Section II

Case Studies

of

Elementary Science Education Reform Efforts

in Urban Districts

CASE STUDIES: CLEVELAND

Conference Participants

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The District

The Cleveland Public School District includes 127 K-12 schools which serve approximately 70,000 students. Of these students, 71% receive free or reduced lunch. Approximately 78% are minorities. There are close to 3,400 teachers, 43% of whom are minorities. There are also 240 administrators in the District. At the elementary level, 90 schools are staffed by nearly 1,500 teachers serving 44,000 students.

Science instruction is a district requirement in Cleveland. At the elementary level, primary grade students are expected to receive science instruction at least once a week, and upper elementary students twice a week. However, in the years preceding the emergence of the Cleveland science reform effort (CREST) very little science was actually taught in the District, with teachers relying on traditional textbook methods when they did teach science. Also the District did not earmark funding or provide professional development opportunities in science prior to CREST. Another key historical feature of the district landscape prior to the reform was the recent move toward decentralization. Following many years of a traditional, highly centralized system, schools were thrown into confusion and uncertainty about how to negotiate the new policy of site-based management.

The Program: Design and Strategy

CREST (Cleveland Revitalizes Elementary Science Teaching) is a project led by a triumvirate -- the Cleveland Public Schools; the Cleveland Education Fund (CEF); and the Education Development Center (EDC), a private, nonprofit research and development company based in Newton, Massachusetts. This triad has its antecedents in a smaller venture in which the Education Fund assisted the District in recruiting 14 elementary teachers to pilot and field test elementary science curriculum units being developed at EDC. The CREST project reflects not only the success of the earlier collaboration, but a convergence of all three partners' interest in systemic change across a large, urban district.

In 1989 EDC, in collaboration with the Cleveland Ed Fund and on behalf of the Cleveland Public Schools, received funding from both the U.S. Department of Education and the National Science Foundation, providing enough resources to improve science education in all 90 elementary schools in the District. The trio defined their roles and responsibilities in the following way: EDC would be responsible for the overall project administration, and for providing technical assistance to the teacher training component, the curriculum implementation effort, and the evaluation. The Cleveland Education Fund would be responsible for the on-site administration, management, and the coordination of project activities, and would serve as the liaison to the Cleveland Public Schools and EDC. The District, in turn, would be responsible for committing time and materials toward project activities, supporting and authorizing school site and district participation in project activities, and collaborating with EDC and CEF in implementing the science program at the instructional level.

The overall design of CREST, which focuses primarily on the school as the unit of change, is compatible with the District's move to site-based management. From its beginning, the CREST strategy was to mount a long-term (five year), sustained, developmental effort aimed at building capacity at the school level. CREST provided staff development to both principals and teachers with the aim of helping them plan and implement hands-on science education programs designed for their own schools. Consequently, CREST was never conceived of as a centralized implementation project. Although it does forthrightly advocate a materials and inquiry-based approach to science education, the project does not tell schools and teachers what to do. Rather CREST assists schools with processes for "figuring it out" for themselves. Thus the overall strategy might be thought of as providing outside support for local school planning and implementation.

Beginning in 1990, all 90 elementary schools in the Cleveland Public Schools participated in CREST, with half beginning as a Phase I cohort, and the other half stepping in the following year as a Phase II group. CREST is built around a lead teacher model in which a designated lead teacher from each school participates in a series of professional development activities focusing on inquiry-based science teaching and leadership, namely summer institutes and monthly meetings. Lead teachers were charged with the responsibility of teaching hands-on units in their own classrooms, initiating the development of a school plan, and forming a school science team composed of grade-level representatives. Their responsibilities continue for the duration of the project, during which time lead teachers work with their principals and their school-based science team to implement school plans.

The Accomplishments

One of the most significant accomplishments of CREST is that it has initiated the broad involvement of all 90 Cleveland schools in a science reform process. One of the major obstacles to any reform in a large, urban district is the sheer number of schools involved. However, through its systematic, school-based approach, using principals and lead teachers as the primary vehicles of communication, CREST has managed to gain at least a small "toehold" in almost all schools throughout the District. Lead teachers at all schools have access to professional development activities and information about hands-on science curriculum and materials. All schools are part of a school self-assessment and planning process.

In addition, in the first two years of CREST, all schools had access to the services of science resource teachers who were able to support schools in a variety of ways, e.g. additional staff development, individual classroom model teaching, help in organizing materials, etc. Each school has a science plan which differs from building to building since most of the decision-making in terms of curriculum, staff development and overall school reform have been left to the individual site. The involvement of teachers in collegial interactions has been extensive. Even though most plans are not yet fully articulated and are far from being fully implemented, they are in place, providing individual schools with a road map to follow.

