Subject Test Preparation as a Purpose of Teacher Development Programs in Science: Summative Evaluation of the Exploratorium Teacher Institute's No Child Left Behind Teacher Quality Program

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EXECUTIVE SUMMARY

Introduction

In 2005, the Teacher Institute (TI) at the Exploratorium obtained a grant from NSF to offer courses for teachers who wish to take one or more California Subject Examination for Teachers (CSET) tests in science. Passing CSET tests is one way teachers can meet the stringent teacher quality standards mandated by federal No Child Left Behind (NCLB) policy. The Exploratorium is known internationally as a center for inquiry-based science. The TI has been offering high-quality professional development programs for middle and high school teachers for over twenty years, and for five years has been concentrating on programs for beginning teachers. For this NCLB Teacher Quality Project (NCLB TQP), the TI set out to provide test preparation courses that build on their existing programs.

The TI offered the new courses in two different formats, all at the Exploratorium: 1) a series of eight 3-hour after-school workshops (one in Fall, one in Winter 2005-06); and 2) a two-week intensive summer institute that enrolled both prospective CSET takers and alumni of other TI programs (two, offered summer 2006). The school-year series were designed to prepare teachers for General Science exams, and the two summer institutes aimed to prepare them for more specialized exams in Physics and Earth Science. Experienced senior TI instructors, with support from two post-doctoral fellows, taught the courses.

Inverness Research Associates, an evaluation group that has studied TI programs for more than a decade, focused the evaluation of the NCLB TQP on three questions:

1. Can the Exploratorium conduct test preparation in a way that is consistent with TI's philosophy and that draws on the strengths of the staff and resources of the institution?
2. To what extent and in what ways did the program contribute to teachers' success in taking the CSET?
3. To what extent and in what ways is the program a useful model for other agencies and institutions that are interested in supporting test preparation for teachers?

Findings

1. Can the Exploratorium conduct test preparation in a way that is consistent with TI's philosophy and that draws on the strengths of the staff and resources of the institution?

> Summary finding. The professional development provided through this program had distinct similarities to TI's other highly effective programs, and it also involved innovations to TI professional development strategies. While the blend of teaching improvement and test-prep purposes was not perfectly seamless, it did provide a professional development experience that participants reported was more valuable than other test preparation, and also better than other science professional development available in their districts. Participating teachers found that the courses helped demystify the test and made them feel better prepared for it. They said that the hands-on activities, a hallmark of TI programs, served as good models for their classrooms as well as helping them understand the concepts they would face on the test.

For this program, the Teacher Institute started with a foundation of the tried-and-true professional development designs, science-rich experiences and a culture of respect for teachers that they have always used to good effect. Teachers responded very positively to these features, saying that they added excitement to the courses and produced lasting knowledge about science content and hands-on teaching strategies that they can use in their teaching. On this foundation of high-quality programs, TI staff added new components—e.g., review of test content, test-taking skills, references to applicable standards—aimed at preparing them for the tests as well as for improved teaching.

For the TI staff, making the adjustments needed for these courses was challenging, both because of the inherent challenge of coverage *vs.* depth that a test-prep course presents, and because the participants had considerably less science preparation than that of most teachers who typically enroll in TI programs. The TI staff drew on a very deep reservoir of knowledge and skill—of science, of problems of teaching and learning science, and of teacher development—to make deliberate content choices and to make changes midstream in response to the participants' characteristics and needs.

2. To what extent and in what ways did the program contribute to teachers' success in taking the CSET?

> Summary finding. Data on CSET pass rates are very limited for these participants; those for whom we have test results passed at a higher rate than test takers statewide. Teachers who had not yet attempted the CSET reported that the program made substantial contributions to their readiness to take the test.

An implication is that if there are sufficient staff members, if the quality of the professional development is high, and if attending teachers are sufficiently motivated, a single course can benefit teachers preparing for different CSET tests.

One limitation on the program's effectiveness was its inability to recruit as many participants as there were available slots. A total of 49 individuals occupied 55 slots (several took more than one course), where 72 were projected. Remaining slots in the summer institutes were filled by TI alumni. Although all participants were aware of the dual nature of the course, the resulting mix of participants was probably not optimal for either the CSET test-takers or the more typical participants. Past experience with new program development at TI suggests that participation rates will increase as word of the program's existence and quality spread by word of mouth.

3. To what extent and in what ways is the program a useful model for other agencies and institutions that are interested in supporting test preparation for teachers?

> Summary finding. Other agencies that want to help prepare teachers who are not only uncertified but also under-prepared in science will need first to have the capacity to offer high-quality science professional development—including the ability to support novice teachers—and then to direct that capacity toward the additional purpose of test preparation. Even though the Exploratorium has some unique assets, many features of the TI program are transferable to other programs.

Optimally, test preparation is built onto to a foundation of high-quality professional development so that it serves both purposes. Features of the TI program that are transferable to other institutions include:

- Capacity to provide high-quality professional development for middle and high school science teachers, and the ability to modify successful programs and practices to address the unique needs of these teachers
- Commitment to addressing a limited number of concepts well and the knowledge of which concepts are most integral for both teacher and student understanding
- Confidence that test preparation is enhanced by authentic hands-on experiences and supports for classroom teaching, and the skill and resources to provide those experiences to teachers

A Final Reflection

The TI's NCLB TQP program is particularly well aligned with the TI's mission to serve new teachers. The program also advances the TI's broader mission of providing science teachers with what they need but cannot get from their schools—science knowledge and teaching skills that are of high quality and relevant to their work situations. This program adds one more dimension to the Exploratorium's position as a regional and national asset for the improvement of teaching and learning of science.

I. Introduction

In 2005, the Teacher Institute at the Exploratorium obtained a supplemental TIP grant (NSF award #9910207) to extend the work of its five-year old Teacher Induction Program. The overall aim of the project funded by the grant is to help newer teachers meet the stringent teacher quality requirements of No Child Left Behind (NCLB).

