) school leadership and team building: and (4) building a collaborative process to facilitate school improvement. Each section provides a detailed account of the entire process, from conceptualization to implementation. A brief history of the collaborating institutions, and an overview of the project's goals and objectives precede the discussion of the four major themes of this project. (CW)

A MODEL PROGRAM IN SCIENCE, MATHEMATICS, AND TECHNOLOGY

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FINAL REPORT

OCTOBER 1987

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Massachusetts Pre-Engineering Program for Minority Students

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INTRODUCTION

Over the past five years parents, industry leaders, and policy makers have called repeatedly for the improvement of math and science education in urban schools and for measures to insure that all students are "technologically literate." Various efforts at the national, state, and local levels have emerged in response to these calls, with projects ranging from software development to teacher training and from student skill development to business, school and university partnerships.

In February of 1986, three institutions which have been engaged in such projects in urban schools sought funding from the Massachusetts Board of Regents of Higher Education for a collaborative science, mathematics, and technology project. These three institutions, the Massachusetts Pre-Engineering Program (MassPEP), the Educational Technology Center (ETC), and the Jeremiah E. Burke High School (Burke), hoped to catalyze and build upon their existing resources to develop a model program at Burke, that could be used in other high schools as well ETC had identified and developed a series of research based programs for teaching mathematics, science and computing in schools. MassPEP had designed an intensive training program to help minority students and their teachers achieve academic success. The Burke had created an atmosphere supportive of learning and equipped with extensive computer facilities. These various resources were to be consolidated and extended to create an exemplary program in one school that might provide information for other schools that wished to follow suit.

This report is a description of that collaborative project. One of the primary goals of this report is to share the experience of this project in a manner that will both guide and inform our colleagues. The report has been organized along the four themes of the project: (1) The use of new technologies for mathematics, science and computing education. (2) student motivation and achievement training, (3) school leadership and team building, and (4) building a collaborative process to facilitate school improvement. Each section provides a detailed account of the entire process, from conceptualization to implementation. A brief history of the collaborating institutions, and an overview of the project's goals and objectives precede the discussion of the four major themes of this project

INSTITUTIONAL HISTORY

The Burke

The Burke is a comprehensive community district high school which is embarking on a new magnet program in computer technology. Located in Dorchester, the Burke in 1986, served approximately 650 students of whom 76 percent were Black, 11 percent were Hispanic, 8 percent were White, and the remaining 5 percent were either Asian or classified as other.

Until the mid 1950s, Burke was an all-girls school serving a largely Jewish and Italian community and preparing young women to concentrate in business education and home economics. By the early 1960s the influx of Black and Hispanic families had changed the demographics of the neighborhood In 1972 the Burke became a coed high school, and its curricular focus changed from business education to vocational education

With the advent of desegregation in the early 1970s and other socio-economic occurrences that had already taken place in the community of Dorchester, the school changed significantly. The tremendous tumult resulting from desegregation led the school system's management to focus attention and allocation of resources on those quarters of the system experiencing the greatest amount of unrest. The Burke, however, was relatively quiet during this period. It did not experience the extent of racial turmoil that troubled other Boston high schools in part because its racial balance was so disproportionate that virtually no white students were enrolled Consequently, the Burke did not receive the attention and examination that might have resulted in the school having more of its needs met. In response to the years of neglect suffered by the Burke, the judge who presided over the Boston desegregation case ordered that the Burke receive funds for renovation of the school's physical plant.

After the opening of the city-wide Occupational Resource Center, the Burke lost all of its vocational education programs, staff, and equipment to a new site miles from the school In addition, the Burke had gained the unfortunate reputation of being a "troublesome" high school because it lacked a well defined and enforceable discipline program, stability in staffing, and strong administrative leadership -- during the two year period between 1979 and 1981 three principals had been removed from the Burke.

In September 1982, Albert Holland, was appointed principal. He and his administrative team began working with teachers and students to establish clear rules, communicate those rules to parents, and make sure teachers, students, and administrators all adhered to them. Over the past six years, the administrative team has built a positive educational environment which has increased teacher morale, increased students' expectations, and improved the public image of the Burke.

Support for the Burke by both its business and university partner have also played a significant part in the growth of the school over the past four years New England Mutual Life Insurance Company has provided job opportunities for Burke students, technical assistance in the development of new curriculum, financial resources, and renovations to the library and the new Electronic Office complex

The Burke's university partner, the University of Massachusetts/Boston, has provided continued support in curriculum development, technical assistance in the development of the computer magnet program, and course offerings to Burke students.

During the past three years the administrative team has invited several special projects into the school, designed to improve curriculum and provide teachers with training, material, and support Part of this effort has included creating a computer magnet program at the Burke

The computer magnet program was designed to integrate the use of the computer and other information technologies throughout the curriculum and to teach students the skills of computer operations needed for work-related purposes. In addition, the establishment of a computer magnet program was intended to help the Burke respond to decreasing enrollments partially attributable to the student placement practice in Boston. Students in Boston are divided among three tiers of schools: the exam schools take the "cream of the crop," schools with magnet programs attract students from throughout the city interested in their special offerings, and the rest of the students attend "district high schools." The latter serve mostly students who are "geocoded" on the basis of their residence, primarily from the school's neighborhood. These district schools are vulnerable in a system like Boston's where enrollments are declining and closing schools is a prime strategy for reducing the budget. Schools with a magnet programs can avoid this fate since they are eligible to recruit students citywide. The Burke would use this advantage to supplement rather than supplant its current student population.

In developing the computer program the Burke acquired hardware from the Boston School Department and from its business partner New England Life. Through its partnership with University of Massachusetts, the school acquired consultation on the educational use of computers. This included the development of a special tutoring program designed for Burke students.

The opportunity to forge a new collaborative effort with ETC and MassPEP was seen both as a means to strengthen the quality of the Burke's computer program and as a way to enhance the work being done by ETC through broadening its research population to include inner-city schools

Educational Technology Center

The Educational Technology Center (ETC) was established in 1983, to study ways of using new technologies to improve education in science, mathematics, and computing at the elementary and secondary levels. Based at Harvard University ETC was formed as a consortium including four public school systems, educational research and development firms, and media production organizations. This structure reflected and supported a commitment to collaborative research. From its inception ETC involved subject matter specialists, learning theorists, experienced school teachers, curriculum and materials specialists, and software experts

Their combined expertise was brought together in research groups that focused on topics in the traditional science and mathematics curricula that were especially hard to teach and hard to learn, yet central to their respective disciplines. ETC collaborative research groups identified approximately one dozen such "targets of difficulty" and proceeded to: (1) clarify the important concepts and ways of reasoning at the core of these topics, (2) study the difficulties students encounter in coming to understand these concepts and master these skills, and (3) design powerful teaching strategies that use computers as well as traditional materials to promote understanding and mastery The active participation of school people in every phase of ETC research helped make the Center's research results applicable to classroom practice

By early 1986, several ETC research projects had identified and developed software and courseware for experimental teaching units. Three of them had conducted teaching experiments which demonstrated positive effects on student learning, and reasonable ways of incorporating the units into regular school settings. One project used software called the *Geometric Supposer* to incorporate inductive reasoning into the traditional geometry course; a second used Microcomputer-Based Laboratory equipment to help students conduct and analyze experiments about heat and temperature; the third incorporated a series of lessons into an introductory computer programming course that helped students acquire important concepts and strategies that are often not well learned.

Each of these innovations illustrated an approach to teaching that might be called guided inquiry. In this approach, the computer is used not as a replacement for the teacher, but as a tool to enable teachers and students to gather and analyze data and investigate problems. The teacher's role in this approach is to present problems, to guide students as they investigate these problems, and then to help students synthesize their findings in terms of the teacher's curriculum goals. This approach reflects a belief that students learn more content and learn about how to reason and solve problems if the traditional instruction is interwoven with opportunities for structured inquiry.

ETC welcomed the opportunity to work with the Burke in order to learn whether and how ETC-developed approaches could be made useful in an inner city high school serving primarily minority students and coping with the organizational structures of a large bureaucratic school department.

MassPEP

MassPEP is a private educational organization which prepares and motivates minority youth for careers in engineering, science, mathematics and computer technology. The organization, which has been operating in the Boston area since 1979, has the dual purpose of fostering both technical achievement and personal development in minority students. MassPEP has established several programs in order to achieve these goals. Each summer MassPEP conducts a program for highly motivated students seeking to prepare them for future technical careers. The program emphasizes academic achievement, personal development and applications of technology. Also, during the summer, MassPEP runs a technical internship program which provides students with job opportunities in technical work environments

During the regular school year, MassPEP supplements the school experience through after-school programs or through the Saturday Science Laboratory. These programs attempt to instill in students a personal standard of excellence that will give them the pride, confidence, and preparation to succeed in the lives and careers they choose Although MassPEP had not worked in the Burke, prior to its participation in this collaborative project, it had run similar programs in other

Boston area schools. MassPEP also had a longstanding interest in developing ways that MassPEP and ETC could work together.

Funding The Collaborative

In late fall of 1985, a Request for Proposals (RFP) issued by the Massachusetts Board of Regents, provided an opportunity to open the Burke/ETC/MassPEP conversation. The RFP called for school/university collaboration in establishing model programs to serve several purposes. Overall the RFP sought to create ways of increasing opportunities for minority students to use computers in preparing for work and further study in technical areas, and to provide training and assistance to their teachers.

ETC administrators regarded the RFP as a way of funding the Center's assistance to the Burke in developing its magnet program. The RFP called for several kinds of training and assistance that coincided with the Center's expertise and that would help Burke develop at least a portion of their Computer Magnet Program. The RFP attention to minority students also made collaboration with MassPEP appropriate.

