

# The Exploratorium Teacher Institute

## *Beginning Teacher Program*

An aging teaching workforce, projected enrollment increases, and attrition among new teachers mean that K-12 schools will need to hire two million teachers in the next decade. Teachers who possess both pedagogical skills and knowledge of science are vital to students' attaining science literacy.

—NRC, *Science Teacher Preparation in an Era of Standards-Based Reform*, June 1997

I took almost no science classes in college and then was asked to teach 7th and 8th grade science. I *hated* it! I knew nothing and didn't know who to ask for help. After all those years at the Exploratorium Teacher Institute, I became a *real* science teacher! I now love teaching science and my students voted my class as their favorite science class. This is a 180° turn of events.

— Teacher quote from *IRA Teacher Institute Evaluation Report*, 1997

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## **Introduction To The Problem**

Currently, in this country, there is no system to support beginning science teachers. Who gets help versus who must fend for themselves is left to largely to chance. This problem is significantly compounded by rapidly emerging demographic and education trends: enrollment is booming, teachers are retiring en masse, class sizes are reducing, and standards are rising.

Beginning teachers are mostly fending for themselves despite the finding that the first few years of practice are the most formative in a teacher's career (Feiman-Nemser et. al., 1998). Good teaching habits that a new teacher establishes in the first few years tend to persist throughout their careers. The converse is also true: bad teaching habits established in the first few years remain in place and become difficult to change (NCTAF, 1996). Leaving the development of novice science teachers to happenstance is devastating--to the beginning teachers, the students whom they teach, the teaching profession and to the current reform movements.

Placing novice teachers in classrooms without support additionally contributes to teacher-attrition, especially in more challenging schools and districts. Research on teacher retention shows that 30 percent of beginning teachers leave the field in the first five years (mostly within the first two years) and this figure reaches 50 percent for many of the large, urban districts. In middle and high school science and mathematics courses, up to 30 percent of the teachers are teaching out of their subject area.

Effective early practices are being linked to retention (Feiman-Nemser et. al., 1998). Researchers argue that beginning teachers are more likely to stay in the profession when we help them develop successful classroom practices from the start. The rationale is simple: people tend to stick with what they are good at doing. Novice teachers who realize positive effects on student learning gain confidence that carries them through a difficult period in their professional careers. Conversely, novice teachers who do not see evidence that they are making a difference for students become discouraged, feel overwhelmed and are more likely to abandon the field before they have the opportunity to master all the complexities of teaching.

## **The Needs Of New Teachers**

Beginning teachers are at a unique stage in their careers—transitioning from being "students of teaching" to "teachers of students" (Griffin and Millies, 1987). Their needs, characteristics, practices, and issues are unique to where they are on the professional continuum--meaning they are not similar to those of either student teachers or more experienced ones (Lortie, 1975;

Huling-Austin, 1990). Some studies suggest that no part of teaching's professional development continuum is as important as the induction year where fresh learning opportunities come in their greatest abundance. In 1997, the National Commission on Teaching and American's Future (NCTAF) found that "beginning teachers who receive mentoring focus on student learning much sooner; they become more effective as teachers because they are learning from guided practice rather than trial-and-error; and they leave teaching at much lower rates."

By-in-large, existing beginning teacher programs are focusing on more general teacher needs such as classroom management and transition issues from college to school. Few focus on discipline-specific questions of content and discipline-specific pedagogy. Yet, NCTAF finds that "what teachers know and can do is the most important influence on what students learn." The working hypothesis of our science teacher induction program is that *a discipline-specific beginning teacher program that links novices with more experienced, exemplary teachers who themselves are part of a professional community of learners will produce more effective science teaching practices earlier in the novice teacher's career.*

The conceptual design underpinning our program is that beginning teachers are immediately introduced into an established community of exemplary science teachers who can help induct these novices into the larger guild of the science teaching profession. In comparison, beginning teachers in non-discipline specific programs do not have content to focus and organize conversations about practice. These novices only have the fact that they are beginners and have little reason to stay together once the label of "beginner" fades away. In these more generic programs, novices may be inducted into the teaching profession, but not into a larger guild of exemplary science teachers.