A second accomplishment is that perhaps a quarter or so of Cleveland elementary schools are beginning to implement hands-on science throughout the school. Generally these best cases are schools in which a number of beneficent factors coexist, e.g. a strong lead teacher, a strong and supportive principal, a school culture or mission that meshes ideologically with the CREST philosophy, and a strong, cohesive teaching staff. These are schools which have collectively made a commitment to "try something new," to spend extra time and energy collecting or engineering the purchase of science materials. They have come to a school-wide consensus that hands-on science teaching is a school priority.

Over the four years since its inception, CREST also has been instrumental in developing and supporting a district-wide teacher leadership group. CREST lead teachers have now benefited from several years of professional development, from their own experiences as school curriculum leaders, from their district-wide perspective, and from their own firsthand practice of teaching hands-on science. They now form a group of lead teachers who are considerably more knowledgeable and sophisticated than they were four years ago. Currently many lead teachers are participating in a variety of advanced study groups which are sponsored by CREST and which are designed to promote individual teachers' learning beyond the parameters of their CREST responsibilities. Thus, there is now an

evolving "learning community" of leaders for science in Cleveland that did not previously exist.

Finally the "CREST model" has helped to spawn other important reform efforts in Cleveland. For example, Cleveland's USI (Urban Systemic Initiative) proposal to the National Science Foundation includes an extension of CREST to the middle school level. Most recently, the Cleveland Education Fund, working cooperatively with the Cleveland Public Schools, received a NSF grant to fund the Teacher Enhancement in Elementary Mathematics (TEEM) program. Designed to enhance elementary mathematics instruction, this new project is an effort that closely parallels and was inspired by the CREST model.

Emerging Issues and Continuing Challenges

Given the policy of decentralization and the move to site-based management in the Cleveland Public Schools, CREST has wisely adopted a school-based change strategy. The great vulnerability of any school-level change strategy, however is its site-dependency. In the case of CREST, how the program "takes" at any individual school is highly dependent on the character and nature of both the lead teacher and the building principal, and also, in many ways, on the quality of their working relationship. In addition, the school-based strategy is vulnerable not only to individual personalities, but also to the frequent turnover of school personnel. Of the original 90 CREST lead teachers only a third or so are still serving as lead teachers within the project. Thus due to turnover, the bulk of the lead teachers have not benefited from a long-term relationship with CREST. In addition the relatively high turnover rate raises programmatic questions for CREST -- what activities or experiences should be offered, in an ongoing way, in order to bring new teacher leaders and principals into the project? What happens to a school when the lead teacher changes, and how can the detrimental effects of such transitions be minimized? Does a school plan still have meaning when the leadership of the school changes?

Perhaps the dominant issue facing CREST at the time of the conference is the marginal status of the project at the highest level of the District administration. Leadership for CREST is provided primarily by two outside agencies, the Cleveland Ed Fund and EDC. Also, a key part of the leadership is the District's Science Coordinator, who serves in a middle management position. In Cleveland's large hierarchical district she does not always have access to higher management levels within the District. In its four-year life span CREST has not yet gained consistent and strong centralized advocacy, nor has science reform been a priority at the district level. The District "supports" the CREST program, but CREST is not yet seen as "the District," or as "the District program." In particular, the District has not allocated finances to the project or been able to come up with a steady source of funds for much needed science materials. Nor has a superintendent yet publicly

"blessed" CREST. Rather, CREST has existed on a parallel track, outside of the mainstream of district policy and administration.

Several factors have contributed to CREST's inability to gain access to the highest circles of influence within the administration. The major one is political and financial turbulence -- Cleveland Public Schools have had three different superintendents since the inception of CREST, each with his or her own agenda and mark to make. One of the unique difficulties of reform in large urban districts is that their superintendents change jobs on the average of every two years. Also, in Cleveland, as in many other large districts, curriculum and instruction simply are not the paramount concerns of the Superintendent and the School Board. Rather, their attention focuses on political and financial issues.

The public school system is beleaguered by difficult financial circumstances, and financial resources for science simply do not exist in Cleveland. The most recent Superintendent has devoted much time and energy to garnering support for the passage of a public levy for education, which, if approved by the voters, would only ensure current levels of funding for the schools. [Note: the levy eventually failed.]

Finally, another looming and related issue for the CREST project is the issue of materials. Successful CREST schools have managed, but only through exceptional energy and commitment, to procure a hands-on science kit or two at each grade level. Teachers have written mini-grants; pooled their classroom materials allotments; or collected bottles, ice cream sticks, Baggies, etc., from home or from the local McDonald's. Principals have done their share too, juggling their budgets to buy science materials here and there, or helping their staffs write grants, or launching appeals to the school PTA or local business partner. Looking across the District, materials acquisition has been "catch as catch can," and therefore spotty and random. In the first years of CREST, struggling with materials issues often built esprit de corps among teachers, but in the third or fourth year the effort is justifiably resented. For one year there was an allotment of Eisenhower funds to support a local kit-making center, which was intended to provide materials to schools almost at cost. This effort was terminated, and schools have been left again to resolve materials questions for themselves. What is still missing is a centralized, district-wide commitment and financial support for a system to provide district-wide the instructional materials necessary for successful hands-on, inquiry-based science education.

