

Evaluation of the Museum of Science PCET Program

Interim Report

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Executive	Summary
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The following report presents the methods and findings of three focus groups conducted by Davis Square Research Associates (DSRA) on March 3, 2006 on the effectiveness of the Museum of Science PCET program, with a particular focus on issues surrounding the implementation of the Engineering is Elementary materials. This program is intended to provide participants with access to knowledge and materials to implement innovative engineering content in the elementary grades (roughly 3-5). The purpose of the evaluation was to gather information on the functioning and effects of the program. The data sources for the study were three focus groups.

Key findings include:

1. Participants report that the project builds on pre-existing collaborations among participants as it helps them to learn and implement content and the engineering design process, or EDP.
2. The implementation of the materials is based on a judgment (whether collective or individual) around the fit of the materials and the perceived learning benefits (frequently as measured in the MCAS) versus the time and curricular costs.
3. Effects on both teachers and students include a greater use of the EDP language and problem-solving strategies, as well as improved attitudes toward using more inductive methods.
4. The participant declared desire of strengthening the curriculum is somewhat offset by their characterization of the limits of the curriculum to accommodate time-intensive innovations.

Sample &	Method
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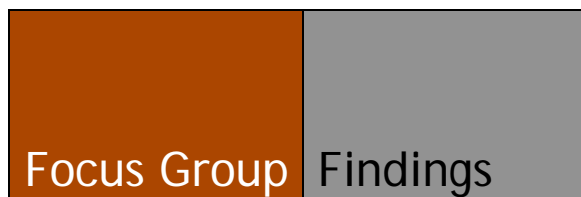
The three focus groups took place one after the other in the afternoon of the March 3, 2006 meeting of PCET participants (N=40). The day was divided into

small group discussions around EIE units that attendees had implemented, or were intending to implement. These discussions were followed by project presentations of two units underdevelopment, with an open discussion of how the units might be improved. With the afternoon there were additional small group discussions and concurrently the three focus groups in succession.

Each focus group lasted from 20 to 30 minutes, with 6-8 participants in each group and each was moderated by Russell Faux. The groups were formed by PCET project management with an eye to putting people together who already had some familiarity with one another. The conversations were recorded and transcribed by an independent transcription service, with the transcripts then imported into HyperResearch for analysis. The focus protocol was a semi-structured series of questions ranging from the motivations for participation, to implementation and learning benefits associable with the lesson. The coding system used to analyze the data is presented in Table 1 below.

The research questions guiding the inquiry were:

- What were the motivations and purposes for participants in the program?
- What did participants encounter as they went about implementing the content and strategies?
- What effects did the participants observe that can be attributed to the use of the materials and strategies?



This section presents the findings of the DSRA analysis of the focus group transcripts. Table 1 provides a synthesis of the analysis by code:

Table 1: Summary by Code

	<i>Motivation:</i> attractors & facilitators (N=37*)	<i>Collaboration</i> (N=29)	<i>Content</i> (N=24)	<i>Contexts</i> (N=50)	<i>Effects</i> (N=47)
Summary Statement	Participants cited several attractors (money, timing, PDPs, institutional sponsorships) to the program as well as the desire to gather materials to enliven and improve classroom activities	The project is helped by pre-existing collaborations that support the teachers during the training and into the implementation phase.	Teachers learn new content and then make judgments about implementation based on the perceived fit between the content and the students and curriculum	The curricular and testing contexts do not readily incorporate innovations, yet the teachers are determined to find time or ways of distributing the content across classes and thereby lessen the innovative load	Students use the EDP language and problem solving strategies to address learning challenges in multiple classes; teacher learning is also important as is the strengthening of the teacher professional network

* Refers to the number of instances of this code

Motivation for Participation

Participants cited several attractors (money, timing, PDPs, institutional sponsorships) to the program as well as the desire to gather materials to enliven and improve classroom activities. Some mentioned “this was an area where we needed to improve.” No participant spoke of being required to do this because of administrative pressures. The resultant picture is one of participants responding to the attractiveness of the content and the institutions involved, working together as a team, and an array of additional compelling external motivators (e.g., stipends, PDPs, etc.) further supporting the decision to participate.

The following is a sample of what participants said:

- And then like seeing something that's its appealing and it's going to be useful and be hands-on and it's exciting and getting paid for it. I was like "That's unbelievable." I felt like pinching myself.
- Well, when it came through - the application and everything - the first thing was science and technology and how to incorporate that with our MCAS standards and framework. That was a real - what would you call it -- area of need.
- And we had just started out our school - we had done an engineering type project to reach some of the engineering standards 'cause we hadn't been doing that in the past and this was a great way to kind of enhance that in those areas that we all felt we weren't as comfortable in before. So we

wanted to get some ideas on how to enhance that project as well as the science curriculum.

- Well, that attracted me plus I love the Museum of Science, I know that a lot of what they do is - they do good work so that appealed to me also. Getting paid for the time I put in helps too.
- I want to do something to spark up the classroom and this hands-on engineering courses are just so wonderful for me because I get a chance to do things that I know they enjoy and that makes them think more than answering multiple response questions and writing long compositions.