## Project Overview

The Exploratorium Teacher Institute has completed the third year of implementing and evaluating a science teacher **induction program steeped in both content and pedagogy.**

We are studying what affect a content-rich induction program—which will make use of the Exploratorium Teacher Institute's content and pedagogical expertise, teaching materials, Internet resources, and exemplary alumni teachers serving as mentors and coaches—has on helping novices meet the challenges of their new classrooms. We are additionally studying how relationships with veteran science teachers, and access to Exploratorium resources reduces the high attrition rate among novice science teachers. Finally, because our induction program

includes extensive training for veteran teachers, we are studying how our induction program helps develop effective teacher-leaders who can pass their expertise to the next generation of science teachers.

As a demonstration program of interest and value to state and national policy communities, the Exploratorium is working with staff and consultants of the National Commission on Teaching and America's Future (NCTAF) to summatively evaluate and disseminate the results of our work. Their research is currently funded by our new NSF teacher enhancement grant (which began on June 1, 2000) which continues our work for the next five more years. Currently, the project is being formatively evaluated by Inverness Research Associates (IRA) and we will continue rely on IRA for insight into how we can improve our program.

### **The Districts And Communities Served**

The two-year induction program for novice middle and high school science teachers currently provides with a 4-week summer institute, academic-year follow-up workshops, support group meetings, in class coaching, and mentoring relationships. Our work has focused on supporting novices employed by our district partners—San Francisco Unified School District and the 23 districts represented by the San Mateo County Office of Education. Recently, we have also expanded our reach and are serving teachers in Oakland and Berkeley Unified School Districts.

It should be noted that the student-population of the schools within which we work is diverse both ethnically and socio-economically. In the San Francisco public schools, the ethnic breakdown of the students in the district is as follows: Asian (30%), Hispanic (21%), African American (16%), White (12%), and Filipino (7%). Students come from a wide range of socio-economic backgrounds, but mostly children in SFUSD are from working-class households.

In San Mateo County, the ethnic breakdown of the students enrolled in their public schools is: Asian (10%), Hispanic (30%), African American (6%), White (41%), Filipino (10%), and Pacific Islander (3%). However, within San Mateo County, we are working almost exclusively with a novices working in a smaller set of districts that the *San Mateo County Office Of Education* identified as particularly in need of our assistance. These districts include *Ravenswood* (60% Hispanic, 26% Black), *Jefferson Union* and *Jefferson Elementary* (both approximately 30% Hispanic, 30% Filipino, and 10% Black), and *Redwood City* (60% Hispanic). Like the schools in SFUSD, many of these children are from working-class families.

## The Teachers We Serve

The primary audience for this project is *middle and high school novice science teachers* employed by either San Francisco or San Mateo schools. Based on demographics, political realities, and the request of our district partners (SFUSD and the 23 districts represented by the San Mateo County Office of Education), we continue to define novices as science teachers who (1) **have earned certification from accredited preservice programs and are in their first two years of teaching**, (2) are **employed by districts on emergency credentials**, or (3) are experienced teachers, but do not hold the appropriate single subject credential **and are teaching science for the first time**. All three of types of novices have been included in the Exploratorium's Teacher Induction Program.

Currently, 32 novice teachers are in their second year of the two-year support program and another 48 are graduates of the program and are now alumni of the Exploratorium Teacher Institute (eligible for further support in our "classic program" for experienced teachers). In the fall of 2000, we accepted another 30 beginning teachers into the 2-year induction cycle, bringing the total participants to 110.

Another group of teachers served by our project are *veteran middle and high school science teachers who are alumni of the Exploratorium Teacher Institute*. These are experienced teachers who are serving as mentors and coaches for our novice participants. These teachers participated in a special summer program (the *Teacher Institute Leadership Seminar*) where they were prepared for their new roles. Participants in the 100-hour *Leadership Seminar* were selected for their concern about the vitality of the teaching profession, their success as classroom science teachers, their demonstrated commitment to the philosophy and inquiry-based pedagogy exemplified by the Exploratorium, and their willingness and ability to mentor and coach beginning teachers.