Through a series of conversations. and critiques of drafts, the three organizations developed plans to create "A Model Program in Mathematics, Science, and Technology" at the Burke. The objectives of the collaborative project centered around bringing these three institutions together in a manner that would make synergistic use of their respective skills and resources, in order to:

(1) Introduce innovative tools and new technologies in the teaching of mathematics, science, and computing.

(2) Identify personal and technical resources within the Burke that can be brought to bear on the goals of the Burke.

(3) Overcome the personal and institutional barriers to building a climate of success in mathematics, science, and computing education at the Burke

(4) Develop an "atmosphere of personal and academic success" among students

(5) Document the process involved in building a collaborative program between an urban school, a university, and a private organization.

To accomplish these ends, the project would carry out two related sets of activities: (1) training and support for students and teachers by MassPEP to build positive attitudes and achievement skills that are a prerequisite for academic success, and (2) training, materials, and support through the Educational Technology Center to help teachers integrate new technologies and innovative approaches in mathematics, science, and computing courses. In addition, participants made a conscious attempt to reflect on the collaborative process between a public school, a university, and a private organization.

Announcement of awards was due from the Board of Regents by May 1986, which would leave time to recruit and train teachers before school started in the fall. Meanwhile, ETC made plans to establish laboratory sites in several secondary schools where ETC-developed innovations could be implemented and studied during the 1986-87 school year Plans for the Laboratory Site Project were developed in the Spring of 1986 and focused on high schools in ETC's consortium member school districts (public schools of Cambridge, Newton, Ware, and Watertown). Given the similarity between the lab site project and ETC's portion of the Regent's proposal (indeed the Lab Site Project grew out of the plans made for the Regent's proposal), and given uncertainty about the Regents funding, ETC included Burke in its lab site preparations In this way ETC could use federal money to provide its proposed services to the Burke as part of an action research project.

As events unfolded, the lab sites project was funded to begin during the summer before school opened in September 1986. The Board of Regents grant was not awarded until late October 1986 and then at half the level originally requested. (with actual funds arriving late November). Thus with its earlier start-up date, the Lab Site Project got underway before the Collaborative Project was funded.

HELPING TEACHERS TEACH MATHEMATICS, SCIENCE, AND COMPUTING

ETC ' gan working with the Burke High School in May 1986, through its federally-funded laboratory sites project (five months before the Board of Regents grant was finally awarded). The laboratory sites project was designed to support and study the implementation of technology-based approaches to teaching mathematics, science, and computing. Each of the innovations, described more fully below, focused on particular subject matter in the regular curriculum and attempted to help students learn this subject matter by gathering data and solving problems. Preliminary teaching experiments, conducted in carefully controlled settings, indicated that the three approaches helped students learn difficult concepts.

The major goal of the project, in keeping with ETC's mandate as a research center, was to learn what kinds of resources and support were necessary to help regular teachers carry out these innovations in normal classroom settings. Clearly, in order to conduct this research, ETC must provide the training and support thought necessary for implementing these approaches. Accordingly, the project was designed to provide the kinds of resources which prior research and experience had shown help teachers carry out new approaches. These included: (1) hardware, software, and teaching materials, (2) initial training followed by regular consultation at school by an experienced advisor, (3) periodic meetings with the developers and teachers from other lab sites involved in the same innovation, and (4) regular access to assistance from advisors and collegial exchange via an electronic conferencing system. Research shows that administrative support is also a key facilitator of classroom innovation. Consequently, the Burke Assistant Principal was asked to serve as a liaison for the project, coordinating communication between the lab site project staff and the participating teachers at the Burke.

To introduce the lab site project to Burke faculty, the assistant principal circulated a description of the project and showed them a videotape, produced by ETC, of alternative approaches to teaching with technology. She focused on teachers who taught appropriate subject matter (i.e., beginning programming in BASIC, geometry, and chemistry or physics) and who were interested in teaching with technolgy. In such a small school, only three teachers met these criteria. Indeed, one of them, the mathematics teacher, was not scheduled to teach geometry. His duties as chairman of the science and mathematics department and computer literacy teacher had filled his schedule for the coming year. The assistant principal urged him to consider participating in the laboratory site project, saying that she would help make any necessary rearrangements in his schedule, because she thought the project would bring valuable resources to the school

All three teachers accompanied the assistant principal to a one-day Introductory Conference sponsored by ETC at the end of June. This conference was designed to introduce lab site teachers and the key administrators in their schools, to the project. It included presentations on the rationale behind each of the innovations and an overview of the project's purposes and activities. Afternoon sessions brought people together with their counterparts from other schools for more focused training on each of the innovations.

A description of the implementation of each of the three innovations at the Burke High School sets the stage for analyzing several general issues surrounding the introduction of technology based teaching approaches in urban schools.

Geometry Innovation

The geometry innovation employed microcomputers equipped with a piece of software called the *Geometric Supposer*, which is supplied on three floppy disks. The *Geometric Supposer* software allows the user to make geometric constructions of the sort created with a compass and straight edge. It also provides a facility to measure angles and line segments and to perform arithmetic operations on these numerical data. The software remembers constructions as a procedure and allows the user to repeat the construction on another geometric figure of the same sort, either a random figure or one specified by the user. Thus the software enables students and teachers to gather geometric data, observe patterns in visual and numerical data, and test conjectures about relationships.

In the approach developed at ETC, the *Supposer* is used to teach geometry quite differently from the way it is usually taught in schools. The standard high school geometry curriculum is organized around teaching students to prove the theorums of Euclidean geometry Teachers rely heavily on a text book to teach students about definitions and conventions for geometric figures. Then students are taught to begin with axioms about geometric relationships and apply deductive logic and algebra to arrive at formal proofs. Many students have difficulty learning how to apply this deductive approach, and even fewer come to appreciate the reason for proof or its relationship to the way mathematics is built.

The approach developed at ETC uses the *Geometric Supposer* software to integrate inductive reasoning into a full-year geometry course. In this approach the teacher guides students through a process of gathering and making conjectures about geometry, ultimately leading them to the need for proof as a way of formalizing convincing arguments about their data. Students work on problems, usually in pairs, using the *Supposer* at computers set up in a laboratory setting. As they work at the computer their explorations are guided by the problem itself, by the structure of the software, and by the teacher. The teacher then leads class discussions to help students synthesize their findings with the teacher's agenda of postulates, theorums, and formal proofs set by the standard geometry curriculum. This approach can be interspersed with traditional geometry lessons so that inductive and deductive approaches become coherently related in the students' minds. Most laboratory site teachers taught *Supposer*-based lessons episodically throughout their year-long course so that the innovation influenced 25-75 percent of the class periods.

Beginning Impressions

The chairman of the math and science department at the Burke was initially interested in the lab site project because it promised to help teachers integrate computers into their teaching. He sees this as a high priority:

> I'm behind anything that will get more faculty into the computer rooms....Everybody's got their main emphasis and ours at the Burke is going to have to be something to draw the kids. I'd like to see the computers do it. If we don't, then I think we'll have problems surviving.

Despite his enthusiasm, this teacher had grave doubts about the applicability of the ETC's inductive teaching approach for Burke. His concerns focused on two basic worries: 1) he felt his main responsibility was to teach students what they needed to know for the system-wide Criterion Referenced Tests (CRTs) based on the Boston Public Schools required geometry curriculum, and 2) he thought this year's geometry students at the Burke were not ready for a teaching approach requiring them to make conjectures about data they collected.

When all seven lab site geometry teachers met in August to plan their classroom activities, this teacher stressed that his situation seemed different from the other lab site schools His curriculum was extremely constrained and enforced through the CRTs, thus he could not afford to spend much time on lessons that did not directly help students score well on that test The multiple-choice test was designed to be scored by a computer so that the students in particular classes and schools could be compared across the system for accountability purpoes. The test required students to supply the single right answer to questions that mostly tested knowledge of the definition and the algebraic algorithms needed to construct deductive proofs He feared that the ETC approach would not help students develop the skills they needed to succeed on this test, which constituted a hurdle they must leap in order to proceed with their education in mathematics.

Furthermore, he thought his students would not handle open-ended exploration as easily as he gathered the students in other schools would. He had formed a geometry class for the lab site project by selecting some students from the existing geometry class. He tried especially to pick students with "with some computer experience so that they could help the other on the computer, " he recalled. The assistant principal said that they also made an effort to select students with good mathematics skills. Despite this selection process, this teacher found that his geometry students were not well versed in the algebra they needed to cope with the geometry curriculum. "Our students need remediation in algebra, more than they need to make conjectures about geometry, " he stated in September.

By the end of the school year, he was convinced that students needed basic mathematics proficiency more than they needed computer experience to be successful with the ETC approach. He found that technologically the *Geometric Supposer* was not difficult even for newcomers to computers. "Another year I'd choose kids with better aptitude in math. Knowing about the computer turned out to be not so important, ...but without math aptitude they don't notice the relationships that are central in the inductive approach," he noted.

Implementation Process and Impacts

Because of his reservations the math teacher asked to meet with the Geometry Group Advisor, a veteran mathematics teacher and department chairperson in a wealthy Boston suburban school department. He wanted the advisor to read the Boston Public Schools required geometry curriculum and tell him how the ETC approach would address its objectives. The advisor reviewed the Curriculum Guide and devised a chart with three colums: "*Supposer* responds directly," "*Supposer* will influence," "*Supposer* does not respond directly." He had discovered that about half of all the objectives could be listed under the first two columns. Of the objectives labeled "priority" in the guide, nearly two-thirds of them could be taught either directly or indirectly with the *Supposer*. "You know," said the advisor with joy, "These numbers are better than the ones I got when I first looked at my curriculum with the *Supposer* in mind." The two men discovered that they used the same geometry textbook in their courses, and that they shared many concerns and experiences as chairpersons of their departments. Given this meeting of the minds, and some reassurance that the *Supposer* could be used to address at least some of the required curriculum, the teacher agreed to participate in the project.