The CREST project has done well in building the capacity of the District in terms of its lead teachers, the involvement of principals, and the initiation of activities at many schools. The project has shown the feasibility of elementary science taught in a hands-on mode, and it has created many successful instances of it. But, after four years CREST seems to be reaching a kind of ceiling of success at the individual school level, one which could be bolstered with a formal show of support from the central office. The key question that now remains is whether the District is both willing and able to maintain the efforts that have been made to date, and build upon them so that more schools, teachers and students have a chance to engage in good hands-on science.

CASE STUDIES: SAN FRANCISCO

Conference Participants

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The District

The student population of the San Francisco Unified School District represents a rich meshing of cultures from the ethnically diverse city it serves. Nearly 30,000 elementary school children, who come from homes where more than one hundred different languages are spoken, attend approximately seventy K-5 schools. 84% of the elementary school population is non-White, with Latino, Chinese and African-American represented at approximately 20% each.

The Program: Design and Strategy

The San Francisco elementary science reform effort is an amalgam of three separate but cooperating projects. These three major partners include: The San Francisco Science Leadership Project, funded primarily by the San Francisco Foundation and the Department of Education; The School in the Exploratorium's (SITE's) Partnerships for Leadership in Science Teaching, funded by the National Science Foundation; and the City Science program of UCSF's Science and Health Education Partnership, also funded by the National Science Foundation. The genesis, design, funding, and management of each of the projects are independent. As a result the projects are quite different from each other in nature. However, the most dramatic element in the story of San Francisco elementary science reform is the growing collaboration of the three projects, and their slow, but steady convergence on an increasingly common effort that builds on each of their strengths.

The San Francisco Science Leadership Project aims at building the capacity of the District for implementing a core science curriculum aligned with the philosophy of the California Science Framework, Project 2061, and other "vision" documents. The primary strategy of the project is preparing and developing a district-wide teacher leadership cadre, which will serve as the "engine of implementation" for the District's new science adoption. Over the

past four years, the Leadership Project has provided approximately 27 teacher leaders with a very extensive and in-depth professional development experience. This leadership group has developed a district-wide science matrix, and grade-level model curriculum units. They have taken several science content courses at both UC San Francisco and San Francisco State University. They have participated in two years of summer institute experiences at the Exploratorium focused on inquiry-based teaching and issues of hands-on science teaching. In addition, the leadership group, working in teams of three, has provided three days of (mandatory) staff development to their own home schools (which comprise more than a third of the District's elementary schools) for two successive years, all in preparation for district-wide science adoption and implementation.

For almost two decades the School in the Exploratorium (SITE) has focused its program on providing individual teachers from all over the Bay Area with in-depth, intensive experiences in inquiry science teaching and learning. Historically, it has offered Introductory Workshops, focused on such topics as "Sound" or "Light and Color," as well as three week-long summer institutes, devoted to inquiry. With the creation of the San Francisco Science Leadership Project, and the District's interest in elementary science, SITE refocused much of its work to help develop the District's leadership cadre. The program offered summer institute experiences for the San Francisco lead teachers in both the second and third years of the Leadership Project, as well as for lead teachers' "partners." Aimed at furthering even higher levels of leadership expertise within the District, SITE has sponsored four Teachers in Residence in conjunction with SFUSD. The Teachers in Residence have played important leadership roles in a number of ways -- they have provided ongoing classroom support to institute "graduates"; they have helped to develop new curriculum and programs for SITE; and they have served as valuable liaisons between the SITE program, the San Francisco Science Leadership project, the District administration, and the schools themselves.

The third major partner in the overall San Francisco science reform, is the City Science program. The City Science program, based on the "Fairfax, Virginia Model," is a kit-based model designed for the teacher who is new to hands-on science teaching. The 100 City Science teachers, representing almost every elementary school in the District, have received intensive training in the use of district-selected, grade-level, hands-on science kits. In addition, the four-week City Science institute offers teachers a range of experiences supportive of their science teaching -- special instruction in teaching strategies, such as cooperative learning or alternative assessment; discussions focused on pedagogical issues; field trips; as well as a variety of opportunities to interact with scientists from both UCSF and other local institutions. After a summer's training on a particular module, City Science teachers receive a hands-on science kit, with the charge to use the curriculum and accompanying materials in their classrooms. Thus, over the course of the four years of the City Science program, these 100 teachers have learned about and

implemented all three teaching modules at their grade level. Moreover, they have developed a strong district-wide network of colleagues, and many have taken on increasingly significant leadership roles both within the project and the District.