During this past summer (2000), 15 veteran TI alumni teachers participated in the *Leadership Seminar* and were trained as mentors and coaches. Of these 15, six had taken the Leadership Institute in prior years and were already serving as mentors and coaches. These veteran teacher provided the group with invaluable insights and suggestions based on their experience in our program. This fall, 12 teachers began serving as mentors, leading mentor-novice support groups and after school workshops. In addition, 7 teachers began working one day per week as classroom coaches. These coaches are veteran middle and high school science teachers who are either retired from teaching or who are on leaves from their schools. Since the inception of the

project, a total of 35 veteran TI alumni teachers have been trained and have served as either mentors or in-class coaches.

Finally, to renew our pool of alumni (from which we draw participants in the mentor program), we also include experienced teachers who have never participated in Teacher Institute summer workshops. These participants are middle and high school science and mathematics teachers from around the Bay Area. These teachers take our 4-week Introductory Summer Institute together with the novices and attend follow-up Saturday workshops during the school year.

These experienced teachers, combined with our pool of alumni, make up the community of practicing science teachers into which our novices are being inducted. The experienced teachers participating in the summer institutes are selected based upon their demonstrated commitment to inquiry-based science teaching. This past summer, 65 experienced teachers participated in the program. Since the inception of the induction project, over 250 teachers have participated in summer workshops and joined the ranks of over 2000 Teacher Institute Alumni

### **Description Of The Current Induction Program**

The core hypothesis of our work is that novices will thrive as science teachers when provided with an induction program built upon strong content and discipline specific pedagogies. However, we have learned that the more general issues of induction (such as classroom management, discipline, setting priorities, forming supportive relationships with colleagues and administrators, designing lessons and units, etc.) cannot be ignored. These issues often weigh so heavily on the novices, that it is difficult for many to have conversations about science content and pedagogy until these "generic" issues are addressed.

We have identified various key developmental needs of our novice teachers based on observations made by our evaluators. We have mapped these needs onto our program elements which is summarized in Table 1, which describes the design of our project from need to activity. Together, they comprise a comprehensive program.

With our evaluators, we have also determined that a one-size-fits-all program does not successfully meet the needs of the diverse population of new science teachers. Some beginning teachers have strong science backgrounds; others do not. Some beginning teachers bring a full repertoire of classroom management strategies to their first science teaching assignment; others have little or no experience dealing with discipline and motivation. Many beginning teachers

require a great deal of emotional support, while the more self-assured do not. In order to satisfy the diverse needs of our novices while providing a coherent program, we have developed a menu of required and optional support structures (Table 2). Mentor teachers help beginning teachers match their needs to program offerings.

### ***Recruitment Of Beginning Teachers***

In the first year of the project, we had hoped that districts would be able to supply us with lists of beginning science teachers so that we could recruit and select participants from their databases. We also hoped that novices would be selected early in the summer, receiving an orientation and first classroom visit by Exploratorium staff before the start of the new semester.

Unfortunately, we found that districts do not make hiring decisions until about one week before the start of school. Therefore, they could not identify beginning teachers for our program until well after the start of the new semester. But to help get novices begin to form a relationship with us, we needed to visit with them far sooner. This meant relying less on the district offices for recruitment into our induction program and taking a more pro-active approach.

We now make “cold calls” to schools and talk with school secretaries. They are often extremely helpful in identifying beginning science teachers as soon as they arrive on the school site. We get the names of the beginning teachers, and fax applications to the secretaries who deliver materials directly to the novices. If we do not receive a completed application within a week, we call the novices back. Science department chairs are also helpful in recruiting novices.

As the project has matured and reached large numbers of beginning teachers, we have also had success recruiting participants through word-of-mouth. Our Teacher Institute alumni and our mentor teachers gave also been invaluable in identifying novices for the program.

**Table 1: Design of the Exploratorium Induction Program**

Induction Program Elements	Developmental Need Addressed
<b>Orientation Day</b>	Build group identity and match coaches and mentors with novices
<b>Mentor-Novice Support Groups</b>	Classroom management, discipline, "tricks of the trade," reduce isolation, connect novices to appropriate Exploratorium resources, reflect on practice with others "in the same boat."
<b>Novice Workshops</b>	Generic teaching issues, designing lessons and curriculum units, sharing ideas for lessons and successful classroom activities, student assessment strategies
<b>Classroom Coaching</b>	Classroom management, discipline, reflect on practice with experienced observer, connect novices to appropriate Exploratorium resources, introduce novices to teachers in their schools
<b>Saturday Content Workshops</b>	Science content, inquiry, pedagogy, special topics (e.g. literacy, diversity, gender equity)
<b>4-wk Summer Institutes</b>	Science content, inquiry, discipline-specific pedagogy
<b>2-wk Advanced Institutes</b>	Curriculum and lesson design, science content, pedagogy