This scene conveys the interaction between these two men as the year progressed. The teacher continued to doubt that this approach would effectively teach his students the required curriculum, but he was willing to try. The advisor continued to believe that the approach could help students learn the required curriculum, and in a way that would build their enthusiasm and understanding of mathematics. The advisor started where the teacher was and built from there toward activities that reflected the advisor's own knowledge of geometry and beliefs about how to teach. Thus, for example, the advisor would suggest a problem based on the teacher's objectives, that students might explore in the geometry lab. The teacher would translate the problem onto a hand-written work sheet that instructed the students about each step they must take, each keystroke they must make. The advisor recalled:

> He [the teacher] assumes that students need to be told what to do on a step-by-step basis. He will read the problem to them, tell them what the first step should be, and so on. I think the kids expect him to do that and it's what he thinks they need....I believe it could be done differently and I think gradually he and I will meet at some place.

The advisor perceived that the teacher's expectations shaped his perceptions about his students' capabilities, which in turn shaped his behaviors and reinforced students' own expectations. He noted:

> The teacher has information to give and the kids expect it and he expects it back in certain forms. He will let the kids work at the computer, but as soon as he senses that a couple of kids can't do it he'll stop the class and tell them how to do it.

The teacher's expectations about his students were also reflected in the structure of his lessons. The advisor observed that the teacher devoted the beginning of most lessons to a review of materials covered previously. This review often absorbed a large proportion of the lesson so that little new material was introduced.

While this pace seemed slower than necessary to the advisor, the teacher felt the ETC innovation absorbed time he could profitably have devoted to drill and practice on material that would appear on the required curriculum test. At the end of the year, his students did a bit worse on the CRTs than the other geometry class at the Burke. He thought this was, in part, because he had not spent as much time drilling students on the geometry formulas and on the algebra and arithmetic, students needed to know to get right answers on this test. "If I had just taken out the worksheets and pounded in the objectives, my kids would have done better on the CRTs."

The teacher pointed out that he was accustomed to a more inductive approach in his programming classes, where students work independently on problems during part of some lessons. But he had not previously used this approach in teaching geometry. "Usually in geometry you try to hold it together and move the whole class through the same topics at the same time."

The teacher did feel that, despite these drawbacks, his students had benefitted from the inductive approach with the *Geometric Supposer*. He thought students understood some parts of geometry "like what 90 degree angles are", because they had worked on their own and come up with their own ideas. "It gives kids a chance to express themselves--that's rare in math They were interested in finding their own way." He also remarked that students used the *Supposer* to explore difficult geometry problems which, in other years, they might not have even tackled. Even off the computer, *Supposer* students were more likely to sketch a diagram in analyzing a problem. He thought this inclination grew out of their experience exploring problems with the

Supposer. He counted his students' ability and willingness to tackle challenging problems as a major benefit of this approach.

Given these benefits, he planned to use the *Supposer* again next year, though probably not as often. He would not make it an integral part of his course, but rather use the *Supposer* to teach particular topics. He would also use it more as a demonstration tool, a "supplement to the blackboard," rather than as part of a "worksheet, hands-on approach". In reviewing the overall impact of the project, he was ambivalent:

> We can teach to the test and they pass, but how much do they remember and understand? With the *Geometric Supposer* approach it takes time for them to build up familiarity with the menu and the approach--and that time takes away from teaching the regular objectives--but maybe they know those things better. But it does put you behind in the regular curriculum.

Burke/Geometry Innovation Fit

How well did this innovation fit with the setting? We have considered this question primarily from the teacher's point of view. Several dimensions of "fit" emerge: curriculum, perceived characteristics of students, and assumptions about the teaching and learning process

The teacher clearly saw the curriculum in terms of the BPS required objectives, the CRT, and the textbook. These items encompassed the material his students should learn. The advisor acknowledged the importance of these documents in defining the official curriculum, but looked to his own knowledge for additional guidance about what to teach. His knowledge of geometry and of the reasoning processes that mathematicians need to employ informed his views of what should be taught. The advisor had a clear map of the domain he thought students should come to understand and saw multiple routes by which students could reach that understanding. He was able to chart the required topics onto that map. The teacher tended to regard the text and tests as the map.

The teacher acknowledged that learning how to gather and evaluate data was valuable for his students, but these were secondary priorities. The first priority was to memorize the formulas and definitions necessary to produce right answers on the CRTs. He regretted that these tests were constructed so that they could be computer-scored, believing that this constraint explains why the test does not include more "conceptual" items that call for students to reason about open-ended problems. Nevertheless, he thought his teaching must emphasize the test material

As the CRT influenced the teacher's ideas about the content of his geometry course, it also shaped his assumptions about the teaching and learning process. He believed that the most efficient way to prepare his students for this test was to concentrate on the information needed to answer the test items. While he acknowledged the value of allowing students to construct their own knowledge, and employed this approach in his programming course, he felt it was of limited value in this geometry class where students must learn certain material and pass the standardized test in order to pass on to more advanced courses.

The teacher's perceptions of his students' interests and needs also shaped his preferred teaching approach. He had a heterogeneous group of students whom he perceived as having below average math skills. He thought his students had "low math aptitude" which limited their ability to perceive patterns and reason about them. He also thought they showed little initiative. He did think he had encouraged them to work independently--and that they had shown increased initiative as the course progressed. But he also remarked that he thought his students needed to be led step-by-step. He adopted this approach because he thought it best served his class. "If I'd had an honors class in geometry, I would have handled it a lot differently..let them take the ball, evolve diagrams themselves rather than me making them, let them evolve the relationships."

Science Innovation

In comparison with the geometry innovation, the ETC science innovation used more complex technology, in a less open-ended approach, to teach a smaller portion of the standard course. The Microcomputer-Based Laboratory (MBL) equipment includes two temperature probes and a heating coil connected to an interface box that attaches to the game port of an Apple microcomputer. Equipped with special software the computer becomes a device for measuring and displaying data about temperature. For example, this equipment can accurately measure even minute changes in temperature over time and display them either as a table of data or as a graph where temperature is plotted as a function of time. The heating coil is engineered to deliver a calibrated pulse of heat on command, enabling students to measure the changes in temperature caused by adding a fixed amount of heat to different liquids. Lab site teachers used this apparatus as well as software that simulated experiments conducted with similar equipment.

Although the MBL equipment can enable open-ended exploration, the lessons used by lab site teachers directed students to gather and analyze specific data as they performed particular experiments. Lab site teachers received materials for approximately one dozen lessons in which students conduct experiments that illustrate such thermal phenomena as latent heat, specific heat, and the influence of mass on the relationship between heat and temperature. Teachers selected lessons from among this set, depending on their particular course content and their students' ability level. In most cases they taught a unit that covered 2-3 weeks of their course

Initial Impressions

The Burke science teacher who participated in this project reported that initially he was interested in working on the ETC project because it involved computer technology. He thought students should have an opportunity to use computers in their courses because "practically all modern machinery is computer-related". Later he came to understand that ETC's primary goal was to teach science more effectively, not just introduce computers into the classroom While this goal was compatible with his priorities, the technology itself was what drew him to the project.

The science teacher concluded that he must have at least 10 computers for his class in order to carry out the science lessons. Because the school's computers were already heavily scheduled, ETC provided the necessary equipment through a donation of hardware from Apple, Inc.

The assistant principal had arranged this teacher's schedule so that his chemistry course would have a double lab period three times a week, thinking this extended period would permit more experimental lessons as called for by the ETC approach. The teacher tended to view the third lab period as extra time, allowing him to conduct lessons not required by the system-wide curriculum objectives. He regarded the third double period each week as a time slot for ETC lessons. This arrangement made some sense in terms of his concern with the standard curriculum, but teaching intermittently was not an effective way to teach students about heat and temperature. The ETC lessons had been designed as a relatively compact curriculum module, to extend over a period of 2-3 weeks not to be spread out at the pace of one per week for 10-12 weeks.

Implementation Process and Impacts

The Microcomputer-Based Laboratory equipment was not yet commercially available at the time the ETC lab site project began. It had to be assembled by hand at the research center where it had been developed, an organization not equipped to mass produce the apparatus. Consequently there were not a sufficient number of the MBL heat/temperature kits until late October. In the meantime, the ETC advisor persuaded the teacher that there were useful preliminary lessons to conduct with his students. The advisor helped the teacher design lessons that involved taking the temperature of various objects with a thermometer and recording the data carefully. The advisor, who taught in a wealthy suburban high school like the geometry advisor, was surprised to discover that the Burke classroom was not supplied with thermometers. The advisor managed to loan the Burke teacher a sufficient number of these items, which he regarded as part of the basic equipment in a science laboratory.

The advisor attempted to help the teacher design a series of lessons that would build from the basic concepts developed with traditional laboratory equipment to the ideas facilitated by the MBL lessons. The teacher was reluctant to develop a plan of this sort He wanted to wait until all the equipment was installed at the school before settling on a course plan.