The Accomplishments

One of the greatest accomplishments of the San Francisco science reform effort is the grafting of three originally separate and somewhat competitive programs onto the common trunk of a district-led, district-wide science implementation. This merging of efforts did not happen without strains, but it did occur naturally over time, much to the credit of the teacher leadership that all three projects helped to develop. The Leadership Project, SITE, and City Science all promoted and drew on essentially the same pool of teacher leaders. There has been extensive intermingling of these teacher leaders -- e.g. Science Leadership teachers served as master teachers in City Science summer institutes, City Science teachers were participants in SITE workshops and institutes, teachers with previous SITE training served as Leadership teachers, etc. Consequently, programmatic boundaries have slowly eroded. Synergistic and mutually supportive relationships have been established. In particular, several high-level science resource positions are held by teachers who have participated in all three programs. The most dramatic example of this hybrid and indigenous leadership is the appointment of the most recent Director of the City Science program, who was formerly a Teacher in Residence at the Exploratorium, and both a former Leadership and City Science master teacher.

As a result, a strong teacher leadership capacity has emerged in the San Francisco Unified School District. The District's science implementation effort now rests in the hands of a substantial cadre of teachers who understand issues of hands-on science teaching and learning quite deeply. In addition, the District has created a viable pyramid of teacher leadership -- with the base resting solidly on several hundred classroom teachers teaching hands-on science for the first time. At the mid-level there are other teachers actively engaged in professional development to enhance their elementary science instruction and serving as reliable conduits to grade-level teammates or next door neighbors. At the top of the pyramid are Teachers in Residence and a highly experienced group of teacher leaders, who are very active in district-level reflection and planning.

"Teachers teaching teachers" has been an effective grass roots strategy for promoting change in San Francisco elementary schools. This strategy was exemplified in the three district-wide staff development days organized by the District in 1993-94 to provide all elementary teachers with three days focused on the science implementation. These massive professional development experiences were designed, prepared and staffed by large numbers of teachers, all participants in one of the three elementary science projects. In contrast, in other districts that lack teacher leadership capacity we have seen district-level edicts, ungirded by broad-scale teacher support, fail to materialize.

The San Francisco initiative has received a large measure of support from the top levels of the District administration. The three district-wide, mandatory professional development days devoted to elementary science were a dramatic and precedent-setting event in this District, and were the direct result of the current Superintendent's support. In addition, the Superintendent was instrumental in obtaining a building to house a Math and Science Resource Center, used for professional development activities and the storage and circulation of materials.

Moreover, an important aspect of the San Francisco effort was the fact that the locus of control remained within the District. In many reform situations, outside agencies seek entry into a school district in order to "fix it," raising issues of ownership and responsibility. In San Francisco, the District not only resisted outside control, but also, unlike many other urban districts, took active responsibility for the reform. With the District as the center of the coordination effort, SITE and City Science stepped in with strong supportive roles, namely City Science's focus on reaching large numbers of teachers and on science kit-training, and SITE's focus on immersion in inquiry science teaching. All three contributed, ultimately, to the creation of a multitiered, robust, and increasingly integrated district-wide program.

A final accomplishment in San Francisco is that a sizable "beachhead" toward kit-based, hands-on science teaching has been established. A kit-based curriculum has been adopted, a district mandate for hands-on science teaching has been established, and a substantial number of teachers are familiar with the curriculum materials. In addition, the first stages of resolving science materials issues have been addressed. In particular, the District has made a sizable initial investment in instructional materials, purchasing multiple sets of hands-on science materials (kits) for each school. They have also established a system for replenishing kits on a district-wide basis.

Emerging Issues and Continuing Challenges

In spite of relative success at the District and the individual teacher level, the overall San Francisco effort remains somewhat invisible at the school level. There are few historical precedents within the District to support school-level change, nor has the initiative actively

focused on developing school-level strategies for change. Although teams of Science Leadership teachers provided staff development to their respective schools, and although all elementary schools participated in the three district-wide inservice days, there are very few schools which, as a whole, have actively taken up a science reform banner. Among the relatively few with strong, school-wide programs are those with historically strong staffs and principals, and well-established cultures.

At this point, there are several design questions regarding school-wide change. Should the effort focus on those few schools that are active and willing, but are also almost always the "stars" in the District, the ones which traditionally receive the kudos and extra resources? Should the effort focus on selected "pilot schools," but run the risk of not being able to extend benefits beyond that small sample? Or should the science reform effort confront the generally undeveloped nature of San Francisco school-level infrastructures, hoping to design transformative processes and activities which lay a contextual foundation for broader school change? Or is promoting the development of healthy school communities work that is well beyond the scope of mere science reform?