**Table 2: Required & Optional Program Elements**

Induction Program Components	Beginning Teachers (hours over 2 years)
<i>Orientation Day</i>	8 hrs (required)
<i>Mentor-Novice Support Groups</i>	16 hrs (required) up to 32 hrs (optional)
<i>Novice Workshops</i>	16 hrs (required) up to 40 hrs (optional)
<i>Classroom Coaching</i>	32 hrs (required) up to 128 hrs (optional)
<i>Saturday Workshops</i>	20 hrs (required)
<i>4-week Summer Institute</i>	100 hrs (required)
<i>2-week Advanced Institute</i>	up to 60 hrs (optional)
<b>Total Hours</b>	<b>192 hrs (minimum)</b> <b>408 hrs (maximum)</b>

## **A. Novice Program Elements**

### **Orientation Day**

The orientation, which takes place at the museum in mid-September, introduces novices to the resources, staff, and philosophy of the Exploratorium Teacher Institute. Novices are also introduced to Exploratorium teaching faculty who provide content expertise, Teachers-in-Residence who provide classroom coaching, and experienced mentor teachers who lead beginning support groups, novice workshops, and help beginning teachers connect with Exploratorium resources and expertise. But most importantly, the Orientation Day contains both formal and informal opportunities for beginning teachers to share experiences, express fears, and develop a group identity—a primary need identified by our evaluators.

### **Mentor-Novice Support Groups**

Our evaluators found that our novices need a formal mechanism for sharing experiences. Beginning teachers need to know that their problems are not unique and they need to share successful coping strategies. However, this support group can not focus solely on helping beginning teachers "feel better"—the goal must be to develop and improve practice.

Each Mentor-Led Support Group consists of five beginning teachers and one mentor. Mentors and beginning teachers are matched based on the recommendations of our evaluators: that the most successful groups were matched based on subject area and grade level as organizing criteria rather than geography or personality. IRA also found that groups that had the highest attendance rates were led by mentors who provided some structure to start conversations, but then incorporated some flexibility to move the discourse to where the novices want to go.

Groups meet *at least* twice a semester (and as often as once a month) to discuss issues of science content, pedagogy, classroom management, and general support and crisis management. Participants also share successful lesson ideas with one another. Mentors also help link beginning teachers to the rich array of resources and expertise that the Exploratorium Teacher Institute and our partner organizations provide.

### ***What We've Learned About "Support Groups"***

When this project first began, we required mentors and novices to meet bi-monthly for support group meetings. We had hypothesized that these regular meetings would give novices an opportunity to share successes and challenges with each other and an experienced veteran teacher who could put their experiences and frustrations in perspective. We also felt that these meetings would reduce the professional isolation that research says contributes to high attrition rates. These meetings were also intended to help novices become inducted into the community of exemplary Teacher Institute Alumni who make the Exploratorium their professional home.

While novices said they were eager to share their experiences with veteran teachers and their peers, we found that attendance at support group meetings were generally poor in the first year of the project. Various factors contributed to this: (1) We initially matched novices and mentors on the basis of geography (e.g. distances they would have to travel) with less consideration to matches in subject matter or grade level. (2) Some mentors led unstructured meetings with the intention of letting novices take the lead in directing the issues to be discussed – which relied on novices to be more confident and assertive. (3) Since many novices were simultaneously enrolled in local schools of education to complete clear credentials and/or involved in other support programs (such as *BTSA* and "*Teach For America*"), many novices reported that they didn't have time to attend meetings twice a month. This was especially the case when the meetings were not perceived as immediately useful in addressing the pressing challenges of their classrooms.