The NCLB mandate that teachers must demonstrate both content and pedagogical knowledge has proved to be a major challenge in California, particularly in the sciences. Teachers who joined the profession after 2002 must have a B.A. in the discipline(s) they teach, complete 32 upper division units in the discipline(s) they are teaching, or pass the appropriate science tests on the California Subject Exam for Teachers (CSET). The challenge is particularly acute at the middle school level, since districts are expected to provide teachers who are qualified in each subject area they teach, and middle school teachers often teach life, earth and physical science.

Exploratorium Mission and Assets

The Exploratorium is an internationally-known locus for inquiry-based science and nationally-known provider of programs for teachers. In our most recent report on the contributions of TI to the formal education system, we noted its unique place and assets as an informal provider of high-quality professional development for science teachers:[1]

> The Exploratorium is an informal science institution that sits outside the formal school system, and yet in its teacher development programs, it aims to help improve the teaching of science within the formal system…. Beyond the floor exhibits that serve both informal and formal education, the Exploratorium has institutes and workshops for teachers, a machine shop where teachers can fabricate classroom resources, a teaching faculty comprising both scientists and educators, a resource library of science and teaching resources, and web-based science and teaching resources. And because the Exploratorium has been serving teachers for nearly twenty years, with a quite stable staff of scientist-educators, all of these resources reflect the deep and rich capacity that derives from cumulative development.
>
> The Exploratorium also has a strong ethos related to the teaching of science and to teachers that sets it apart from the public school system…. In a quite literal way, the Exploratorium teacher programs do their best to cater to teachers of science, and they are guided in doing so primarily by the institution's commitment to high-quality science and love of learning science…. The TI's aim, stated most simply, is to provide "a home" for interested science teachers throughout their career and to support a professional "guild" of science teachers who occupy this home.[2] The TI staff and the Exploratorium as an institution are a repository of considerable content and pedagogical expertise, as well as of other resources, and the TI staff sees themselves and these resources as being "at the service" of teachers who want to engage with them. TI staff has

[1] *The Place and Role of the Exploratorium's Teacher Institute in Strengthening the Teaching of Science* (June 2006). Inverness Research Associates has documented the work, culture, assets and impact of TI since the mid-1990's. This report, posted on http://www.inverness-research.org, summarizes our findings about the program.

[2] Content of this section is distilled from a focus group with TI staff as well as from TI-written documents about their goals and strategies. Quotation marks signify TI language about their theories and work.

> deliberately staked out a dual role combining teacher and professor that allows them to be creative and frees them from the expectation that they will offer "typical professional development." Each of them believes in and is expert in science instruction that is hands-on, inquiry-based, and student-centered. They create programs where teachers can deepen their discipline knowledge and teaching skills, create materials to use in the classroom, reinvigorate themselves through immersion in their discipline and interaction with colleagues, and learn the specialized and challenging techniques of teaching hands-on inquiry-based science.

Since early this decade, the Teacher Institute has also demonstrated its ability and capacity to support the development of novice teachers through its Teacher Induction Program. In our 2006 report, we also noted:

> The TI contributes significantly to the formative teaching repertoires of new teachers because it advances their acquisition of both content knowledge and pedagogy. Some new teachers who bring strong content knowledge lack knowledge of effective pedagogy, while others teachers lack content knowledge… new teachers may have never experienced for themselves high-quality science teaching and learning. At the TI, they see for the first time what exciting science could look like, sometimes in programs at the Exploratorium and sometimes in their own classrooms.

The Exploratorium NCLB Teacher Quality Program (NCLB TQP)

For this project, the Exploratorium Teacher Institute set out to provide test preparation workshops that build on the high-quality professional development programs and support for novice teachers already in place.

Goals. The project has dual goals. As stated in the proposal, its purpose is to "test a NCLB support program for novice science teachers that will help them *demonstrate subject matter competency* in science," i.e., pass the CSET. Beyond test preparation, the project was designed to meet administrators' and teachers' requests for NCLB support that would "both *strengthen science content and develop science teaching strategies* at the same time," i.e., help teachers gain lasting and useful knowledge and skill for teaching science.

Program components. The Exploratorium offered three iterations of CSET Test Preparation Seminars in fall 2005, spring 2006 and summer 2006. The first two series were designed to prepare teachers to take the CSET General Science I and II tests, though several applicants preparing for other CSET tests were accepted. In summer 2006, TI provided two institutes; one was designed to prepare teachers to take the CSET Earth Science exam and the other provided preparation for the Physics examination. The summer offerings, which were two weeks long, were held during the weeks that TI typically offers advanced workshops for alumni of its annual four week Classic Institute.

Recruitment and participants. Participants were recruited via the TI listserve and website, local university credential programs and contacts at San Francisco Unified School District. Some participants also applied on the recommendation of colleagues. There were 18 slots in each of the four programs. About half of the enrollees were new to the TI, most of the rest were TI alumni, and several were enrolled in the TI novice program. All enrollees in the fall and spring programs planned to take the CSET; for the summer programs, TI accepted some alumni who

did not intend to take the CSET. TI alumni, who knew that the summer programs' purpose was to help participants pass the CSET test, attended with the expectation that the workshop would be useful to them, too. A stipend was provided, and credit was available.

Format. The fall and spring series comprised three-hour weekly meetings held from 4-7:00 p.m. over eight weeks, for a total of 24 hours each. Consistent with the format of TI's annual two-week Summer Institutes, the Earth and Physics workshops were each held for 5-1/2 hours daily, for a total of 55 hours each.

Content. Each meeting was organized around content areas covered by the relevant CSET exam. The structure of the test helped organize the flow of activities. For example, each of the eight after-school meetings in the spring had a topical theme that paralleled one of the subsections of the General Science II exam. Time was allocated, during the spring meetings, to the exam topics as follows: Exploratorium orientation, introduction to CSET, the nature of science (3 hours); force and motion (6 hours); genetics, inheritance, DNA, and mutations (3 hours); magnetism (3 hours); plate tectonics, the rock cycle, earthquakes and volcanoes (3 hours); human body systems (3 hours); and the periodic table, atoms and molecules (2 hours).