In particular there are two "missing pieces" at the school level that the San Francisco science reform effort must address. The first is the issue of staff development. Most classroom teachers, in spite of the three district-wide days devoted to the science implementation, simply do not have enough knowledge about the adopted units to teach them confidently. Less than a third of the K-5 schools have received any kind of additional or long-term inservice on the science curriculum through their work with the Science Leadership teams, and even in these schools Leadership teachers would agree that acceptance and implementation is "spotty." Thus the challenge for the change effort will be how to provide the resources, both in terms of expertise and release time, to teachers to enable them to understand and become familiar with the curriculum initially, and how to provide ongoing support to bring new teachers on board. A second missing element at the school level is materials. Once science kits have been purchased and delivered, it is very much up to the school to unravel issues of sharing, maintaining, and storing the materials. As is well-known, these issues can make or break the viability of a hands-on science program. Although the District has established a replenishing scheme with a full-time resource manager, it has not been widely used.

Another source of concern in any large district is simply the danger of "the rubber band poised to snap back." In spite of the extraordinary accomplishments of the triad of programs in San Francisco, progress rests on a precarious platform. Much could be lost through inevitable events, such as the leave-taking of a supportive Superintendent, who sees "math and science as the gateway" for minority students. Or the science reform could lose its momentum as the state adoption cycles move the whole District to turns its attention to math or literature.

Finally, the continuing collaboration of three distinct but mutually supportive projects is subject to a natural funding demise. As of the writing of this monograph, the Science Leadership Project is technically no longer in existence, the SITE program is funded for only another six months, and City Science has an expected life span of only one more year. [Note: At the time of publishing this monograph, San Francisco has received a Local Systemic Initiative grant, and the Exploratorium has been funded to serve as a national center for inquiry teaching and learning.]

CASE STUDIES: PASADENA

Conference Participants

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The District

Pasadena is one of 83 school districts in Los Angeles county. It has 22,500 public school students with an additional 6,000 attending parochial schools. Described as a "microcosm" of Los Angeles county, its student population is diverse, and in fact it was the first district west of the Mississippi to undergo federal desegregation. Of the public school students, 45% are Latino, 36% are African-American, 16% are White and 3% are Asian/Other. Of the 16% who are White, about half are Armenian refugees or first generation Americans. Approximately 65% of all of the public school students are in the two lowest income categories.

There are 23 elementary schools serving more than 10,000 children in Pasadena Unified School District. The teaching population of 450 teachers is relatively mature, with a median age of 51.

The Program: Design and Strategy

The science reform effort in Pasadena, Project SEED (Science for Early Educational Development) is the result of a strong partnership between a university, California Institute of Technology, and the Pasadena Unified School District. The antecedent effort to Project SEED, initiated by two Caltech scientists, focused on a single school, a "lab" or "pilot" school. Here scientists and teachers worked together, as a "cooperative learning group" to identify and develop instructional materials, and to understand the professional development and support needed for teachers to successfully teach hands-on science. In 1990, after this two year collaborative effort, the partners felt that they had developed a successful national model for an elementary, hands-on science program, and applied for and received funding from the National Science Foundation for Project SEED.

The model for Project SEED, based on the cumulative lessons learned from the first pilot school experience in Pasadena, is well defined. First, the classroom teacher is responsible

for science instruction. Science teaching is not relegated to a specialist, or to a pull-out program. The model is kit-based. Elementary science curriculum units and kits were selected from nationally developed sources, and then adapted for district-wide use over several years by scientists and teachers working together in classrooms.

Professional development for teachers is also kit-based, e.g. teachers learn to teach the four hands-on science units designated for their grade level. Pasadena teachers participate in two years of professional development activities. In the first summer, teachers attend a one-week institute at Caltech, returning again midyear for two additional days, and the following summer for another week. Each summer training session is led by a team of three consisting of a lead teacher, a scientist, and a PUSD resource teacher. The lead teacher, who has taught the module in his/her classroom, is responsible for leading the institute, while the scientists and resource teacher are available to assist and facilitate group discussions. Usually, no more than ten teachers attend any single institute or mid-year session.

The overall strategy of the Project SEED model is to start small, working intensively for several years with one or two pilot schools. Then project leadership can draw upon the knowledge and leadership capacity developed there to expand the effort outward to a more widespread use of kits throughout the District. Key to the success of the model beyond the pilot school stage is a strong and ongoing partnership between university scientists and the school district. The scientists lend technical knowledge, political support and credibility to the project. More significant to success is that the ultimate locus of control and responsibility for implementation resides within the District. In the case of PUSD, the District has made a commitment to provide political and financial support for the project. The Board of Education adopted the program in 1991, thereby legitimizing it within the District, and garnered widespread support for it from the local parent community. The District has also supported science reform by contributing Eisenhower and State Mentor Teacher funds to Project SEED, and, after a recent state science adoption, by using its state instructional materials monies to purchase many kits and consumables newly added to the approved state list.