Through our formative evaluation, we found that novices wanted these meetings to more formalized and focused on single issues of immediate concern (e.g. preparing for upcoming parent nights, organizing paperwork, discipline, classroom management, finding cheap or free sources of science supplies, etc.). The most successful support groups were led by mentors that assigned a topic to start discussions, but then allowed the conversations to drift into other areas as needed. Successful groups also met at restaurants where novices and mentors could talk while sharing a meal. Not surprisingly, the largest, most well attended support group attracted participants willing to travel long distances to make the meetings – demonstrating that novices were willing to sacrifice the little time they had for valuable experiences.

Based on these findings, we made the following changes to this program element: (1) We now require that support groups meet twice a semester, but they may meet as often as bi-monthly. (2) Mentors and novices are assigned to groups largely on the basis of subject matter and grade

level expertise. (3) Mentors are taught to lead support groups that balance structured discussions with more spontaneous conversations about teaching. (4) Groups are encouraged to meet over meals. Since making these changes, support groups have been more regularly attended and both novices and mentors find discussions valuable.

### **Novice Workshops**

Novice Workshops meet throughout the school year (on Saturday afternoons) and focus on more generic issues of teaching, but in the context of the science classroom. For example, recent topics have included parent conferences, gender equity in the science classroom, cooperative learning, bilingual teaching, and classroom management techniques. We also offer sessions on curriculum planning, lesson design and inquiry. Novice Workshops are co-led by mentor teachers paired with Exploratorium staff. We currently offer sixteen sessions a year. Novices sign up for four sessions each year, but may attend as many as ten.

Since designing these sessions to focus on more generic issues of immediate concern to our novices (rather than solely on improving content knowledge, as originally intended), we have noticed a sharp increase in attendance. Despite enormous pressures on their time, we have had little difficulty filling each of the 16 novice workshops offered each year. Sessions are generally filled (at 15) and most of the novices come to more than four per year (the minimum our program requires).

### **Classroom Coaching by Teachers-in-Residence**

Each year, five teachers-in-residence (at one day per week, or .20 FTE each) and two staff teachers provide our beginning teachers with in-class coaching. Each beginning teacher receives a minimum of 32 hours (8 half-days) of coaching during their 2-year program. Additional coaching is available based on need, up to a maximum of 128 hours (32 half-days). We contact the novices at the start of (or ideally, just before) their fall semesters and provide support and advice immediately. We also provide the coaches with some successful support models (based on what we learned during the pilot) as starting points.

### **Saturday Content Workshops**

Saturday Content Workshops—a key element of the Teacher Institute for alumni teachers for over a decade—are made available to beginning teachers. These workshops use museum

exhibits and classroom activities developed by the Teacher Institute to teach both content and pedagogy. Because these workshops are attended by experienced teachers who are also active alumni of the Teacher Institute, these sessions allow beginning teachers to connect with veterans and develop professional connections within the larger science teacher community.

Participants engage in simple, inexpensive activities that can be immediately transferred to the classroom. Workshops are led by Exploratorium staff and teachers-in-residence. The content is theme-based, interdisciplinary, grounded in national standards, and closely connected to existing curriculum. Examples of recent topics include hands-on astronomy, middle school chemistry, biological illustration, and oceans.

### **Four-Week Introductory Summer Institute**

The Introductory Summer Institute has been *the* core workshop experience for our teachers for over 15 years. Each summer we offer four 4-week (100 hour) Summer Institutes on the topics of middle school physical sciences, middle school integrated math and science (high school level in alternate years), high school life sciences (middle school level in alternate years), and high school physics.

In the Introductory Summer Institute, teachers are exposed to strong science content and teaching strategies stressing inquiry and critical thinking. The foundation for our work is the Exploratorium exhibit collection. In workshops, exhibits are tools to (1) intellectually challenge teachers with unusual or counter-intuitive physical phenomena, (2) provide a launching point for classroom activities that allow teachers to deepen their own understanding and knowledge, and (3) furnish models for hands-on, inquiry-based teaching. In the Exploratorium machine shop, teachers work with staff to make classroom versions of exhibits. Quite literally, teachers bring the exhibits, philosophy, and pedagogy of the Exploratorium back to their students.

Beginning teachers attend the institute *at the end of their first year in our induction program* (the half-way point of the program). They attend along with roughly equal numbers of veteran teachers accepted to the Teacher Institute Introductory Program. Our goal of having a nearly 1:1 ratio of beginning teachers and veterans in each summer workshop encourages informal sharing of knowledge and tricks of the trade. It encourages professional networking into the larger community, thereby reducing the isolation plaguing novices and veteran alike.