Activities, materials, resources. The fall meetings each began with a hands-on activity from the TI staff's large repertoire, and moved on to tutorials and problem solving. During the spring session, the first half of each meeting involved whole-group instruction and activities. Then after a catered dinner, teachers worked on their own or with peers and instructors on areas with which they needed more help. In the course of an evening, teachers might review sample test questions, engage in hands-on activities, use floor exhibits for explorations, listen to short presentations, engage in class discussions, and work alone or in small affinity groups. They were asked to complete sample questions as homework. The summer program included the same elements as were used in the spring, though the individual/group work was less structured. At least one instructor added a traditional TI activity in the summer: teacher presentations of activities.

Resources that were used included program materials from CSET, content and activity handouts (posted on the web by some instructors), college textbooks and other TI library resources for additional content and lists of helpful websites. As always, inexpensive, readily-available materials were provided for hands-on activities, and the exhibits on the floor of the Exploratorium were available for exploration. And as for all TI programs, one of the most valuable resources was the expertise of staff instructors.

Instructors. Experienced senior TI staff taught each class. The project's co-directors, who hold PhDs in Physics and Science Education, led three of the four offerings. A veteran TI science educator led the fourth. Other TI staff and post-docs with appointments at the Exploratorium stepped in frequently to lead activities and assist in other ways. During sessions, there were often three to five instructors available to the participants.

This Study

Inverness Research Associates has more than a dozen years of experience studying the Teacher Institute and its programs. We drew on our knowledge of the program, and particularly of its Teacher Induction Project, to study the NCLB Teacher Quality Program. The evaluation addressed three questions:

1. Can the Exploratorium conduct test preparation in a way that is consistent with TI's philosophy and that draws on the strengths of the staff and resources of the institution?

2. To what extent and in what ways did the program contribute to teachers' success in taking the CSET?

3. To what extent and in what ways is the program a useful model for other agencies and institutions that are interested in supporting test preparation for teachers?

Evaluation activities. In spring 2006, Inverness Research initiated evaluation activities. We observed firsthand the spring and summer workshops and institutes, and collected staff and participant data on the fall 2005 workshop series. Specifically, we:

- observed at two or three sessions for both the spring CSET General Science preparation workshop series and the summer CSET Physics and Earth Science preparation institutes
- conducted and transcribed tapes of focus groups with all teachers at each of these sessions
- interviewed three TI staff who led the program
- interviewed two IPSE post-docs who assisted with the program
- collected test data from all participants at focus groups, reviewed participant data that TI collected on applications and a survey to ascertain participants' passing rates on the CSET, and reviewed state level data on passing rates
- provided program staff members with an informal memo containing formative observations and suggestions to accompany this summative report

II. Findings

1. Can the Exploratorium conduct test preparation in a way that is consistent with TI's philosophy and that draws on the strengths of the staff and resources of the institution?

Summary finding

For this program, the Teacher Institute started with a foundation of the tried-and-true professional development designs, science-rich experiences, and a culture of respect for teachers that they have always used to good effect. On this foundation they built and added on new components (e.g., review of test content, test-taking skills, references to applicable standards) in order to address the dual purposes of helping teachers demonstrate subject matter competency in science (i.e., pass the CSET) and also to help them gain useful and lasting knowledge and skills for teaching science. The professional development provided through this program had distinct similarities to other TI programs, but also involved innovations to TI professional development strategies. While this blend of purposes was not perfectly seamless, it did provide a professional development experience that participants reported was better than other test preparation resources, and also better than other science professional development available in their districts.

Program Design

> *There is a desperate need for any help [NCLB TQP participants] can get. Not only will it help them pass the CSET, they will see us teaching as they are supposed to teach. (Paul Doherty, Project Co-director)*

Strategies. The program employed a variety of strategies to accomplish its dual goals:

- *Test-taking preparation* included formal presentations on CSET testing requirements and test structure during the first class meeting, administration and discussion of sample tests, and discussions of general test taking strategies. In addition, during activities and discussions, staff would point out concepts and factoids that were likely to be on the test. This element was entirely new for the Exploratorium.

- During each class meeting, staff presented *hands-on activities* with a focus on standards and the CSET tests. The presentations followed proven Exploratorium approaches for inquiry learning and reflection on classroom applications, including facilitated experiences at Exploratorium floor exhibits. The activities were selected to deepen teacher understanding

of key content and concepts covered by the tests. Many were activities that we have seen used successfully in other TI programs.

- Relevant *California Science Standards* were posted and referenced by staff and participants.

- *Individualized coaching* was available from senior TI staff and several post-docs funded through an IPSE grant. Coaching took various forms: one-on-one sessions to review content areas where a participant felt they needed help, weekly small groups for teachers wanting additional assistance in a discipline, and ad hoc consultation when needed.

- Staff provided *extra references*—handouts, web sites, and other resources—related to specific content areas and activities.

- Participants were expected to do a limited amount of outside preparation for the classes, such as *completing sample test items*.

- Participants also were provided time to use the Exploratorium's deep collection of *library resources*, including sets of plans and activities for commonly taught topics compiled by groups of Teacher Induction Program participants.

Program culture. The culture of the program is similar to that of other TI programs. Staff members establish a warm, welcoming and supportive environment from the first day. An abundance of resources beyond the core instructional hours is made available to participants, and there is time and flexibility so teachers can identify and can make use of the resources they need. The assumption is that teachers will be proactive in getting what they need.

Variations across program offerings. One of the positive features of the project is that the workshop series was offered three times, each aimed at preparing teachers for different tests; thus, there were three somewhat different iterations of the program, each with not only its own programmatic details, but also with its own "flavor." Similarities across the offerings included a high ratio of instructors to participants, sharp focus on content covered in the CSET, brisk pacing, and intent to improve teachers' knowledge and skill for teaching science as well as to help them pass CSET tests. The series differed in their flexibility in terms of who enrolled, the place of inquiry-based activities, the amount of individual coaching available, and participant use of "free choice" time. These variations provided staff with opportunities to learn how well different elements of the program worked for participants. (We discuss this further in the "TI Staff Experiences" section below.)

Teacher experiences and benefits

In this section we first discuss the experiences and benefits to teachers preparing for the CSET. Then, we discuss the general benefits to all NCLB TQP participants, and finally we speak to the benefits specific to more typical TI alumni who participated in the summer institutes.