The Accomplishments

The major accomplishment of Project SEED is that it has achieved widespread kit-based science teaching throughout the Pasadena school district. Moreover it also has succeeded in initiating, developing, and sustaining a district-wide system for the support of science instruction. Specifically Project SEED supports a district-wide system for purchasing, maintaining, and delivering science kits to teachers' classrooms. As mentioned, the project also includes a system for two years of professional development based on grade-level appropriate kits for each PUSD elementary teacher. Through the services of centrally located science resource teachers, there is also a system for ongoing classroom support for

science teaching. Last, but not least, a strong and consistent set of expectations for hands-on science teaching has been established at all levels of the school system -- at the central office level, as well as at the school, teacher and parent levels.

Key to the project's success are the linkages it has forged with the District. Project SEED is the district program. Especially instrumental to the survival and continuing presence of a hands-on science program in the District is the relationship the program enjoys with the Assistant Superintendent of Instruction, whose unique position allows him access to both the elementary principals and to the superintendent. This assistant superintendent meets monthly with principals, frequently including Project SEED on the agenda -- asking them to bring in and discuss good examples of student work in science. It is important to note that Pasadena is a relatively "small" urban district. It has only 23 elementary schools as opposed to 70 or more in many others. In many very large districts sheer numbers make building relationships and communication channels almost impossible.

Through Project SEED, a strong and multitiered leadership cadre has developed. There are four district-level resource teachers supported by the District, led by the original resource teacher from the first pilot school effort in Pasadena. There is also a large pool of lead teachers who have had numerous experiences teaching in summer institutes and support workshops. In addition, there are presently a few advanced study and/or unit development groups of teachers who focus their work on such issues as assessment or inquiry. Again, the District is small enough that it has been possible for the project leadership to engineer many ways for this leadership cadre to interact and co-mingle with one another, thus ensuring the passing back and forth of good ideas and practices and building esprit de corps.

Project SEED has not only had deep influences on PUSD, but it has also had an impact on Caltech. Caltech, under the leadership of the two scientists who made the first proposal to the school district, now has a formal science education effort. CAPSI (Caltech Pre-college Science Initiative) has been established and represents a permanent home and university commitment for science education. This institutional commitment is the direct result of Project SEED and receives strong reciprocal support from the District.

Finally, as Project SEED has helped create a cadre of teacher leaders, it has also helped create a group of scientists who have a firsthand, and therefore more sophisticated, understanding of elementary teaching and public education. The project has structured working partnerships between teaching practitioners and scientists in which their status is equalized and their work together becomes mutually beneficial. As a result Project SEED is one of a few projects which has been able to provide scientists with authentic and useful roles, so that they can contribute their expertise in an appropriate and productive fashion in public school settings.

Emerging Issues and Continuing Challenges

There is always turbulence in any urban district and Pasadena is no exception. Most recently a new superintendent has been appointed, and the assistant superintendent who served as the great friend of Project SEED has left the District for a new superintendency of his own. Because of the turbulence at the highest administrative levels, hands-on science education is always under threat in Pasadena. There is a constant need to re-establish and redevelop relationships, and to re-educate administrators and members of the school board. In spite of the years of work that have taken place, Project SEED is still vulnerable to the political and educational agendas of new personnel and personalities.

Pasadena, like other urban districts, suffers from diminishing financial resources. Therefore the money allocated to Project SEED, like the political support, is also under threat. In response to tenuous district finances, Caltech and the District have applied for several large grants, and because of the strong successes of Project SEED, they have been successful in receiving them. The downside, however, is that the project is built largely on "soft money," never a reliable or long-term source of revenue.

An emerging issue for the Pasadena effort is related to the project's overall strategy of "Let's get it going, then let's get it good." This approach has now encountered a kind of intellectual ceiling defined by "kit implementation." Teachers have focused first on teaching the kits, and, only later, on the underlying pedagogical principles of inquiry or constructivism. As a result the project leadership has not seen, for example, many teachers making generalizations about hands-on pedagogy, or transferring and applying Project SEED strategies to other areas of the curriculum. Although many teachers are using the kits, they are unable, as one new PUSD administrator commented, to articulate what they are doing and why. The challenge then is to offer teachers professional development experiences which will deepen their understanding of the underlying rationales and principles of interactive, hands-on science teaching.

Finally, because of the relative successes and "high profile" of Project SEED, the project is facing increasing political pressure to "prove" itself. The project is expensive in terms of human and financial resources -- can it justify the expenditure? Can the project show that hands-on science teaching is more effective with students? Even though Project SEED has been very successful in implementing hands-on science across the District, there's been no let up in the work that is needed to sustain its gains. [Note: subsequent to the Inverness conference, Pasadena received a NSF grant to disseminate its model to a dozen additional California school districts.]

CASE STUDIES: BALTIMORE

Conference Participants

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The District

> *The changing face of Baltimore has a profound impact on every aspects of life in the region.*

The demographics of Baltimore have changed dramatically in the past three decades. The population has decreased by a third since 1960. School enrollment has fallen as a result by nearly 44%, reflecting an aging population and the loss of younger families in the city. "Urban flight" has led to a condition where most of the people who work in Baltimore now live outside of the city limits. The median family income in Baltimore in 63% less than the state median; one in five households meet federal poverty guidelines compared to the state figure which is one in ten. More than 60% of all Baltimore citizens are of African-American ancestry.