During the summer institutes, novices meet regularly with veteran teaching taking the *Leadership Seminar* (see below). The goal of these meetings is to help novices develop successful lessons and inquiry-based activities that they will use during the next school year. In these meetings, groups of novices and mentors discuss content and pedagogy – all in the context of what the novices will be responsible for teaching when they return to their classrooms. Novices get the benefits of the expertise of the veterans, while veterans have their very first opportunity to pass their expertise onto less experienced science teachers.

### **B. The Leadership Program**

Participants in the Mentor Teacher Program provide support and leadership to the Beginning Teacher Program. Each year, 15 mentors are selected competitively from our existing pool of 1,500 Exploratorium alumni teachers. They are selected for their concern about the vitality of the teaching profession; their success with students as classroom science teachers; their demonstrated commitment to the philosophy and principles of the Exploratorium; and their willingness and ability to coach beginning teachers. We don't begin with an assumption these experienced teachers know how to work with novices, only that they want to.

In the summer prior to assuming mentor responsibilities, mentors attend a 4-week (100-hour) *Teacher Leadership Seminar*, led by the coordinator of the Mentor Program, Modesto Tamez and Teacher-In-Residence, Victoria Brady. The *Teacher Leadership Seminar* prepares mentors for their roles as support group leaders, leaders of the novice workshops, and classroom coaches.

The seminar consists of five elements in which participants will (1) refine their abilities to reflect, critique, and coach, (2) plan for generic topic areas helpful to beginning teachers, such as science materials management, curriculum management, and organizational survival skills, (3) be given starting points and working models to provide enough structure to initiate relationships with beginning teachers but enough flexibility to allow the relationship to develop naturally thereafter, (4) assemble exemplary lessons, units, and other materials to prepare for the novice workshop sessions, and (5) work directly with beginning teachers attending the introductory summer institutes (which occur simultaneously) to help the novices develop "*Teaching Boxes*," a collection of curriculum materials, activities, and other resources (see description below).

### ***What Are "Teaching Boxes?"***

A challenge we faced in the first two years of the project was a conflict between the need for novices to have "stuff" and the desire mentors had to share their ideas about teaching and learning. Because novices were focused on day-to-day survival in classrooms with few supplies or other resources, they wanted mentors to supply them with materials and lessons that they could use immediately. Mentors, who had just spent the 4-week *Leadership Seminar* sharing their classroom experiences and pedagogical philosophies with their peers, felt a need to pass their knowledge and their "tricks-of-the-trade" to the next generation of science teachers.

While sympathetic to the novices, we also wanted to foster more meaningful dialogues between novices and veterans, preferably in the context of the content the novices were actually teaching. To accomplish this, the Teacher Institute developed a "product" that novices and mentors work on together called the *Teaching Box*. The concept was born from the realization that most science teachers committed to hands-on, inquiry-based teaching, have storage areas filled with file boxes that each contain materials needed to teach a science unit. Not only does a file box contain the "stuff" that the novices hunger for (like lesson plans, descriptions of activities, supplies, worksheets), it also externalizes a teacher's internalized views about pedagogy, learning, and assessment.

By engineering opportunities (during the summer and throughout the school year) for novices and mentors to work together to create these *Teaching Boxes*, beginning teachers got the "stuff" they desire and are able to reflect on deep issues of teaching and learning with veteran science teachers eager to share their knowledge.

### **C. Teacher-in-Residence Program**

Each year, one classroom teacher is selected from the leadership and mentor programs to be a full-time Teacher-in-Residence (TIR). Five retired teachers from the alumni pool are also hired as TIRs—each working one day a week. TIRs spend a year working beside Exploratorium staff. They are involved in all aspects of the program and have primary responsibility for classroom visits with beginning teachers (see *Classroom Coaching* above). Their role is critical in keeping the

program and staff vibrant and responsive to classroom realities, and they inject new ideas and viewpoints into program development and implementation.