Once the computers were installed, two complications hampered early lessons with the MBL equipment. First, the equipment often malfuntioned for a variety of reasons. The units contained fragile equipment which broke easily under normal wear and tear in high school science classes. Some of the units were not properly assembled, perhaps because they had been hastily manufactured at a facility not accustomed to producing them in large numbers. Second, the equipment was rather elaborate. Clear diagrams and instructions would have helped students understand the component parts of the MBL apparatus, how each component functioned and related to the others, and exactly how to assemble them correctly Yet such materials were not initially provided by ETC. Under experimental conditions, the equipment had been assembled by researchers who never faced the challenge of directing an entire class to set up their stations. Eventually such instructions were prepared and lab site teachers who taught the lessons later in the year found this aspect of the project relatively easy to manage. But the Burke class was the first to attempt the lessons and found this hurdle a significant one. The combination of difficulties in correctly assembling the apparatus and frequent malfunctions made it very difficult for most students to make sense out of their early lessons.

Once the equipment problems were overcome, the teacher began to design materials for teaching the ETC lessons. He found that the problem sets provided by the ETC staff were too difficult for his students. He preferred to transfer some of the material from these lessons to hand-written sheets which he copied for his students on the mimeograh machine. The advisor offered to help the teacher plan his overall approach to the heat and temperature lessons and design clear worksheets with space for students to record data and make necessary calculations. But, while the teacher appreciated the advisor's assistance in providing him with equipment and supplies, he did not welcome advice about how to sequence or design lessons.

Two other sources of difficulty presented challenges to the successful implementation of these lessons. First, the subject matter itself is very difficult. Distinguishing heat from temperature and understanding the two concepts is a very fundamental, but very hard task in science education. No matter how beautifully presented a lesson may be, students always have difficulty grasping these ideas. Second, the lessons involved conducting scientific experiments, a complex undertaking for which students must learn several prerequisite skills. Knowing how to move around a room to gather equipment, working with a partner to collaborate on experimental activities, knowing how to read over an experiment in advance to identify types of data to collect and times and formats for recording them--all these skills must be systematically developed with a class before they can successfully carry out science experiments. In sum, as the teacher said. "There were quite a few moments of confusion for the students and for myself."

Despite all the difficulties, the teacher was convinced that his students had benefitted from the lessons. "I'm almost certain it made the concepts much clearer than I would have been able to otherwise," he concluded at the end of the year. The MBL equipment had helped students make a distinction between the quantity of heat and the effect of heat on temperature He thought the instant display of graphical data on the computer screen helped students to understand the phenomena they were studying better than if they had painstakingly recorded. analyzed, and plotted the data themselves. He thought his students could accurately interpret the graph on the computer terminal, but would have had great difficulty creating the graphs by hand. He was eager to use the equipment and lessons next year

Burke/ Science Innovation Fit

Successful integration of a teaching innovation into a teacher's regular curriculum and approach requires a careful mapping of the new lessons against the teacher's syllabus and accustomed activities In this case the teacher seemed very eager to incorporate the new lessons into his course, but his efforts were hampered by several problems, having to do with the technology, the lessons, and the organization of his course. The technology presented sizable logistical problems. The teaching module itself did not include all the lessons that it should have and even those that were included needed substantial modification (according to the teacher) before they could be used with his students. His course schedule was unclear and was frequently interrupted by diversions that took students out of his class. This made it difficult to choose an appropriate sequence of lessons from the materials offered and to fit these appropriately into the course curriculum. The intermittent scheduling of the lessons on Heat and Temperature made it difficult to build coherent understanding through a sequence of related lessons.

Programming Innovation

The programming metacourse employed very little new technology because programming teachers customarily use computers. ETC's Programming Metacourse lessons are designed to teach students the important ideas and strategies they need in order to understand and produce programs with computer hardware and software. The lessons present mental models, strategies, and conceptual frameworks intended to help students understand the programming enterprise and become proficient in interpreting and producing BASIC programs. The metacourse was designed as eight specific lessons to be taught at intervals throughout a one-semester course in introductory BASIC. In pedagogical approach the metacourse pursued a middle course between the open-ended geometry lessons and the more tightly specified science lessons Metacourse lessons are teacher-directed, but they are designed with the assumption that between these lessons teachers assign programming problems that students explore independently. In effect, the metacourse itself can be viewed as assisting the teacher in providing guidance in a course that overall employs a guided inquiry approach. In scope, the metacourse sphere of influence was also somewhere between the *Supposer*-based and MBL-based innovations. Lab site teachers found they needed more than eight class periods to complete the eight metacourse lessons, and were encouraged to "infuse" elements of the metacourse throughout their teaching. Overall, the metacourse probably influenced, either directly or indirectly, 20-30 percent of the semester's lessons in lab site teachers' courses.

Initial Impressions

The programming teacher reported that he was initially interested in teaching with the ETC-developed programming metacourse for several reasons. First, programming is still a relatively new course in high schools, and there are few accepted guides in designing a course While there is a general curriculum published by the BPS, no standard textbooks are widely used, and few teaching materials have been developed for an introductory programming course. So he was interested in learning how other people teach this course. As he became more familiar with the metacourse he saw that its methods and materials fit well with his approach He noted:

> My goals in teaching programming are minimally to have the students understand a certain programming language--to be able to utilize it to solve some problems. More generally my goal is to teach students to think and solve problems--analzye things and break them down into parts. Our students aren't very adept at looking at a problem and seeing it as a lot of little problems that need to be solved. A lot of them, when they see a difficult problem, if they can't see a solution to the whole thing, they often times drop the ball.

He traces his students' reluctance to tackle difficult problems to a basic lack of confidence. They have "very low self esteem...If they're presented with something difficult, they just quit. They won't do it. They'll just say, 'I don't understand it. Show me how to do it.'" In contrast his honors Algebra class will try to figure out what they don't understand by thinking about it. "They really have the motivation and a little bit better self esteem; they've had some success before. A lot of these other students have had very little success ...I try to make sure that everyone has a chance to succeed in my classes."

Despite his desire to use the metacourse with his students, the teacher was clear that he would not attend lab site project meetings. He explained that he had made prior commitments to coach Burke athletic teams after school. He felt that the students needed experiences of consistent, successful teamwork supported by a devoted coach, and he was not willing to sacrifice that for these meetings. It became apparent that he chooses a limited number of priorities and deals with them thoroughly. He balances the distribution of his resources so that he can do a few things well, rather than fewer things extraordinarily thoroughly or more things haphazardly. In a setting like the Burke where a great deal is going on and there are multitudinous tasks that could each absorb all one's energies, the capacity to focus on priority goals appears to be a major asset

Implementation Process and Impacts

The teacher found that the metacourse was well designed for him and his students. The problems presented in early lessons were relatively simple, giving students a taste of success The series of lessons was designed systematically so that concepts, vocabulary, and strategies were reiterated and reinforced in a coherent way throughout the sequence of lessons. There was enough time between metacourse lessons that he could weave metacourse elements into his other lessons. For example, the metacourse distinguishes the purpose, the action, and the syntax of a programming command. He found these to be useful distinctions that he reinforced throughout the course. They appeared in a sign posted on his classroom wall, and were also left on the chalkboard in another classroom where he had presented an introduction to programming in another teacher's class.

The metacourse design also included several features that helped students understand and recall programming concepts. Visual models and diagrams complemented verbal explanations of the computing world The visual models helped students grasp the overall programming enterprise and understand how a particular action fit into the larger process Certain programming patterns were labeled with catchy phrases that the teachers thought might seem "trite" to students, but he was pleased to see that the names seemed to help students recall these patterns and their purposes

The teacher noted that there is a required curriculum for introductory programming courses, but it does not much constrain his own decisions about what to teach. It's a different situation from math, he noted, where the required curriculum (and the systemwide midyear and final exams) always includes more than any teacher can cover. In math courses, the teacher is always juggling whether to proceed when some students are still confused or slow down and risk not covering some required material. He does not experience the same pacing problems with programming courses. "The programming curriculum doesn't have that many objectives and last year's final was very simple."

The ETC advisor who worked with the Programming Group found that the Burke teacher was very conscientious in implementing the metacourse as it had been designed. He promptly read the materials as they were sent and taught them according to the directions and suggestions supplied by the ETC research group. He recognized certain concepts and techniques in the metacourse lessons as generally useful and incorporated them into his other lessons. He thought about the rationale underlying the course and incorporated the spirit of the metacourse into his teaching rather than just mechanically delivering the prescribed script. Besides thoughtfully teaching the lessons, the teacher diligently completed feedback sheets that the researchers needed to assess the implementation process and its effects.

The programming teacher was very positive about the lessons. He planned to use them again in the coming year and hoped to introduce other teachers and classes to the metacourse.

Burke/Programming Innovation Fit

The goals of the innovation fit the programming teacher's priorities. It emphasized content and techniques that he saw as important. The innovation reinforced the very skills that the CRT tested. He felt that teaching the metacourse helped him cover that material more effectively rather than detracting from that responsibility. "It was not a substitute for the regular curriculum, but a different, better way of presenting it," the teacher noted.

The activities of the course were also consistent with his teaching approach "It's presented in such a way that you can use simple ideas to develop more sophisticated procedures; it helps students recognize patterns and then use them to solve more complex problems." The form of the innovation was very complete, including all the materials necessary to teach a specific set of lessons laid out in a recommended sequence designed to fit smoothly into a typical programming course. Thus the innovation itself was more complete than the geometry innovation and much more complete than the science innovation

While the innovation was well tailored to the teacher's situation, he was also adept at fitting this innovation into his existing, well-designed course. He was a very organized person He was clear about his goals, clear about how his teaching activities relate to those goals, clear about his expectations of students, and he prepares thoroughly.

He used his own judgement to decide which requirements to take seriously and disregarded those he feels distract him from his priorities. Clarity about his goals, coupled with good planning and the strength of his convictions, put this teacher in a good position to integrate a new approach so that it reinforced his own priorities.