Baltimore City Public Schools is one of the largest systems in the United States with more than 110,000 students, 70% of whom receive free lunch, 60,000 students are at the elementary level, with 118 elementary schools that serve a population that is predominantly African-American (81%).

The Program: Design and Strategy

The "Baltimore Elementary Science Teaching" (BEST) program had its origins in 1988 when a group of like-minded science educators from around the city met together to explore ways to improve science education through a hands-on curriculum. This group helped initiate a district-wide assessment of elementary classrooms, that what was taught was text-book oriented, and that hands-on materials for teaching science were not available. At the same time, the assessment revealed that teacher interest in teaching science was high and teachers would be willing to provide hands-on science instruction if good curriculum and appropriate support were provided.

Contributing to the momentum of the reform effort were several events. First, 1989, Baltimore City Public Schools piloted three nationally recognized hands-on , kit-based

science programs. Teachers, as they became familiar with the materials and the process of hands-on science through their pilot programs, were generally enthusiastic. Given this initial burst of interest in elementary science, members of the District's Office of Sciences and Mathematics moved ahead. Realizing that the pilot materials did not meet the needs of an urban setting like Baltimore's, they decided to design their own curriculum. Between 1989 and 1992, twenty curriculum units, called STARS (Science: Thinking, Application, and Research Skills) were developed by Baltimore educators with assistance and review from personnel from local universities and science institutions.

Eisenhower funds were used to hire a BEST coordinator. A massive effort was launched to solicit funds from private "school partners," during which $250,000 was raised for the purchase of science materials. Finally, after negotiations with the district administration, a core group consisting of the Baltimore Public Schools, Towson State University, and a consortium of local higher education and science institutions applied for the received NSF funding for a five-year program designed to provide professional development to teachers.

Today, STARS is the elementary (1st - 5th grade) science program for Baltimore City Public Schools. The overall organizational structure of the project is straightforward. The District suggests that four modules of science should be taught at every grade level -- one in life science ,one in earth science, and two in the physical sciences. Scheduling for science at the elementary level in Baltimore is also articulated by the District Elementary teachers are required to teach three weeks of science every quarter, for approximately an hour each day, with the same time block used by health and social studies for the remainder of the quarter.

The BEST project is primarily a professional development effort aimed at the school level to provide training for the effective implementation of the STARS curriculum. Schools are asked to "buy in" to the program. Except for the first pilot year, when the first 11 schools who volunteered to participate in the project received materials purchased with corporate donations, schools are required to purchase the STARS kits, an initial investment or start-up cost of approximately $2700. (Many schools have found business partners or philanthropic groups who have made substantial contributions to the purchase of kits and supplemental materials.)

Schools principals are also asked to select two lead teachers, one a primary and one a upper grade teacher, to actively promote the program at their school. The two lead teachers from each school then participate in fairly intensive professional development activities. In January of the academic year, preceding the school's entry in the projects, all of the leadership teachers who have been identified in the fall take a graduate credit course, taught by a physics/science education professor from Towson State and the District Coordinator of the Office of Sciences and Mathematics. The class meets once a week for 15 weeks, and the class sessions are held in the schools, not a Towson State.

Using a constructivist philosophy and instructional strategies which model hands-on, interactive teaching, the focus of the class in primarily the science content that is in the modules, although there are sessions which address leadership issues as well. Over 250 Baltimore lead teachers have taken the course.

As the year progresses, the District office staff works closely with pairs of leadership teachers in helping them to become "experts" in one of the modules. In June, the leadership teachers who have received training throughout that year, then become the trainers of curriculum-based summer workshops for the other remaining teachers from participating schools. These workshops are grade-level specific, with half the day spent on module training and other half focuses on pedagogical and philosophical issues.

Inclusion in BEST requires a school commitment, BEST schools must allocate funds for the purchase of science materials, they must promise administrative support for the effort, there must be a school-wide expectation that the entire faculty will participate in training, and the school must make an effort to inform parents about the project. In turn, BEST provides access to readily available materials, a centralized materials replenishment service, and on-going professional development for school staffs, including support to attend conferences and other events.

The Accomplishments

The BEST staff who initiated and have remained with the project since its inception feel that one of its greatest achievement is, simply, its survival. Since the program began, Baltimore has had three superintendents, and five assistant superintendents for the division in which the project resides. In addition almost 30 people have cycled in and out of the Office of Sciences and Mathematics. Thus, partially as a result of instability, the BEST project has received little concerted or sustained support from the higher levels of the District administration. Rather, it has survived in the margins of the overall district "turbulence." Ironically, perhaps its lack of visibility has proved to be an unforeseen benefit, allowing the project to remain untouched when other more visible counterparts might have been sacrificed to political tides.