### **Formative Evaluation Findings**

Our program continues to be evaluated by Inverness Research Associates (IRA). Their evaluation efforts have been formative, focusing on a critical assessment of the project's various program elements to determine how they can be modified to meet the complex needs of our novice participants. Their evaluation also is helping to identify critical features of our work that can be exported to other professional development programs interesting in providing similar support to beginning science teachers.

Our evaluators have also been assessing the effectiveness the programs we have in place to train and support the work of our mentors and classroom coaches. Data has been collected from focus group sessions, observations of Exploratorium summer institutes and academic year workshops, observations of mentor-led support group meetings, classroom observations, and interviews with participants (both mentors and novices).

To summarize their findings, program elements and features of our work that IRA has found to be highly successful included the following:

- *Novices reported that the Summer Institute experience was a highly valuable learning experience both in terms of improving content and pedagogical knowledge. Factors that contributed to their positive experience included: the opportunity to interact with experienced teachers; access to Exploratorium staff eager to help them become better teachers; observing models of exemplary teaching during class sessions; engaging in the variety of summer activities and using the resources available to them; the flexibility of the summer program that allowed novices to tailor the program to meet their needs.*
- *Novices benefited from having a year of school-based support prior to their participation in the intensive 4-week Summer Institute. Most novices agreed that the support they received during the year preceding the summer programs helped them gradually get to know the staff and culture of the Exploratorium Teacher Institute. One full academic year of classroom support and mentoring helped novices gain confidence in their basic classroom management skills and "survival" techniques, leaving them freer to focus on deeper issues of content, pedagogy, and student learning.*

- *Veteran teachers are deriving a number of important benefits from their new roles as mentors and classroom coaches in this program.* These rewards included forming long term relationships with other teachers, deriving satisfaction from “giving back” to other teachers and the profession, and feeling rejuvenated and inspired to improve their own teaching and learning. All-in-all, the Leadership Program is contributing to the professionalization of these veteran teachers and giving retired teachers an opportunity to continue to make important and lasting contributions to science education.
- *Both novices and veteran teachers found the “Teaching Boxes” to be an effective strategy for concretizing a variety of complex issues around learning, pedagogy and classroom practice.* As one mentor teacher said, “The box is a metaphor, a focal point for me to share my story with the novices and convey ideas.” The development of the “Teaching Boxes” represents a breakthrough for our induction program because it facilitates deep and rich discussions between novices and mentors while giving the novices a tool for personalizing and enriching their own curriculum with Exploratorium activities and other resources.

### **Some Broader Lessons Learned**

We have begun to share general findings and lessons that we have generated from the first three years of the project with colleagues and panels around the country. These are some of the broader lessons we have learned about content-specific teacher induction:

- *Novice science teachers are as different from each other as they are from veteran teachers.* The needs of beginning teachers are qualitatively different from those of more experienced teachers in terms of knowledge, skill and basic management. **To complicate matters further, not all novice teachers are alike.** A “one-size-fits-all” approach to the academic-year beginning support system will not be effective. In response, we created a program with enough flexibility to accommodate our diverse audience but with enough structure to provide coherence.
- *The most effective support is at the school site.* This is where the real help was needed by the novices and where school culture intersects with their practices and either enhances or diminishes a new teacher’s chances for success. Our most effective coaches spent considerable time helping the novices navigate around the rest of the school, securing whatever was needed at the sites to support the new teachers, and revealing plenty of very practical tricks in the profession that complemented our strengths in content and pedagogy.

The challenge was finding exemplary teachers who are available during in-school hours and free of full-time classroom service. The solution for us was recruiting retired teachers or teachers on leave. This is not difficult for established professional development networks who have a number of teachers in any given year on leave or newly retired.

- *This work is expensive.* Because of the release time required to find and support coaches to work with novices in-class, beginning teacher programs are very expensive. In California, the state provides about \$5,000 per beginning teacher per year who participate in the BTSA program (primarily elementary school level teachers), but school districts report adding \$3,000 of their own money to that total. Washington, DC allocates \$12,600 per beginning teacher per year for its novice teacher program. This experience appears to be the same for most states and districts starting similar programs (NASDTEC, 2000).
- *New science teachers want "stuff," in particular, any help translating content into practical activities, lessons and units that will support their science curriculum.* Beginning teachers need assistance with specific curricular issues done within the context of their own classes and students, rather than on a de-contextualized examination of content. Although we argue that deepening content understanding in its own right is a significant contributor to a teacher's success, beginning teachers have not yet acquired the ability to translate for themselves the relevance of content instruction into achievable academic goals for their students. This both emphasizes the significance of the in-class coaching assistance and compels us to add another program element that focuses specifically on helping new teachers develop their curricula and lesson plans.