Overall Themes

Several themes recur in these stories of implementing technology-based classroom innovations at the Burke. They point to a set of conditions that would likely arise in any effort to introduce these kinds of innovations into inner-city schools that are part of a large public school bureaucracy

Curriculum

Math and science teachers at the Burke are concerned about "coverage" of the BPS required curriculum. Many of them feel, however, that their students need work on basic skills before they can handle the regular course material. Students in earth science may be unable to read the text, but the time teachers spend teaching reading doesn't "count", i.e., isn't directly measured by the earth science CRTs. Given this perspective, the integration of innovations that do not directly address the CRTs is difficult, especially with students whose achievement is below grade level.

The required curriculum is set by actors far outside the school. Teachers feel they cannot alter the curriculum, but must prepare students for the tests based on it. Any innovation that doesn't help students perform better on required tests is extremely unlikely to succeed under conditions of rigid requirements which teachers feel powerless to modify. In other lab site schools an innovation addressed an espoused goal that had not yet been incorporated into official texts and tests--e.g. ability to reason systematically in math, to understand how to develop and test explanations in science, or to approach problems systematically in programming--then teachers might still be interested in it. They might negotiate with their department chairperson if they were concerned about meeting curricular guidelines, or otherwise create a little leeway about the requirements. This negotiation is less likely in a large bureaucratic system where teachers feel remote from the people who make decisions and expect to be recognized and rewarded or reprimanded primarily on the basis of their students' test scores.

Expectations of Students

Burke teachers often stated that most of their students did not have the skill, motivation, or basic subject matter knowledge to explore open-ended problems effectively Many indicated that school is low on their students' priorities, that students lack confidence in their abilities, and that they don't know how to take initiative. Some teachers tended to think, therefore, that most students need to be led step-by-step. Given this belief they were disinclined to offer opportunities for exploration and provided instruction at the first sign that students' explorations were stymied or going astray. Clearly, not all teachers reached this conclusion or responded in this way all the time. All the teachers offered some opportunities for students to investigate open-ended problems. But a tendency to think students needed step-by-step instruction seemed a common one, particularly in courses where teachers felt responsible for covering a large, required curriculum.

As described below in the section about students, what appeared to be lack of motivation might have had deep and complex roots. Some students confided that they did not participate in class or complete homework assignments because they did not feel teachers respected them They explained their withdrawal from school activities as a way of protecting themselves from painful interactions, as a way of protecting their dignity.

Clearly this set of interactions can become a costly self-reinforcing impediment to learning. If teachers feel students have low motivation, but feel powerless to confront this issue, and if students withdraw from school work because they feel teachers don't care about or respect them, they are unlikely to break their cycle. This pattern hampers any kind of learning process, but is particularly poisonous to an approach that requires teachers and students to work as colleagues in constructing knowledge together.

Beliefs about Learning

In a meeting near the end of this project where Burke staff reviewed the impact of teaching with technology, teachers expressed complex views about how students learn. The programming teacher said he thought that students understood better what they had figured out on their own as opposed to things that the teacher had told them. He acknowledged that the inquiry approach takes more time and said he felt a balance had to be maintained between the costs and benefits of this approach for particular topics. The geometry teacher acknowledged that students were more interested in learning on their own, but he felt continually constrained by the required curriculum. The science teacher thought students should definitely work on their own, rather than watch a demonstration, but he had difficulty providing enough guidance to make students' explorations productive.

While these ideas emerged during a conversation directly concerning the learning process, other beliefs were implied by many teachers' comments. They often spoke of "coverage", of needing to expose students to topics and move on, of emphasizing concepts and vocabulary to be memorized. These remarks reveal a conception of learning as a process in which ready-made knowledge is conveyed to students whose role is to remember that knowledge.

Feelings of Isolation and Helplessness

Like most teachers, especially those in large urban systems, many Burke teachers feel they are working in relative isolation. The problems of low basic skills and low motivation are pervasive with their students, but they feel powerless to attack these problems. They feel there are few useful opportunities to collaborate either with their fellow teachers or with students. Their feelings of helplessness fester and they cannot muster forces to mount a sufficiently comprehensive attack. The Burke administrators confront this series of communication gaps in their efforts to devise systematic curriculum planning procedures at the school. The assistant principal noted that she and the principal felt under the gun about raising test scores and wanted to convey that sense of urgency to teachers. However, they weren't sure how to develop a sense of collegiality as an aid to establishing a school-wide curriculum planning process.

Surely, the culture of isolation is not limited to the Burke; it seems to pervade most schools. Indeed, the Burke appears to have laid the groundwork of respect and stability that are first steps in addressing this crucial problem. Still, further work is necessary to build powerful connections among teachers so that they feel bolstered by a supportive community in their efforts.

Structural Impediments

Certain realities of schedules and space allocations had a pronounced impact of the implementation of these teaching innovations. Assignments of courses for teachers, students, and rooms are all made by the school administrators in consultation with department heads. In a school this size, the relatively small number of students contributes to some rather odd groupings. For instance the programming teacher's classes included only four students in one case and eight in another. Meanwhile, the Earth Science teacher had 33-34 students in each of the five classes she taught every day, while her furniture was set up to accommodate 32 students Her course is a prerequisite for many other science classes, while the programming course is an elective. Neither class size is near optimal.

These scheduling tasks are constrained by the usual 45 minute period, which everyone recognizes as a stumbling block in conducting thoughtful, experimental lessons. The teacher who directs the computer-assisted remedial program said his first prerequisite was to operate this program in a three-hour time block. He had the bells disconnected in his wing of the building and feels this extended class period is essential for conducting focused, productive work

Scheduling becomes especially challenging when classes must be given access to computers that are shared with other courses. Either teachers may find themselves pinched into prearranged access to the computers that does not really suit their lesson plans, or the computers may be reserved exclusively for one course condemning them to frequent idleness.

Summary

Required curriculum objectives, enforced by district-wide tests, can exert powerful brakes on teachers' willingness to try out a new approach, unless the innovation parallels their requirements very closely. This reluctance may be heightened if teachers find it difficult to construct a map of their course domain other than the one offered by the required text and tests. Striking out from the path set by the textbook chapters requires teachers to have confidance in their own map of the domain and to give up the security that the textbook path affords. So long as their lessons follow that accustomed order they can take comfort in knowing that they taught what they were supposed to teach, even if the students didn't learn it.

Concern about deviating from the required course is also exacerbated in teachers who doubt that their students can learn the required material quickly. These concerns are further amplified if the teacher believes that the innovative approach is not well-suited to their students' needs. But teachers expectations sharply influence their own behavior and can readily become self-fulfilling prophecies. If teachers think their students cannot wrestle productively with open-ended problems, they may not teach these skills nor provide many opportunities for students to develop them.

Similarly, students' beliefs and expectations greatly influence their behavior in class. If they doubt their abilities to succeed, they will be unlikely to persevere in situations that require them to think or invent. If they expect teachers to tell them right answers so that they can memorize them for later use on a multiple-choice test, students will be wary of lessons that call for them to explore, conjecture, and evaluate multiple right answers. If students believe that teachers disrespect them, they will be unlikely to participate in class at all, let alone take the risks that open-ended inquiry entails.

We cannot claim to know the truth about the abilities of Burke teachers and students, but we can guess that neither group fully appreciates the others' capabilities. Furthermore, we can assume that multiple conditions maintain a gap between them that interferes with each group's developing more realistic assessments of the other's desires and abilities.

STUDENT MOTIVATION/ACHIEVEMENT TRAINING

The Collaborative Project's desire to pay attention to student and teacher attitudes towards achievement grew out of the experience of MassPep in its five years work with Boston area high schools. MassPep works with high school students to encourage them to consider careers in engineering, science, mathematics and computer technology. Through this work MassPep began to realize that many minority students do not view themselves as learners Too often they view school as an experience to endure, not as a step in a process that will eventually lead them to their desired goal.

Furthermore, many of these students, though able, do not succeed in science and mathematics course, thereby undermining their self-confidence and limiting their opportunities to seek further education and jobs in these areas. Progress is hampered by low expectations, poor study skills, and student attitudes about learning and the relationship of schooling to lifelong goals.

Assuming this is a common pattern among students served by schools like the Burke, any program wishing to improve mathematics, science, and computing instruction in such a school must address these issues. Such programs would need to combine excellent instruction in mathematics and science with explicit efforts to build the positive expectations, attitudes, and skills necessary for academic success. Simultaneously they must provide a means for teachers and students to feel more empowered as a result of such a program.

This project addressed these issues by adopting many of the techniques used and developed by MassPEP. Workshops, seminars, and small discussion groups provided students with experiences intended to help them develop a personal standard of excellence that would give them the pride, confidence and preparation to succeed in the lives and careers they choose. This section of the report describes which students were involved in this training, how input from teachers and students was used to design the workshops objectives, and the salient themes that emerged from the workshops. The section concludes with a summary of the key observations from the work regarding students.

Student Selection

In order to participate in the workshops, a student needed to be able to participate in two 90-minute small group assessment sessions, attend a one-day work shop, attend a weekly one-period meeting for the duration of the school year, attend a one-day closing seminar, and attend two 90-minute closing interviews.

The decision as to which students would be involved in this training was a result of scheduling issues, program needs, and other concerns at the Burke. We wanted to include students from each grade level; students who were using the ETC innovations in their classes; and students of varying academic achievement levels from across the academic range It was also essential that students' teachers approved of their being in the program. The students eventually selected for the program included all of the ninth graders who enrolled in the Computer Magnet Program [23] and all of the students in one chemistry class [22 eleventh and one 12th graders]. These students where chosen for three reasons. First, it was important to work with the ninth graders because they were students who had chosen to come to the Burke for its technology-based program. Second, the chemistry class was one of the classes that used an ETC innovation Third, the chemistry class and the ninth- grade computing class were each two period classes This allowed us to work with the students for one-period session in groups no larger than fourteen.