Collaboration

The project is helped by pre-existing collaborations that support the teachers during the training and into the implementation phase. The project's suggestion that teachers come and work together in teams was especially helpful in this regard. There are several key points to be made in this area of the analysis. One is that the program has a strong "grass roots" quality, as no one was mandated to attend. Programs that appeal to the isolated activist teacher, while they may be of great value, are less likely to achieve much dissemination. In contrast, the PCET program builds on pre-existing collaborations with built-in supports for the challenges of learning the new content. In particular, the oft-cited EDP notion of "failing often" can present real emotional challenges to the adult learner. Working collaboratively in this context allowed the participants to share the emotional burden of these challenges.

Second, the implementation phase of the project was said by focus group participants to be assisted considerably by the collaborations built up during the training. Informants spoke of distributing the content, materials, and activities across classrooms, while preserving the EDP language. This will be explored more in the following section, however it is worth noting that the teachers' social networks allowed them to implement the content, modifying the lessons, yet sustaining and reinforcing basic EDP discourse and strategies.

The following is a sample of what participants said:

- Even before this program we're a pretty collaborative group and we really do support each other as a grade level and so a program that feeds into that is very appealing to us.
- I wanted to do it with a partner from my school so I figured that I would take the elementary school one and I could always modify the lessons or modify materials if I needed to. But I was very interested in learning about engineering.
- And we chose not to do that activity just because our kids do a lot of acting and things like that and we thought that to stand in front of the room with a picture wouldn't get to what they knew how to do and then

sort of be a little bit bored by it. So we chose to skip that activity because we just felt, you know what, they have this information already and to stand with a picture and be a tree - it wouldn't maybe interest them as much as some of the other activities would. But I mean overall we loved the unit because it had a lot of engaging activities. But we just chose to not do that one.

- And we were lucky because we could each get a different unit. So I got a wall unit, she got a simple machines unit, she got a wind unit, she got a water unit, so now our school had four different units and we were all able to implement those; whereas if I were just one teacher going back to the school I would only have my one unit that I [would try to implement].
- So, therefore, we could come together and we could kind of work together and I would know that I would have a class of students that I could work with and a teacher that I could work with so we can team together and learn together and see how we could then maybe stretch out and reach out to other 3rd and 4th grade people in the building.

Content & Contexts

The analysis of the focus group transcripts frequently resulting in twin codings of utterances. These codings were “content” and “contexts.” It appears to this evaluator that while the content can be easily distinguished from the context of its implementation, the focus group discourse, being more grounded in the practical realities of teaching and learning, made no such distinction. Content was content for teaching and teaching occurs in contexts. These contexts include time, the demands for testing, and the potential of sharing the content with other teachers. The curricular and testing contexts do not readily incorporate innovations, yet the teachers are determined to find time or ways of distributing the content across classes and thereby lessen the innovative load. In brief, the participants learn the new content collaboratively, and then make judgments (frequently collaboratively) about implementation based on the perceived fit between the content, the time available, the capacities of the students and the looming MCAS. In all cases, no matter what the contextual implementation strictures, participants offered nothing but high praise for the qualities of the EIE materials.

The following is a sample of what participants said:

- Yeah, we were talking about [engineering]. I don't think anyone had a really good idea of what an engineer does. So for us this was helpful for us to understand this field that we want to try and push some kids into some day; to be able to answer questions.
- Well, you're doing it for your curriculum and what's required so - like right now I did the windmills experience but I did not do - lesson one, lesson two, I didn't.
- And sometimes it's a matter of time. Looking at an activity, what am I really getting out of it, and how much time's going into it - am I going to

get something, some kind of payback? How far will it advance the understanding of this topic? If it really isn't going to do that, if I'm not going to get that much out of it then it's really not a good use of time because time is the most precious commodity we've got and I can't afford to relax and just enjoy thinking about concepts. I have to get some kind of additional understandings.

- For our particular curriculum we selected whichever units matched our science curriculum topics the best and were this most natural fit to obviously then put engineering into those units in a easy way and a way that made sense. So, for instance, for our particular school and grade level, walls was not something that fit in at all, that unit, to what we teach already. So none of us had the intention this year of ever - we didn't even ask for the walls kit or the walls unit at all because that wasn't the intention at the start of the year. So we really - all of us selected something where we felt it was a natural fit into what we already do within the science curriculum. And maybe two things fit really well, three things fit really well so we are going above the expectation that we'll just do one because we have in science a lot of units that did fit well.

Effects: Teacher, Curricular & Student

The themes of the effects of the program in schools appeared to branch out in three directions: Teacher, curriculum, and students. The teachers became more confident in their understanding of the content. A possible interesting piece of teachers' learning to collaborate better was *not* in evidence here, though it is unreasonable to hold that the teachers became *worse* at collaborating.

The EDP language and strategies began popping up in unanticipated areas. Some of this was the conscious work of collaborating participants, and part was attributed to the students themselves. Participants reported having heard from other, non-participating teachers, about students using the EDP strategies in new contexts (e.g., art). It was thought that students now spoke with their parents about engineering-related issues. In addition, the multicultural aspects of the materials were said to be of particular value, as the standard texts do not always match closely with actual student profiles.