Another important accomplishment, one that may in fact be key not only to the survival but also to the success of STARS, is the strong partnership between Towson State University and the District Office of Sciences and Mathematics. This partnership has been one of mutual reliance and mutual benefit. Towson State has provided science resources and expertise to the BEST project, as well as a measure of institutional stability. In turn, Baltimore City Public Schools have provided the university with a "living laboratory" replete with the contextual realities that come with science reform efforts in large urban districts. Thus, both partners have brought something to each other. Perhaps, the successes of the partnership are most clearly illustrated in the collaborative development of

the for-credit class which has been offered to STARS lead teachers. Taught by representatives from both the university and the District, it has provided an arena not only for the project leadership, but also for the growing cadre of teacher leaders, to move beyond kit implementation and operational issues toward a "learning community," where pedagogical questions involved with hands-on science teaching can be explored.

The BEST project has had a notable influence on individual teachers at the school level. It has created a growing pool teachers throughout the District who are interested in and enthusiastic about hands-on science teaching. The STARS Materials Manager spoke about her own classroom experience:

> *STARS did something for me that I think is typical of many of the teachers in Baltimore City. It gave the energy to want to teach again. It gave me a sense that children can have fun learning. It gave mea sense that classroom management does not have to be keeping the children still -- that we could go beyond the "Don't move, don't talk!" approach.*

In a kind of spillover effect, the project has rejuvenated many Baltimore City teachers who have started going to workshops and conferences again and, in general, teachers are showing an interest in participating in professional development activities beyond the scope of the project.

> *Many of our teachers are seasoned teachers. They are being reaffirmed and revitalized, and that is a plus for us.*

In addition the District is developing a strong cadre of teachers who, through the professional development activities provided by the BEST project, are building their understanding of and enthusiasm for science teacher. The program not only provides opportunities, through classes and workshops, to learn about science and hands-on science pedagogy, but also opportunities for teachers to teach more another in summer workshops which address content and instructional issues. Thus fare then, the project ahs developed a strong foundation level for a multitiered teacher leadership effort.

Emerging Issues and Continuing Challenges

By their own self-description, Baltimore, as much as or even more than any of the other cities participating in the Urban Elementary Science Conference, represented the "Too much, too soon, with too few people and too little money" syndrome so characteristic of many urban efforts as they engage in systemic science reform. This phrase -- "Too much, too soon!" -- coined by the Baltimore team, drew belly-laughs of recognition from the conference participants. To illustrate, in the first year BEST worked with 11 schools. In the second year, a cadre of 29 schools were included in the projects, and in the following

year 31 more. In the 1993-94 academic year, 23 more schools were included, and 30 schools were expected to start in the fall of 1994, the fifth and final year of the project. The BEST project has suffered from having too much to do, with too few resources. Although primarily designed as a professional development effort aimed at elementary teachers, the project became trapped not only by the sheer numbers of schools they had promised to "work with," but by the demands of a systemic approach to addressing all of the interrelated dimensions of science education reform. The project found it needed to address curriculum development, materials, pedagogy, as well as site-based management and leadership issues simultaneously.

Curriculum development was a major focus of the project in its early years, a strategy for change the project leadership said they would probably not choose again if they were starting over. Developing and writing good hands-on science curriculum is very difficult, and much more complex and time-consuming than most science educators realize. Once the STARS team understood the dimensions of the task they had set out for themselves, it was too late. They had committed to producing four units/modules for each grade level. Today the results are mixed. The units were "cranked out," and completed, but there is variation in their quality. In addition, STARS leadership feels that the units need to be revisited and revised now that they have been "field tested" by Baltimore teachers.

Materials for hands-on science teaching continue to be a major barrier to more widespread adoption of Project BEST at the school level. In the first year of the project, the first eleven schools had access to $250,000 (raised from private donations), a generous allotment for each school that allowed them all to be well-supported with ample materials. In the following years, however, there simply was not enough project money to supply schools with materials. Thus the responsibility fell to individual sites to acquire financing for a hands-on science program. Unfortunately, many schools lack resources, either the know-how or the dollars, to be able to make the extra effort required of them. In addition, many schools simply lack the commitment to a hands-on modular science program. Without strong advocates on their staff, or a strong mandate from the District, it is more familiar, more comfortable and more cost efficient for schools to continue traditional science teaching by requesting a waiver from the District to purchase science books.

Finally, the obvious challenge is to garner more substantial district-level support for the science reform. In the meetings, STARS lead teachers have told the project leadership that the two most valuable sources of support for them would be for the project to exert more pressure on their principals, and for the project to arrange a meeting with the area superintendents. As in other urban districts, some significant successes have occurred in individual schools, but in order to make a significant district-wide impact, the central level administration much "bless" and continue to advocate strongly for the project and the hands-on philosophy.