Determining Workshop Design

Separate meetings were held with both students and teachers to gather the background information that was needed to refine the stated objectives and to design the workshops in which students would participate. The meetings held with teachers focused on ascertaining their assessment of students needs. The exploratory meetings held with students were concerned with identifying the major achievement and communication skills that would need to be dealt with

Teacher's Assessments of Student Needs

Prior to meeting with students or designing a format for how those meetings would be structured, several discussions were held with the math, science, and computer teachers. We wanted to use their combined experience at the Burke to determine what issues would be most important to address in our work with students.

In the beginning the meetings were tense and difficult. Most of the information exchange was one-way, impeding true communication. This was partly due to common barriers that outside agencies must work to resolve. Among these are reluctance on the part of teachers to become involved in new projects that might add to their daily work load, and skepticism among some people about the research and what it would entail. While these factors contributed to the start-up difficulty, the more fundamental barrier resulted because no one presented the teachers with a clear set of objectives or activities for the collaborative project. Thus, for the most part the teachers usually arrived with no idea as to why they were at the meetings, what the meeting was to accomplish, and what their role in the overall project was. Indeed, the initial confusion as to the definition of the project meant that teachers' participation in the first two meetings was at best marginal. They drifted out of these meetings before they ended and/or left abruptly when the last period bell rang or the designated ending time of the meeting arrived.

Although many of the same problems persisted after the second meeting, the discussions became lively, interesting, and informative. As the meetings continued, people stopped being time conscious and focused more on the subject at hand. This was both a measure of the teachers concern for their students and an improvement in the collaborative project's status in the school. As one teacher noted, these conversations provided him with information about people he works with but has no opportunity to talk to. "I've worked with him [another math teacher], for over five years and didn't know we had felt the same about what these students needed."

Several themes emerged in the conversations with teachers that can be captured under the heading of academic preparation. Many students, they felt, come to them from middle school working well below grade level in most subject areas. Without exception all the teachers agreed the most important deficiency in the students' academic skills was low reading skills. In fact low reading skill was consistently identified as the basic limiter to student learning. As one teacher indicated, "How can we expect students to do well in earth science or general chemistry when they are unable to read, with some form of consistent comprehension, the text?" Some teachers expressed it differently. They often find themselves in a situation where they have to provide less substantive or in-depth work in their subject area to make time for remediation on skills that students should already have. As a result a "cycle of below grade level skills" is perpetuated.

Yet, teachers acknowledged that many students at the Burke do have the basic skills. For some of these students their progress is blocked by a lack of the study skills needed to succeed in more rigorous courses. "I have students who are bright and can work but come to class without paper, a pen or anything, or they will sit there after a class and not write a thing. But they show up almost everyday." The desire of these students can be defeated by their own actions. For the most part they need merely to learn the techniques of studying -- taking notes, reading for comprehension, or reviewing material -- in order to boost their performance and satisfaction with school. While this is also true for those students without the necessary basic skills it is particularly important with students whose opportunities for "making-up work" are limited once they pass through the school system.

Whether low skill levels are brought about because of reading difficulties, subject area difficulties, or poor study habits, some teachers believed that low skill levels and numerous other factors can create a situation in which many students lack the personal motivation to overcome their academic problems and/or address the institutional ones. For the most part, teachers saw the motivational issue as closely tied to unrealistic goals on the part of students. "The goals they set for themselves are not realistic given their behavior," cites one teacher. "They would say they wanted to be a doctor or an engineer but would avoid doing math related work." Another teacher acknowledged that "while many of these kids talk of going to college they do not take the courses, or do the work in the courses they do take, that will make that a reality for them."

This comment seemed to capture the feelings of all the teachers. While they were not questioning the capability of the students, they were indeed calling into question the students' understanding or acceptance of the relationship between their behavior in school and their ability to obtain a certain social position in adult life. In short teachers seemed to be saying the students are unwilling to accept responsibility for their part of the educational formula because they do not see its link to their future goals.

Teachers cautioned that if we were going to work with students on achievement skills, we should attempt to "get at the root" behaviors of students that were the cornerstone of their academic problems. As one teacher stated, "I would be willing to let my students out of my class for one day a week in order to receive this [motivational and goal setting] type of training. If they had this then I could use the other four days more efficiently and provide them with a better learning experience." The ideal students for such an intervention according to this teacher, would be those who were either so far behind that it wouldn't matter if they missed a day or those who had the wherewithal to make up any work they missed. "Perhaps" he stated, "if these two group of students were together those students that have the skills could help teach those that don't."

Aside from attending these preliminary meetings, several teachers participated in the first workshop held for students. Their participation in that workshop was to be one of many opportunities in which teachers and students would be able to learn about each other. Unfortunately, further opportunities were lost except as they were captured in this report, because the director of the project did not schedule opportunities to report back to teachers on how their observations of students coincided with students' observations of themselves.

Determining Student's Views of Themselves

To assess students' self perceptions of their own learning habits we met with all 35 of the students involved in this project in groups of five for two 90-minute periods each. These sessions, along with what was learned from the teachers assessments of students, provided the background information needed to design a full-day training session for the students.

One exercise used during these meetings focused the students attention on communications and self-concepts. For some students this meant simply acknowledging and modeling for other students what they already did well. In other cases, where students were less forthcoming, it meant assisting them in discovering what they did well. Often the students knew of their accomplishment, but did not know to value them. For example, one student described to a group how she got a recent job. She began by just stating the facts: "I needed a job so I looked for one, filled out applications and finally got one." As the workshop facilitator queried her, she began to recount the decisions she went through in order to decide to look for a job, the fear she had in approaching potential employers, the anxiety that surrounded waiting for someone to call back and let her know whether she received the job, and the happiness of being told to report to work. Throughout this whole discussion, though she spoke of fear, anxiety, and happiness, her voice modulations and body language never expressed any of those feelings. It was as if she were recounting a story that was about someone else, a story that she was not intimately involved in.

She was then asked to repeat the story and do it in a way that would make it clear how she felt. She repeated the story, this time with more inflection in her voice and more expression in her body. Finally the workshop facilitator had her just talk about what it felt like when she got the job. What did she do when she hung up the phone after finding out she had the job. "Well I just stood there for a minute and started jumping up and down saying, "I did it, I did it". The facilitator asked her to show the group. She stood in front of the group, jumped a little bit, and said, "I did it" The workshop facilitator ask the group if they believed that is exactly how she acted. All replied "No" The facilitator then asked her how she felt when she hung up the phone. "Proud and excited and very happy," she said. "Can you show us proud and excited and happy?" she was asked This time the student stood there for a moment repeated, "I did it, I did it, I did it" and began to jump higher and higher and let out a yell that said, "I got the job".

The effort required by this student to acknowledge her own achievement is reminiscent of a common pattern among some students: Even when they are aware that they have achieved something. they do not view it as something resulting from a series of actions they took. Furthermore, they often de-personalize the achievement and do not allow themselves to feel or share the joy of their accomplishments.

Other patterns in the students' behavior became quite clear in these initial meetings. Although the workshop facilitator recognized that there are exceptions to each of these patterns, they are she states, "consistent throughout enough of the group to justify the generalizations."

(1) Often the students appear to be unused to being asked for their thoughts and feelings about their experience. Questions often stimulated giggles, silence, and grandstanding, which when acknowledged as responses to discomfort and unfamiliarity, decreased. Since the ability to articulate one's expectations is key to being able to achieve them, this initial "reticence" could be used as a baseline from which to measure their growth.

(2) Students are often viewed as being externally motivated--as evident by their preoccupation with peer status. These students were more self-motivated than anticipated, but still tended to be externally oriented in value formation and goal decisions. Throughout our work we decided to provide them with experience in both making choices and accepting judgments and evaluations from the outside, while at the same time being aware of their own values and criteria for decision making and action.

(3) In decision making, many of the students showed little awareness of the connection between present and future. They separated immediate actions from future goals and needed some experience at broadening the time-frame upon which decisions are made, moving from present to immediate to short-term to future decisions.

Workshop Goals

Based on the feedback from teachers, and the experience of trainers who had worked with MassPEP, the student motivation/achievement workshops were designed to address the areas of learning skills, communication skills, and achievement skills. Towards these ends, the following objectives were adopted:

(1) Establish understanding and ownership of the project goals.

(2) Introduce concept of learning skills and begin examination of each individual's learning process.

(3) Introduce fundamental communication skills.

(4) Introduce intra/interpersonal cybernetic model and its application to learning, communications, and achievement.

(5) Begin self-concept work, shifting students into fundamental awareness and acknowledgement of their capacity to learn.

(6) Gather information about student's existing learning, planning, and achievement strategies.

(7) Teach effects of personal beliefs on learning and begin installing beliefs about self, others, and learning process.

(8) Affirm and support student's curiosity and begin developing awareness of ways it has been repressed, so that blocks can be addressed.

To meet these objectives three activities were used: a one-day Orientation Workshop, Weekly Workshops, and a Closing Workshop.

The orientation workshop was designed to build on the skills that were introduced in the small groups, and to provide all participants with a means of identifying themselves as being part of something special.

The workshop was a series of one-hour weekly meetings. These sessions were to serve as the heart of the achievement and motivation and communications training. The closing workshop activity was an activity that served both to bring closure to the experience and to provide an opportunity for the students to reflect on the usefulness of the experience. A brief description of the major themes of these activities follows.