Benefits to teachers preparing for the CSET

Teachers liked the format of the NCLB TQP courses, particularly the embedding of test preparation into a rich and satisfying professional development experience. The following comment reflects the sentiments of many:

> *Even though all the activities might not have been directly tied to the test, I got enough related to the test that I felt I was being prepared. If it was really all about the test, I don't think I would have come after school for four hours. I knew I was going to be excited by what we were going to do and that made me come here after school.*

Teachers were aware and very appreciative that the program operated on three parallel tracks that almost simultaneously contributed to: 1) their readiness to take the CSET, 2) their personal knowledge of science, and 3) their classroom practice. While the group engaged in an activity to deepen their own understanding of an important phenomenon such as magnetism, the instructor would remind them that particular facts or concepts would be on the CSET. The instructor would, in the next breath, point out the particular aspects of the topic that are often misunderstood by students and their teachers.

The CSET candidates found the hands-on activities useful for test preparation as well as for classroom use. As one teacher said:

> *For taking the test, the hands-on [activities] burned things into my memory. They were like things you could hang ideas on, which was really cool.*

Most teachers thought that the combination of structured instruction and free-choice time gave them an opportunity to focus on the areas that they needed most help with. The teachers in the spring session, which was particularly notable for the high ratio of staff to participants, especially valued the free time.

Teachers were aware that staff members were balancing depth *vs.* breadth in choosing what to include in the class. They appreciated that the instructors took time to review the CSET content domains with them to identify the content areas and concepts where they as a group felt the weakest. These became the areas where the instructors put their focus.

Teachers who enrolled to prepare for the CSET universally found the program to have value beyond test preparation.

> *I came here for the CSET preparation, but then as I showed up from the first day, I really liked it and I found out it may become a major source to me to teach science.*

> *If you were to take the class just to pass a test, it doesn't matter whether you understand the concept or not. You just pick out the formula and use it…. but if you want to know how to use it and at the same time understand why you are using the formula, then this is really beneficial…. Let's say, we can just go take the test now, but at the same time, we need to use this to teach the kids and so we have to understand the concept enough to teach kids, not just use a formula.*

At the same time, those teachers who were familiar with TI programs (e.g., participants in the TI Beginning Teacher Program) were aware that this program was "different" from the regular TI program:

> *In the regular TI program, you are out on the floor when the general public is not there, taking in one display and then totally digesting it and getting down deep and uncovering these layers upon layers upon layers of what math and science is really in the display. And [in this program] we are not going into that much depth in any one specific area and so it is much more skimming the surface. On one level, there is more lecture replacing it, but it is not really having that depth in any one particular thing…. It is not better or worse, it is just different.*

Many teachers reported that an important contribution of the sessions was focusing their attention on the CSET: learning about the test structure and content, addressing weak content areas, setting aside time to study, and scheduling the test rather than delaying taking it. As teachers became familiar with the tests, they became motivated to take them while their preparation was fresh.

For teachers fearful of the CSET, the TI class made tackling the test less daunting. As teachers learned about CSET's content, some gained confidence to attempt the tests, which before then had seemed overwhelming:

> *It really helped me focus on what I needed to do for the test. They made it not be overwhelming but completely doable and it actually took very little studying outside of class time, to actually go in and take the test.*

> *[The staff] know what it is that we need to know, because they have studied the standards and that is how they have been able to zero in on what it is that we need and make it doable. I tried to just read up on this stuff, but you can't read up to pass those tests. You need to understand exactly what you need to know. And then they have gobs of activities to help us learn it, in a way that you don't have to stick with the book for four hours and study it to get it, because we have done it kinesthetically and had conversations and done questions. That is how everybody learns, even as adults.*

Test candidates regarded the TI program as their most valuable preparation for the CSET, regardless of whatever other preparation they had done. Teachers came to the program knowing little if anything about the CSET unless they had already taken one of its exams. Those who had gone to the CSET website did not regard it as very helpful. Until mid-2006, there was no test preparation publication on even the CSET General Science exams, and participants had very few other options for learning about the test. Moreover, the teachers said that there are no preparation classes for taking CSET science tests other than at the Exploratorium, so the class was of great value by its mere existence. In this informational vacuum, they found the basic information about the test that the staff provided during the first session, and the opportunities to take and discuss sample test items, very valuable.

> *That is a huge advantage; to network with other people and find out this information is huge.*

The great majority of participants had done nothing to prepare for the CSET prior to taking the TI classes. A few had studied some on their own and found it difficult to sustain. Interestingly, a few who had taken other professional development for teaching science realized it would help them on the CSET after they learned more at the Exploratorium about the test.

Most participants were given an opportunity to take sample test questions and to talk about test-taking strategies as part of their workshops, and found that experience valuable. The Earth Science teachers, who did not have that experience, thought it would be helpful.

At the same time, some were not sure how much more they would need to do to prepare for the test, even they thought their time was well spent:

> *I don't think there is a wasted moment in the class, and I think all of the information that we are getting has really been solid, but the big question mark in my mind is: to pass the exam, how much more am I going to have to study on my own, to get what we are not covering? They have been pretty forthright about saying we are not covering everything; we are still going to have to study on our own.*

Not surprisingly, the program's contribution to a participant's success in passing the CSET depends in part on the teacher's prior knowledge and preparation. Several participants in school year sections had a solid background in physics, and with TI assistance, were able to pass the test. However, some participants in the summer Physics section were so far from being able to pass the CSET that if they took the test, their score might be higher than it would be otherwise, but they still likely would not pass. The courses were rich enough that at least one of the weaker participants enrolled a second time. She commented on her gains from the first session:

> *The course was very helpful, but I need more because of my lack of background. So I'm taking the seminars again, which I am finding much easier due to my increased understanding from last time's work.*

Participant success also depended somewhat on personality and initiative. Those who were assertive got the help they needed from staff; those who held back might not have. This is a pattern that we have observed in other TI programs, due, we think, to the staff's conviction that teachers can and should ask for what they need and that TI staff should do what they can to meet those needs.