### Some Closing Thoughts

In 1997, California needed 26,200 new teachers just for the new positions created by class size reduction policy. Another 4,150 were needed to fill positions created by enrollment growth; 7,100 teachers to replace retiring ones and another 15,000 to replace teachers whom were leaving for reasons other than retirement (Ed Source, 1997). That represents 52,450 new hires a year in a state teacher workforce that only numbers 270,000 in total. However, the California State University system only graduates 9,000 new teachers a year. As a result, one-fourth of the teachers do not have the appropriate credential to teach in the class they are assigned and some 13 percent of all teachers are on emergency credential (California Statewide Task Force on Teacher Recruitment, 1997).

The situation is particularly serious in mathematics and science. More than 2,100 science and mathematics teachers are on emergency credentials—representing one-third of all single-subject emergency credentials issued by the state. Nearly one-third of all teachers assigned in mathematics or science classrooms are in their first or second year teaching the subject. Furthermore, when class size reductions occurred in grades K-3, it was not beginning teachers who took these attractive positions. Instead, multiple subject credential teachers in grades 4 through 8 transferred to these grades. The results, particularly for urban middle schools, were devastating. In one Bay Area urban district, 80 percent of its middle school teachers teaching mathematics or science do not have a single subject or supplemental credential in the subject.

Although the problem is becoming critical in California, it is not unique. Emergency credentialing has created a situation in which 56% of high school students taking physical science across the U.S. are taught by teachers outside the field (NCTAF, 1996; *What Matters Most*, 1997; *Pipeline to the Future*, 1997). Moreover, most states are considering similar class size reduction policies that were implemented in California.

Because there are no discipline-based models for professional development geared for beginning teachers, programs are being built around teacher acculturation issues or as extensions of either preservice programs or existing in-service models. Our pilot work strongly suggests that beginning science teachers are different not by degree, but by *kind* (IRA, 1999). And while teacher acculturation into a school environment and classroom management are important issues to be addressed at this stage in a teacher's careers, we suggest that the opportunity to infuse these critical years with real-world learning in content and pedagogy is at least as important.

The Exploratorium Teacher Institute received funding from NSF, Eisenhower, and the California Department of Education to develop and implement an induction program. The purpose of the pilot was to assess the ability of the Exploratorium to develop and implement a beginning science teacher program based on the strengths of our well-established inservice program for experienced teachers. In developing the pilot program, we had to eventually resolve the question "what are we inducting the beginning teachers into?" Possibilities included the school culture, the district's way of conducting business, the teaching profession, etc. We ultimately determined that we are inducting novices to a particular way of approaching science and science learning that reflects inquiry-based approaches to developing content understanding.

However, a model program cannot ignore these other important issues that are of such pressing concern to beginning teachers. The discipline specific elements must be complemented with the very best of what we know about addressing these more general needs. Therefore, we believe that an exemplary beginning teacher program is multifaceted, exceeding the potential of either a general program or a strictly discipline-based one. We learned how to develop and blend these multiple approaches and have adopted a developmental model of teacher induction. We are moving beginning teachers through materials management, student discipline, diversity issues, and parent relations in the first year to questions of student learning and pedagogy by the start of the second year.

States, districts, universities, and educational agencies across the country are currently devising strategies and programs to support new teachers. The dollars and political will are being mobilized to launch significant initiatives in this arena. Because the trend is accelerating, there is opportunity for real systemic change. However, in the absence of any viable discipline-based models, no empirical evidence exists to support this approach to beginning teacher support. The efficacy of content-based beginning teacher programs needs to be assessed before significant time, money and resources are committed to more generic approaches.

The time for further research on discipline-specific teacher induction for those with vested interest in these programs is now. As individual districts and states gear up to develop policies and programs for beginning teacher support, the need for knowledge about successful induction and the role of discipline-specific programs is critical. Smart designs in the first instance means established practices or entrenched interests do not have to be un-done later.

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