The Orientation Workshop

The orientation workshop was held at the corporate office of the Burke's business partner, New England Life. The workshop was designed to build on the skills introduced in the initial meetings and to give students a more complete experience in three areas: (1) communication, (2) planning goal/setting, and (3) personal power. Most of the students, teachers, and advisors who were part of the collaborative project participated in the workshop

Perhaps one of the most important experiences of the day was the opportunity for teachers and students to interact with each other as learners. This experience allowed them to alter their expectations of each other. In the exercise, several names of animals were placed along the wall. Everyone was told to go and stand by the animal that best represented them. Then the groups gathered under each name had the task of learning why each person had chosen that animal, what group members had in common, and what each person in the group felt was positive and negative about his or her identification with that animal. When the groups reconvened and reported on their discussions it became apparent that the students had not acquiesced to adult authority, but had taken charge in a clear and purposeful manner that allowed the group to complete its task. One teacher remarked that he was surprised how articulate the students were He had never witnessed some of these students being inquisitive, challenging, and open. In addition, one student remarked that he had not realized that a particular teacher was alright to talk to. The exercise suggested that one reason for the tensions between students and teachers is that they most often make decisions about each other without knowing each other outside of their roles and or positions in schools.

Weekly Workshops

After the one-day workshop students continued to meet on a weekly basis. These weekly meetings were used to reinforce the concepts that were introduced during the one-day workshop. It was also constructed to deal with verbal communication skills, self-examination, listening skills, appropriate questioning, and exploration of ideas.

The sessions met for twelve weeks on Monday, Tuesday, and Wednesday mornings for 50 minutes. The Monday session was for half the ninth grade magnet students, the Tuesday section was for the other half. On Wednesday there were two sessions, one for each half of the double-period science class.

During the first few weeks of meetings, our efforts to build on the learning gained from the previous meetings with students were quite successful. During this time we concentrated on the students' images of what constitutes a "good" student and what constitutes a "good" teacher Each group brainstormed a list of characteristics of both successful and unsuccessful students. We then spent two sessions going over the list and discussing why each item was on a list. Was it there because of someone's experience, was it there because of a stereotype, or was it there as part of the folklore of youth?

For both the ninth and tenth graders the images of the successful student where quite similar. Such a person needed to be determined. "You got to have it in yourself in order to make it through all the things that are out there trying to stop you. You know drugs, hanging out shootin' hoops with the fellows, anything that just keeps you off the mark." The person also had to be assertive. "There are people out there who will help [you] but most of the time you've got to push your way through." Another characteristic was that the successful student had to be willing to work hard and be self directed. They also saw the successful student as a rebel, someone who was willing to challenge authority, someone who was a little bit roudy, someone who could "hang" and at the same time "book".

Interestingly, many of the characteristics that students used to describe the successful student were also used to describe the unsuccessful student. When pressed about this seeming contradiction they replied that the unsuccessful students "took it to the hoop " "They don't know when to stop or how to set limits, they're just out there."

These comments indicate that for this group of students, the difference between kids who made it and kids who didn't was not a lack of certain characteristics, but rather the intensity of those characteristics. The image of "taking it to the hoop" may indeed be apt. One interpretation of such an image is that of someone who is caught up in his own momentum to the degree that he is out of control and unable [or unwilling] to "pass off " to others who might be of assistance.

In addition this notion that successful and unsuccessful students display many of the same characteristics also implies that students view most of their peers as having the potential for success. They do not see themselves or their friends or classmates who are "not making it" as deviate or incapable. Often they remark that "he just needs to make up his mind that he wants to do it." While this sounds like a "pull yourself up by your own bootstrap" argument, it is not. In fact, many student comments showed their awareness of institutional barriers to their success. At the same time they recognize that individuals have some responsibility for where they are.

The students' images of teachers were less consistent. While the ninth graders saw most of the teachers as "not caring," the eleventh graders were accepting of more teachers. In part, the ninth graders' reaction was "typical" of their age group, as it tries to forge new relationships in a new school. Indeed, this reaction was exacerbated because all the ninth grade students were part of the computer magnet program which had stricter guidelines then the rest of the ninth grade program. Regardless of the reasons, some students admitted that they often withheld their efforts for certain tasks as a means of protecting themselves from unfair treatment by teachers. "Why should I put myself out for her", remarked one student ".. all she cares about is that I just repeat what she says. She's not interested in what I know. I don't know what she's interested in but for sure it ain't me." As a result, students found themselves in a cycle of mistrust and lack of respect that reinforced teachers' perceptions and ways of interacting with the students.

Many activities during the small-group sessions attempted to deal with these types of problems as they came up. In one case a student remarked that the teacher never paid attention to him in class. "I sit there with my hand in the air and he never calls on me, so I just give up." However, many other students in the class saw another dynamic occurring. "You don't give him (the teacher) any respect," replied another student, "that's why he ignores you. You always say 'Yo' to him and just call out in class." After hearing these observations from his classmates, the first student promised to try for two days a new approach to the teacher to see if it would make a difference. He would raise his hand and wait to be called on before he spoke, he would address the teacher as Mr., and he would go to the teacher at the end of class and comment on what happened in class that day. The student tried it and reported back that not only had his behavior changed but the teacher had become more responsive to him and the group of students that he usually sits with. This improvement in their relationship was sustained through the school year

Final Closing Workshop

At the students' suggestion, the closing workshop was a two-day retreat at Sargents Camp, an environmental training center run by Boston University. The objective of the final workshop was to create an opportunity for students to: (1) identify and acknowledge their experience in terms of individual learning and group experience, and (2) evaluate the program

The culminating event for both of these objectives was for the students to work in small groups and draw collages of what they had originally expected the project to be and of what it turned out to be. In the collages and in the individual comments written by students, they repeatedly emphasized the importance of getting to know each other.

In response to the question, "What was the most important learning or experience in this program?" they answered:

(1) Sharing with other students and the group facilitators

(2) Getting to talk about what's going on.

(3) Making new friends.

(4) Getting to know each other.

In a second collage, students identified their feelings about the Burke -- as it is now and as they would like it to be. Though each small group collage was different, some common themes emerged. The students identified a lack of consistency in the application of rules along with the lack of personal support as something they want changed in school. In addition, students identified academic achievement -- as indicated by finishing school and attending college -- as important to them.

In the portion of the workshop that dealt directly with the students' self-evaluation, not only were they able to own (with much hesitation and nervous laughter) their own positive and useful qualities, but equally important, they were able to express directly to others the qualities which they found valuable in them.

Summary

It often appears from outside an institution like the Burke that there exists an ever widening gap between what students want and what teachers perceive they need The brief work done in this project suggest that gap is real, but not so wide as it may appear. The skills and attitudes identified by teachers as barriers to students' academic ability are legitimate, and are often acknowledged by students. There are some teachers who characterize poor student performance or achievement as lack of motivation or ability, yet these teachers often do not realize that they may have failed to motivate their students because they themselves have low or no expectations of their students. The tension that exists is more often than not the result of a lack of communication between students and teachers, low expectations on the part of students and teachers, a lack of trust. and (especially in the case of ninth graders entering a new school) adapting to the strains of a new environment.

This tension, while important, is easily resolved by such activities as providing space for teachers and students to talk with each other. Unfortunately, one effective means of alleviating such tensions -- the sharing of student impressions with teachers -- was not pursued within this project. Because of the Project Director's inattention to this opportunity the Burke was unable to benefit as much as possible from the work with students.

On a final note, as the weekly student workshops drew to an end, students were allowed an increasing amount of time within the sessions to talk through the issues that were important to them both in and out of school. During this period, many of the students began to confront and share with each other the reasons behind their behavior. This exchange also provided students with an opportunity both to receive and to provide constructive criticism and praise to other students. This process revealed that students are very observant and capable of assisting each other through these psychological stresses, if they are provided with the opportunity to build a "safe" environment in which to do so. Perhaps this potential ability of students to be both supportive and critical without being shallow and harsh could be used by schools to help students cope with their own life pressures.

LEADERSHIP AND TEAM BUILDING

Building an organizational climate to support academic achievement was one of the Collaborative Project's original goals. To complement the work with teachers around introducing new technologies and approaches, and with students around motivation and achievement skills, the Collaborative planned an off-site staff development retreat for key faculty and administrators The retreat was planned for August, 1987, with a focus on problem solving and decision making concerning day-to-day operational matters and long term planning. The plans for the retreat were announced in June, and Burke faculty were invited to volunteer to participate.

Twelve staff members participated in the three-day leadership and team-building retreat The group consisted of the principal, three assistant principals, four department heads, two teachers, and two staff members from Compact Ventures a system-wide dropout prevention program). The objectives of the workshop were:

(1) To understand key historical and environmental variables that enter into future plans for change in the building.

(2) To develop a set of desired outcomes for the school, indices for measuring their accomplishment, and strategies for implementation

(3) To begin to build a broader base of leadership within the building

(4) To define the role the leadership team should assume and to begin to build collaborative skills needed to achieve it

Historical and Environmental Variables

An initial assessment of the historical and environmental forces affecting the Burke revealed the degree to which the climate in the building has been an artifact of social and political dynamics in the school system at large. The tremendous tumult resulting from desegregation led the school systems management to focus attention and allocate resources to those quarters of the system experiencing the greatest amount of unrest. The Burke was relatively quiet, consequently, it did not receive the attention and examination that might have answered questions about what the school needed. Moreover, leadership instability at the highest levels in the system resulted in continual shifts in priorities, undermining program consistency and faith among teachers that any change would endure.