Teachers had a few suggestions for improving the program. Because the sessions could not cover all the material on tests, teachers thought it would be desirable to provide suggested readings for areas not covered. Teachers in the summer sessions felt that the structured time was preparing them well to teach, but they had several suggestions for modifying the class so it would better prepare them to take the test. One suggestion was to assign more homework, especially materials (e.g., readings, a list of concepts that they need to understand for the test, sections of the CSET prep manual) that would help prepare participants for the following day's activities. If all participants were to feel solid in a concept, the class could move through it swiftly, and if not, it could spend more time. Teachers acknowledged, however, that after attending over five hours a day, they might not be able to handle much homework. They also recommended making the noon-to-2 p.m. time slot more structured for those who wanted it. There could be optional facilitated study groups, for example.

General benefits to all program participants

Consistent with our findings for other TI programs, this program was judged by teachers to be of very high quality and better than other professional development available for them as teachers of science, particularly because of its applicability to the classroom. We heard many comments like the following:

> *I do a lot of professional development and a lot of the courses are telling you how to do [activities]. But this one, you are actually doing it. I do a lot of hands-on in my classroom and I will get anything anywhere—I will take stuff off the net and try it in my kitchen, like the night before. But this way, it is already tried and true, and we talk about it with other teachers, and I can then picture it working in my class.*

It was also valued highly for its contribution to the teachers' own learning. Many teachers reported that they now understood key ideas and concepts that they had never really understood before.

> *The course contributed to my own learning. It was like an anchor, and so when I read stuff now it makes more sense to me because I have concepts, and I think that is really the key outcome.*

All participants—CSET candidates and other teachers—valued the contribution of the course to their ability to teach science better. Many participants took the course to bolster their own preparation to teach science courses for which they felt inadequately prepared. For example, summer participants in the Earth Science section included a resource teacher who is required to help 9th and 10th grade students in all subject areas and a biology teacher who wanted to move to teaching integrated science courses.

Universally, teachers valued the hands-on component of the classes, and anticipated that it would be useful in the classroom.

> *The hands-on experience is important because even if you pass the CSET, it doesn't mean that you can teach it. I think It means that you know the material, but how do you convey that to students? Thanks to this experience, if I suddenly should need to teach earth science, I feel pretty confident that I have some things available to me that I can do for kids.*

Because the courses were designed to help teachers pass the CSET, they provided repeated opportunities for all participants—CSET candidates and others—to experience and reflect on classroom practices that also help students pass tests. One teacher, for example, identified the Exploratorium's way of going deep with an activity as a key contribution:

> *There is a way they have designed their activities so that they really just look at one simple principle and they teach it really clearly. I don't think that there is any place that does that better…. They have an activity that gets to the answer, and then the deeper explanations behind it, and that really works well in the classroom too.*

Participants liked the multiple resources they found at the Exploratorium: contact with TI staff with specialized knowledge, the handouts they received, the resources posted to the TI website, lists of relevant websites, videos shown on breaks, and introductions to relevant professional groups. Teachers' appreciation for the ready availability of a plethora of resources grew over the year. They know that they could find many of the resources on their own, but, as one teacher said, it would take "forever" because they are so busy. Teachers felt confident that if they needed additional questions answered after the workshops ended, whether about classroom applications or test concepts, they could count on staff to respond by email or point them to someone who could be helpful.

For several understandable reasons, there may not have been quite the development of community that typically occurs in a TI class. The school year groups met just once a week for eight weeks at the end of long teaching days. In the summer institutes, the instructors moved rather rapidly through content areas and activities, and participants did not have a chance to work together building things in the workshop. There was also a somewhat wider than usual range of prior science preparation on the part of teachers who attended. Because there was not as much informal peer conversation during activities, there seemed to be more off-topic conversation some days than we typically see at TI activities.

<u>Experiences of TI alumni not preparing for CSET</u>

As we have noted above, typical TI two-week institutes are offered for TI alumni. In contrast, these sessions involved a combination of alumni and teachers preparing for a CSET. The TI alumni who participated noticed that there were fewer hands-on activities than in other TI programs, and missed them, but understood that the CSET test prep sections needed to cover a lot of science topics. Some alumni noted that there were fewer "dedicated and experienced" teachers in the classes than usual, and missed their input. One teacher said that the culture of the class suffered a bit from sidebar conversations not related to science, attributing that to the reduced time for interaction during science activities and possibly a weaker commitment among participants to engaging fully in hands-on learning experiences. Finally, TI alumni

typically find that instructors are very responsive to questions and interests that crop up during activities. In these sessions, however, digressions into deeper science concepts could not be pursued because of the pressure to stay on track with topics covered on the CSET.

TI staff experience and contributions

TI staff found designing and implementing the project "interesting." The Exploratorium professional development staff pride themselves on adapting to new demands and needs from the field. They enjoyed the challenge of building on successful program elements and choosing activities from their vast repertoire that would best serve the purposes of the program and the audience it drew. They all felt that they learned a lot, but that there was more to be learned.

The inherent challenges of designing for test preparation. One of the bigger challenges the staff experienced was time pressure, because of the broad content and many concepts covered by the CSET. Not surprisingly, teachers face these same time pressures in preparing students for tests. Though they worked hard to narrow the content of the courses to key areas, staff sometimes thought that their sessions suffered as a result of trying to cover too much.