Students began to use the EDP language and problem solving strategies to address learning challenges in multiple classes. Students also benefited from working collaboratively, sharing ideas and developing respect for one another. In this instance, the learning goals of the teacher became coextensive with her character development goals for the students.

The following is a sample of what participants said:

- It's changed the way we think about science.

- I mean I think the kids got a huge amount out of that and they've been able to go home and talk to their parents, they've been writing things down. As soon as I say "windmills," they know "renewable resource" and they know the terminology but I have given up something else and I'm trying, of course, to try to figure out how it's going to get in. And I can sneak it into my class.
- [The arts teacher] came to me and she said, "You know, I can't believe the language that the kids are using when it applies to art." Because they're thinking of some of the same [ideas and strategies].
- You know, we do the talk about diversity but we don't integrate lots of our curriculum around cultural diversity really. And so this has been fabulous. We have a lot of kids from India and so they have [kids] from India too. But the walls one was especially poignant for some of the kids - some of them had actually visited the Great Wall of China or they'd heard their parents talk about it or they had some background knowledge that they could bring to the class themselves, which they don't get a lot of opportunity to do that.
- We use - I use - the word all the time "consensus." Consensus is really important in the design process and I use it in everything we do now so we have a consensus about this. So they have a better understanding about what a consensus is, that you don't always have to agree but you have to come to some kind of agreement in the end.
- I've always been huge on - if you go back to - the kids nowadays do not have the same amount of respect that you feel that you were raised with and I spend a huge amount of time just teaching them manners and how to talk to each other and those things. So that's just something that I focus on from the very first point and that collaborative grouping which makes it a lot easier for them to do these projects together. These are not projects that could be worked on individually but just learning those processes. And I think our school is actually going to be doing special development next year to try to teach all the teachers to have the same skills with their kids because a lot of kids can't work collaboratively. That is a part of these projects so they have to learn the fundamentals.
- And I could explore much more of this than I used to explore before. And I think - I can tell this workshop, it was excellent for me. It opened my mind and my brain to talk to the kids about engineering.
- I feel more comfortable being able to talk to the kids about that and when they give their answers then I'm better able to say whether or not they're on the right track. Before I might just say, "Uh-huh."
- Not thinking of Social Studies again particularly, but we would have used a different vocabulary for it. So a common vocabulary across curriculum I think helps to make those connections with kids.
- I would like to say one of the themes or what I found one of the objectives of the whole program was to make sure that all students felt comfortable with the engineering process. I think before this a lot of girls, for instance, may have felt uncomfortable with the whole engineering design concept

and also it seems as though they're also trying to interest minority groups as well. And I think the program has been very successful in getting the points across to all different kinds of people.

- I think they probably have more of that connection once they go home and then talk to their parents about it and then there's more of a communication that they can have and then maybe they learn more about what their parents do.
- For me it's definitely has an impact on our Social Studies. We teach Ancient Civilizations and so I've started to incorporate more in talking about the technology and engineering of the three ancient civilizations that we teach.
- Now we've looked at it from a different perspective and the kids understand it from a different perspective. More like a problem-solving perspective. Problem-solving, and the redesign piece.
- It's good teaching. It's really good teaching.



Conclusions

Garet, et al. (2002) found through a nationwide study that certain features routinely characterize effective professional development. The three "core" features of effective professional development are (1) a focus on content, (2) opportunities for active learning, and (3) coherence with other learning activities (e.g., learning standards, a broader reform, etc.). Through these core features, the following structures were cited by the AIR team as necessary for the professional development to be effective:

1. Form – teacher networks work best as a context for professional development
2. Duration – longer is better, while traditional “sit and get” formats are rarely seen as effective
3. Collective participation – target groups should be working together

Comparing the findings of the AIR study with the current study of the three focus groups, one can immediately draw clear parallels between PCET project and the first two core features of effective professional development as well as all three of the most effective structures. Participants work together for extended periods of time, sharing and experimenting with challenging content. In short, the PCET program, within the limitations of the current data and with the qualifications arising from implementation, can be readily identified as an embodiment of effective professional development.

The remaining, and somewhat more problematic, core feature of coherence refers to the fit between the content of the professional development and the day-to-day life of the school. In the current case, we have seen that teachers saw the fit as challenging, yet found two ways of working the EIE content into their teaching. First, teachers spoke of picking and choosing the materials that could be used most readily. Second, some teachers spoke of distributing the implementation of the content across classrooms, thus lightening the implementation "load" of any given teacher.

For future research it may be worth considering how the teacher networks evolve over the course of the project and into the future. Do participating teachers change in the patterns or content of their communications with colleagues? Do these changes extend to other, non-participating teachers? What can be determined as to the effects on student learning attributable to the altered communication patterns? If the key factors in building the social networks can be established, then the program may be in a better position to disseminate and scale its efforts across other locales.

References

Garet, M. S. et. al. (2002). "What makes professional development effective? Results from a national sample of teachers." AERJ **38**(4): 915-946.