In addition, the system's three-tier structure -- exam school, magnet schools and district high schools -- places district schools at the bottom of the academic hierarchy. The image associated with this structure is that the cream of the crop of students attend exam schools and the least of the performers fall to the district schools. Academic expectations for students in these schools tends to be lower.

The combination of these forces contributed to a feeling among teachers that the system administration has little regard for them, and a top-down decision making pattern left them feeling powerless to influence directly those decisions affecting policy, curriculum, and day-to-day activities.

In addition, a relatively high rate of staff turnover had created considerable instability and anonymity in the Burke. The boundaries of the school were highly permeable so that the building was vulnerable to traffic from the community unaffiliated with the school. The environment was unstable and unsafe.

Today's Climate and the New Leadership

The new building administration has successfully marshaled resources for restoring the physical plant, has buffered staff from some of the flux and uncertainty in the system, has created an environment where physical safety of staff and students is no longer a concern and where there is relative stability among the staff.

In spite of considerable change, the climate in the Burke is still one in which teachers find little opportunity to communicate meaningfully with one another. One result has been that teachers focus almost exclusively on the activities in their classrooms, with little sense of ownership or responsibility for broader building issues. According to the staff development workshop participants, 95 percent of faculty communication is with students, and 5 percent is with adults. This "retreat" into the classroom is, in part, a pattern defense against the vicissitudes and uncertainties of the system and in part, a function of the absence of viable mechanisms for communication among faculty and departments.

In effect, the Burke has moved from operating within a framework of 'survival' to achieving a posture of relative 'maintenance.' When the latter is more fully achieved attention can more successfully turn toward 'enhancement.' This three-tier framework provided a simple and useful way in which to view the following desired outcomes generated in the team retreat:

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Desired Outcomes

(1) A level of faculty and administrative participation that reflects *responsibility* and *ownership* for decision making, problem solving and planning for day-to-day operations.

(2) A progressive discipline policy that is consistent, that has contingencies that are known to all relevant actors, and is legal.

(3) Effective communication --that is, timely, consistent, efficient, and clear--among individuals and groups in the school community (administrators, teachers, staff, parent, support staff, and outside agencies).

If the leadership team could facilitate more dialogue among faculty about day-to-day matters in ways that foster participation and lead to greater faculty control, it was believed that faculty would feel more potent as a group and would take more ownership for decisions and problems in the school. Once such a climate is established, a more thorough examination of decisions about what to teach, and methods for teaching can ensue.

Along with developing outcomes according to specific criteria, participants developed indices by which to measure the extent to which these outcomes have been achieved For example, outcome #3, effective communications among individuals and groups, will be achieved when the following developments occur:

- More people at meetings and more punctuality
- More positive memos from teachers and administrators
- Paperwork completed in an accurate and timely manner.
- More input in staff meetings from teachers
- More open, direct, constructive expression of dissatisfaction
- More frequent positive interaction among teachers and between teachers and administrators (50 percent or better).
- Effective follow-through on policy decisions.
- Effective use of resources in the building.

Along with development of these outcomes and indices rich discussions took place about assumptions and normative patterns of behavior and communications that must change if these outcomes are to be realized. The impetus for these changes was to come from the leadership team.

After examining the obstacles it faced, the group indicated several specific patterns among the administrative staff that mitigate what they want from teachers. These included a tendency to be aloof and unilateral about big decisions and an acknowledgement that administrators have a limited repertoire of responses or behaviors for getting what they want from others. This analysis indicated the need to develop greater administrative skills for work with staff.

Summary

The retreat was successful in providing time and opportunity for the leadership to work and think together about the school and the needs of the staff. The outcomes that were generated were specific, and they provided clear direction for how the group should proceed to realize them. Against the first three objectives the team made considerable headway. There was not sufficient time, however, to make headway with the fourth objective, to build collaborative skills. The team's analysis of some of its own behavior helped to reveal the need for alternative ways to engage each other and faculty. Motivation for continuing the learning and development of the team was high. Plans were made to continue the team development effort in the fall.

THE COLLABORATIVE

One of the overall goals of the Regent's in funding this and similar projects was to enhance collaboration between universities and schools. Within this project the collaborative efforts also included one private organization, MassPEP. This section of the report describes how these three organizations, through their representatives, forged a collaborative effort to implement the goals of this project.

The Collaborative was the name that the planning group responsible for implementing this project adopted for itself. The group initially consisted of one of the assistant principals from the Burke, the Educational Director from MassPEP, and two representatives from ETC, and the Project Director. In addition, after they were hired, the two part-time research assistants also participated in the Collaborative's planning efforts. Except for MassPEP each of these organizations remained active participants in the Collaborative until the end of the project

Initially the work of the Collaborative was concerned with management of the project After notification by the Board of Regents in early October that its proposal was being recommended for funding, the Collaborative began to meet every two weeks. Planning and implementation were the main objectives of these meetings. While the proposal for funding outlined the types of activities that would be carried out under the project, a plan for actualizing those activities had to be developed. In addition the staff had to be hired. These activities occupied the Collaborative during the first two months of the project. In subsequent months, the Collaborative met less regularly and spent most of its time reviewing the activities that had been carried out between meetings, charting directions for the next activities, and mediating any miscommunication within the collaborative.

Staffing

To run this program the Collaborative hired a Project Director whose responsibility was to coordinate the various activities that would occur in the project. In addition two research assistants were hired. One of these individuals was responsible for documenting the efforts of the collaborative. The documenter was to attend all meetings, interview participants and develop a means of describing the work within the collaborative.

The other individual was hired to assess the extent to which computers and technology were being used in the Burke. It was felt that in order to determine where the Burke was going it was important to understand what resources, both human and capital, were presently available

While all three of these tasks were essential to the program, the loose management style of the Project Director resulted in the latter two activities--documentation of the Collaborative Project and assessment of technology-related activities at the Burke--not being carried out in a fashion that was usable by the Burke.

Making It Work

From the outset, the notion of collaboration among the three agencies was hampered by misconceptions on the part of participants as to which program they were involved in. Teachers who initially signed on as part of the ETC lab site project continued to identify with that project. Teachers who had a relationship with MassPEP continued to identify the work of the collaborative as MassPEP. Consequently, for the first two months of the program there was an ongoing "Who's on first" confusion regarding the Collaborative.

The creation of a shared understanding of the Collaborative began to take hold with the development of an implementation plan. This plan called for in-service training for teachers, introduction of innovative technology, student training, sharing of research on the teaching of minority students, assessing available technology-related resources at the Burke, and starting conversations within the Burke in order to build a shared vision of what the school can be.

In a project with such a large and complex agenda, success depends on the ability to build an overall shared vision within the planning group and to establish trusting communications. Yet for a multitude of reasons, the Collaborative had problems achieving these goals. While a recounting of the individual stories that contributed to the air of miscommunication would be informative, this report will focus only on the effect it had on the Collaborative work.

Faced with a welter of goals to achieve, some individuals on the Collaborative tended to define a specific agenda and proceed to try and make progress on that set of activities. Knowing resources were scarce, each of these people used what available resources they had to achieve as much as possible on that agenda. Some members of the Collaborative started to focus on parts of the Burke community as opposed to the entire community. The major division was between those who gravitated towards students and administrators, versus those who gravitated towards teachers and administrators. As a result, the project could have been enhanced if the Collaborative team had been more effective in implementing the following:

(1) Defining and sharing specific outcomes of the project with all participants.

(2) Involving teacher participants in all aspects of the proposal development and project implementation.

(3) Establishing a clearly defined evaluation process to measure the effectiveness of the classroom innovations and the success of the collaborative project.

(4) Providing adequate teacher training and support for teachers who were less skilled in integrating technology and teaching with new approaches.

(5) Creating on-site time and space for project participants to meet informally with collaborative team members.

(6) Reviewing and analyzing existing research on achievement of minority students in math and science.

(7) Holding meetings with participating teachers at school; too many meetings were held outside of school for teachers involved in the technology innovations.

(8) Assisting the school in developing a long-range plan for technology-based programs that extended beyond the life of this grant

Outcomes

While these problems existed, the individual work devoted to students and teachers was exceptional and of lasting benefit to those individuals involved, with some primary and secondary benefits to the school. Above and beyond the learning that is described in the preceding sections, other gains to the Burke and the Collaborative include

(1) Access to invaluable resources in terms of staff development, in-service training for teachers, and hardware.

(2) Opportunity to develop a collaborative relationship with MassPEP and the Educational Technology Center which had previously worked in the areas of student motivation and achievement and teaching with technology.

(3) A forum for teachers to interact with each other and to share ideas about pedagogy with their colleagues in other school systems.

(4) A framework to sensitize educators to the multi-faceted needs of the student learner in building a learning environment that motivates success

(5) Willingness on the part of teachers to become involved with outside organizations and people who are interested in working with teachers in their classrooms.

(6) Guidelines that will be useful to the school in developing a long-range plan for integrating technology-based programs as well as a process for working with outside agencies.

(7) Better understanding by all participants in this project that the collaborative process can be more effective when teachers, administrators, and agency representatives are involved in all stages of program development, implementation, and evaluation.

Summary

The coming together of people to plan, implement, and evaluate any endeavour is a complicated process. The description of the problems with this collaborative effort attest to this fact. Yet, the problems inherent in this project are instructive about what will likely be needed in any collaborative effort. While this project had various problems, one problem it did not have was a lack of talented, educated, and experienced people. What was lacking was leadership on the part of the Project Director and attention on the part of the Collaborative members to their own process issues, e.g. ways of making decisions and monitoring progress. Because of these failures, the opportunity was lost to build a lasting cohesive institutional response, in spite of the good work and individual gains accomplished through the project.