> *We are very good at activities. But we were trying to cover so much content in such a short period of time that instead of presenting the activities as we would like to, with the time involved to be able to investigate it and spur the questions based on the activity, we kind of had to blaze through those much quicker than we would have. I am assuming that people came away thinking, 'these guys know what they are doing and they did a great job.' But had we had more time, I think they would have obviously gotten more out of it and been able to explore the activities more.… We were blazing through because we wanted to hit all of the content domains in the standards and the curriculum associated with the tests.… It was this invisible pressure on us where we thought that we had to get through all of the content standards to pass the test.*

Adapting to teachers with non-typical backgrounds. Sometimes the staff's ability to offer high-quality instruction was tested by the mix of teachers who attended. A staff member used an example about teaching the water cycle to describe the challenge of adapting proven TI approaches for teachers with weaker backgrounds than typical TI participants:

> *A lot of times, we expect a certain type of knowledge from the teachers that are here, and we are just giving them a new way of teaching it. In a typical class at the Exploratorium, we might have a class on the water cycle and we would have an activity for it. The participants know about the water cycle, so we would find five activities showing the water cycle to make their teaching more hands-on. That is what we are good at. However with this program [the participants] don't know the water cycle… so we have that same class and then after that, we talk about it and we try to find ways of learning it and we have people talk to each other about …and so that is a different way of doing what we usually do.*

TI staff also say that they still have not found exactly the right balance between focusing on the test versus providing high-quality professional development in areas they know teachers need help with. In the first fall series, they were "feeling [their] way." They knew that the participants' needs were different than the needs of their typical teachers, so they tried starting each session with a hands-on experience and then moved right into problem solving and tutorials. The staff-to-teacher ratio was high, probably higher than it needed to be. Based on teacher feedback, they added more hands-on activities and provided more supporting materials and resources for the spring offering. In the summer, they added even more. They concluded

that connecting hands-on experiences directly with problem solving required for the test would be a good approach: providing hands-on experiences made the CSET problems "real" for participants. In the future, the staff want to do more of that. There was some consensus that of the three offerings, the spring session did the best job to prepare teachers to take the tests.

Staff found the summer institutes the most challenging for several reasons. First, many who signed up were not taking the test, so participants did not share a focus on preparing for the exams as they had in the two earlier iterations. Perhaps due to their long days at TI, many teachers did not do all of the assigned homework, which slowed instruction.

> *[In the summer] they really needed to do more homework, and they were not doing enough. We gave them sample tests, and [in the fall and spring] they came back with questions. In summer, they didn't do the homework.*

Second, those that enrolled in the two summer offerings were significantly less prepared in the subject areas than typical TI participants, according to the staff. This required major adjustments to the instructors' plans. In a typical Exploratorium Physics section, for example, instructors are accustomed to participants who come to the program with a traditional mathematics-based physics preparation; the instructor aims to give these teachers the antithesis of that instruction by providing experiences of the phenomena, and only when questions come up or after class does he provide the math. In the CSET Physics section, on the other hand, the instructor found the participants to be "woefully under-prepared" in physics, and he had to include a strong component of math because the CSET in Physics requires test-takers to solve traditional physics problems. The instructor also realized that he needed to help participants really understand how a phenomenon tied into a CSET problem. Therefore, he tossed out his lesson plans and modified the course to meet teachers' needs. Rather than aim to prepare them to succeed in taking the exam, he endeavored to strengthen their personal understanding and classroom practice and to prepare them to answer selected items on the test.

> *What finally worked was having the teachers see the phenomenon first at the exhibit, then when they are doing the problem similar to the one on the test, having the experts to help solve it, and then having the snacks [i.e., Exploratorium-developed classroom activities using inexpensive materials] to make each problem real.*

One might expect that working with this group might be frustrating for TI staff, who generally teach better-prepared TI alumni in their two-week summer institutes. And staff were, indeed, sometimes frustrated. However, because of the strong "service to teachers" mission and teaching skills of the staff, a co-director felt it was a good use of their time, reflecting:

> *They really need someone who knows how to solve problems and I am an expert at listening to where people are and helping them. I am a teacher of all people as long as I see that they are learning and having fun—because discovery is a positive for all people.*

Another staff member valued the program as a new way to serve teachers that might otherwise not know about the TI as a professional resource and as a way to bring into the TI "guild" some teachers who had not attended the traditional entry experience, the four-week classic institute.

> *Hopefully we will get people that are not part of our family [to attend] the summer institute. For the other people, it is continuing support… yes, they get the lessons, but now they are also getting help for something that they absolutely need to keep on teaching.*

Based on the summer experience, the instructors decided to recruit differently for summer 2007. They will not offer the Physics section again; rather, they will offer an additional physical science section for teachers preparing for the General Science tests.

IPSE post-doc experience and contributions

As originally envisioned, the program was going to pair senior TI staff with experienced coaches and mentor teachers trained by TI in its Beginning Teacher Program. However, the staff recognized that these classes offered a good opportunity for two post-docs funded under an IPSE grant to learn more about the Exploratorium approach to working with teachers. Moreover, the post-docs brought strong content expertise to the program so they, rather than experienced teachers, augmented TI staffing for the program. This shift in plans had mostly positive outcomes. Staff modeled good professional development practices for the post-docs who assisted with the classes, and the post-docs had an opportunity to gain experience by working with individual teachers on their own and by co-leading some full-group activities. Staff provided feedback to the post-docs. The post-docs found the program, along with other experiences at the Exploratorium, extremely valuable in deepening their understanding of inquiry and improving their efficacy as science educators.

> *I now feel like an expert in designing and teaching inquiry. Before I came to the Exploratorium, I felt that a good lesson had to include a Power Point presentation. I have learned, from modeling and feedback from the TI staff, how to determine what level of understanding my audience has and how to break down the science to that level.*

The post-docs' presence also enriched the general environment for teachers, who seldom encounter them in professional development settings. As an Exploratorium physicist-instructor said,

> *They are kind of a unicorn—they are mythical creatures—young and up-to-date when science questions come in.*

The post-docs were an especially valuable resource for teachers preparing for difficult CSET exams, especially the chemistry and physics tests. In these areas, in particular, the post-docs extended the capacity of the staff to field questions and provide individual coaching.

The IPSE post-docs were valuable team members, and at the same time, staff believe that if they were not available the program could employ strong classroom teachers who are TI alumni as co-teachers. This would follow the more traditional TI program model. What staff believe strongly is that the instructors and participants both benefit from having leaders with diverse expertise and experience co-lead the course.

2. To what extent and in what ways did the program contribute to teachers' success in passing the CSET?

Summary finding

While passing rate information is very limited for teachers who attended the NCLB TQP sections, those who did provide their CSET test results passed at a higher rate than test takers statewide. Teachers who had not yet attempted the CSET reported that the program made substantial contributions to their readiness to take the test.

An implication is that if there are sufficient staff, if the quality of the professional development is high, and if attending teachers are sufficiently motivated, a single course can benefit teachers preparing for different CSET tests.

To address this question, we examined the program's success in recruiting and retaining CSET candidates, as well as program participants' passing scores.

Recruitment for NCLB TQP classes. Like some other TI programs that we have studied in their first year, the NCLB TQP found it somewhat challenging to attract and recruit teachers targeted by the program. The program was initially designed to serve CSET candidates, with an emphasis on assisting teachers in the San Francisco Unified School District. A total of 49 individuals attended one or more NCLB TQP sessions, including 13 public school teachers from SFUSD (25% of all participants) and another five (10%) from private schools in the city.

Several teachers attended several sessions, so there were 55 participants over the year. Seventeen teachers enrolled in the fall, 12 in the spring, 14 in the summer physics section, and 13 in the summer earth science section. The program had projected that it could serve a total of 72 participants, so it fell somewhat short here. The fall and spring programs served only CSET candidates. To fill the summer sessions, the decision was made to accept TI alumni, who were clamoring to take these summer workshops but did not need CSET preparation. Nine teachers (33% of the summer participants, and 18% of all teachers who took a NCLB TQP session) indicated that they did not need to take the CSET. As has happened for other TI programs, there was a higher attrition rate between acceptance into the program and enrollment among non-alumni than among alumni.

Retention in NCLB TQP classes. The retention rate for NCLB TQP participants was very high, with 51 of the 55 enrolled participants (93%) completing their session. Three of the four drop-outs left the fall program, and the other dropped out from the spring program. Given that teachers are busy during the school year and loathe to waste their time, the high retention rate suggests that the program found the right balance of requirements of, and contributions to, participants.

CSET passing rates. The CSET in science was first administered in January 2003. Pass rates for the General Science I and II tests were quite high over the program's first 3 ½ years (87.1% and

86.2% respectively).[3] Rates for the discipline tests were lower. According to the California Commission on Teacher Credentialing's (CCTC) April 2006 *Report on Passing Rates of Commission-Approved Exams for 2000-01 to 2004-05*, "the cumulative passing rate for the sciences ranged from 66.9% for Physics [III] to 87.9% for Chemistry [IV] (specialized)."

Looking at CSET findings for subgroups, some interesting patterns emerge. As the table below shows, teachers who take the general science exams to add an authorization —the primary clientele for the TI's test prep program—have a lower pass rate on most science exams than those who are taking the tests to obtain an initial teaching credential.[4] Also, when comparing the state's cumulative pass rate (i.e., for January 2003 - July 2005) with data for the most recent period included in the report (Sept. 2004 - July 2005), it is clear that the highest pass rates were obtained for the early administrations. For example, the cumulative pass rate for Biology/Life Science (III) over the program's first 2 ½ years was 77.5%, but for the most recent period for which results were available, the pass rate dropped to 70.2%, meaning that the pass rate was well over 80% for the earlier CSET candidates. One might presume that less prepared teachers delayed taking the exams. We used the most recent statewide data for comparison with pass rate data for the NCLB TQP cohort, where it was available (in the second table below).

CUMULATIVE PASS RATES ON THE CSET FOR ALL TEST TAKERS, CANDIDATES OBTAINING AN INITIAL TEACHING CREDENTIAL AND TEACHERS ADDING AN AUTHORIZATION (JAN. 2003-JULY 2006 FOR GENERAL SCIENCE EXAMS, JAN. 2003-JULY 2005 FOR OTHERS)

	All test takers		Test takers seeking to obtain initial teaching credential		Test takers seeking to add an authorization	
Examination	*N*	*Pass rate*	*N**	*Pass rate*	*N**	*Pass rate*
General Science I	5,983	87.1%	NA	-	NA	-
General Science II	5,853	86.2%	NA	-	NA	-
Biology/life science (III)	2,802	77.5%	2,240	81.2%	331	61.0%
Chemistry (III)	882	82.3%	645	84.0%	174	77.6%
Earth/planetary science (III)	643	77.3%	393	77.1%	193	78.8%
Physics (III)	544	66.9%	371	72.8%	126	50.8%
Specialized exams (IV)						
Biology/life science	459	75.2%	316	79.4%	80	63.8%
Chemistry	231	87.9%	114	88.6%	92	88.0%
Earth/planetary science	136	84.6%	33	84.8%	85	87.1%
Physics	118	78.0%	53	84.9%	56	73.2%

** Presumably, these Ns do not add up to the cumulative Ns because some test takers did not provide information about their motivation for taking the CSET.*

The CSET test-taking success of Exploratorium-prepared teachers appears high, based on very limited data. Inverness Research distributed questionnaires to all program participants during focus groups at the spring and summer sessions in order to document CSET test-taking

[3] Pass rates for General Science I and II cover January 2003 – July 2006. They were provided via email by Dr. Phyllis Jacobson, administrator of the program for the California Commission on Teacher Credentialing.

[4] http://www.ctc.ca.gov/reports/Exam-Pass-Rate-Rpt-Apr-2006.pdf

attempts and pass rates. In addition, TI staff emailed surveys to all participants, including fall attendees. Even when we combined data from both surveys, the findings about pass rates are incomplete for a variety of reasons: teachers did not necessarily take CSET tests soon after attending the preparation programs, and some participants in the summer never intended to take the CSET.

We were able to collect pass rate data for 11 teachers who took one or more CSET tests after attending NCLB TQP courses at TI (i.e., 22% of the 49 teachers who took one or more CSET prep sections). Based on these limited data, the program participants who took the tests had higher pass rates.[5] They passed 23 of the 25 CSET tests they took for an overall pass rate of 100% on General Science exams I and II and 92% overall. In the table below, we present the tests taken and pass rates for these 11 teachers alongside pass rates reported by the CCTC.

PASS RATES ON THE CSET FOR ALL TEST TAKERS AND FOR EXPLORATORIUM TEST TAKERS

	All CSET test takers		**Exploratorium CSET test takers**	
Examination (level)	*N*	*Pass rate*	*N*	*Pass rate*
General Science I	5,983	87.1%	7	100%
General Science II	5,853	86.2%	5	100%
Biology/life science (III)	688	70.2%	2	100%
Chemistry (III)	202	76.7%	3	100%
Earth/planetary science (III)	156	71.8%	4	75%
Physics (III)	120	56.7%	1	0%
Specialized exams (IV)				
Biology/life science	206	73.3%	-	-
Chemistry	111	85.6%	-	-
Earth/planetary science	66	81.8%	-	-
Physics	63	71.4%	1	0%

Statewide pass rates for the General Science Exams cover Jan. 2003-July 2006 and for other exams reflect the most recent program year reported (Sept. 2004 – July 2005).

[5] We tried to delete results for tests taken prior to the NCLB-TQP courses, but are not positive that we eliminated all of them because of inconsistencies found in the TI program database. It might be desirable for the TI program to follow up later this year to update passing data, as eleven participants said that they intended to take CSET tests in the next year.

3. To what extent and in what ways is the program a useful model for other agencies and institutions?

Summary finding

A lesson learned from study of the TI's NCLB Teacher Quality Program is that test preparation alone is unlikely to provide high-quality professional development, i.e., learning experiences that enhance teachers' knowledge for teaching. Optimally, test preparation is built onto a foundation of high-quality professional development so that it serves both purposes. For other agencies that want to help prepare teachers who are not only un-certified but also under-prepared in science, the implication is that they will need first to have the capacity to offer high-quality science professional development—including the ability to support novice teachers—and then to direct that capacity toward the additional purpose of test preparation.

Helping new teachers gain lasting knowledge and teaching skills (as well as pass the test) is important to the profession as a whole and to the spirit of the teacher quality mandates. It is of paramount importance to make sure that the basic science professional development provided is of high quality, and that test preparation is only a partial purpose of programs preparing teachers to take the CSET.
Below we list features of the TI program that we think may be transferable to professional development providers in other settings who are helping to prepare teachers for science tests such as the CSET:

- A solid track record of providing high-quality professional development for middle and high school science teachers
- Resources and expertise to mount school year series and/or summer institutes that can attract the target audience for CSET
- Recognition that the CSET candidates have unique needs and a willingness to modify successful programs and practices to address them (e.g., adding explicit test taking strategies to the agenda)
- Commitment to addressing a limited number of concepts well and the knowledge of which concepts are most integral for both teacher and student understanding
- Commitment to meeting the needs of the group of teachers that shows up for test preparation, rather than a commitment to covering the test
- Confidence that test preparation is enhanced by authentic hands-on experiences, and skill in providing those experiences to teachers
- Confidence that test preparation can be enriched by also providing teachers with support for their classroom teaching

We think that the features below are more unique to the Exploratorium and are highly desirable. Other agencies and institutions that lack these assets could mount valuable CSET preparation programs by drawing on outside resources, including the Exploratorium.

- Ready availability of a team of experienced staff with deep content and science education knowledge (especially for the advanced CSET exams)
- Access to world-class hands-on exhibits for purposes of demonstrating phenomena experientially
- Access to post-docs or other young scientists so they can gain experience working with teachers, with payoffs to both the scientists and the teachers

Further implications from the TI experiment

Ideally, test preparation enhances but does not detract from the foundational high-quality professional development program. The lesson from the NCLB TQP is that adding a new purpose to an existing program takes real care in professional development design; if not done with clarity of intention, the "seams" show. For example, the TI's spring and fall after-school workshop series appeared to be more carefully designed to serve the dual purpose (test prep within high-quality development in science), whereas in the summer, the test preparation was less well integrated into (more "tacked onto") the existing content and format of the well-established Alumni Institute model.

High-quality test preparation requires knowledgeable and experienced teacher educators, and probably a team rather than an individual. TI staff say that a good science educator—one with subject matter knowledge and teaching experience—can teach to the CSET's General Science tests. For the Physics test, however, instructors are likely to need a doctorate and skill in teaching problem solving. Further, individual teachers come with different gaps in their preparation, so having available staff with different areas of expertise is invaluable for providing individualized support. To help teachers deepen their own knowledge and broaden their repertoire of classroom strategies, all instructors should be skilled in use of hands-on strategies and helping teachers see how to apply what they are learning to their classrooms.

High-quality test preparation programs can use and build on materials provided by the state about the CSET test. Teachers gained confidence through learning about the format and content of the tests and gained valuable experience working through examples from the test. Staff, in turn, learned about the participants through their performance on these items, so they could provide appropriate variations on the CSET questions to solidify learning.

It is critical to know the participants and be flexible, i.e., to meet teachers where they are. Some teachers will come to test preparation programs with unexpectedly weak preparation. It may be necessary to throw out lesson plans and revise expectations. Instead of preparing an entire group to pass a test, it may be more realistic to prepare them to pass some sections or items, with the acknowledgement that they will need more preparation. As noted by a TI instructor, this is just good teaching practice:

> *We listened to the teachers, we weren't afraid to find out where they were and throw out the lesson plan and start again. Listening to students and then changing to meet them where they are is one of the important things a teacher must be able to do.*

Similarly, it is highly desirable to make a commitment to fine-tune the program in the first several offerings. A new program can draw in a variety of ways on an institution's resources. TI varied its approaches across the three offerings and four courses, learning through the alternative versions about the needs and capabilities of its audience and how best to meet them.

III. A Final Reflection

Over the past decade, the TI has evolved a strong commitment to novice teachers, who have special needs both because they are new and because of NCLB quality mandates. The TI's NCLB TQP program is particularly well aligned with the TI's objective to serve new teachers. The program is also of value to other TI alumni who need subject-specific certification. More broadly, this program helps to advance the TI mission of providing teachers with what they need but cannot get from their schools: high-quality science knowledge and teaching skill that is relevant to their work situations.

The quality of this NCLB TQP program in its first year, along with the quality of other newer programs at the Teacher Institute, relies and draws upon a deep reservoir of knowledge, not just about science, but about teaching and learning science. The TI staff's knowledge—coupled with their boundless enthusiasm for science and for learning, and their 20 years of experience serving teachers—gives TI the cumulative capacity to build new programs with high potential for success. We think that it is important to acknowledge that this program is just one more piece of evidence that the Exploratorium is a regional and national resource that can be an asset in many ways in supporting the improvement of teaching and learning of science.