Teachers' burning questions: Understanding challenges that science teachers face and Problem-Based Learning as a framework to support teacher research

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Abstract

Understanding the challenges that science teachers face and providing corresponding support are critical for effective professional development. However, the field lacks a clear understanding about the real needs of teachers. Drawing on 3 years of data collected in a professional development program for science teachers, in this study we explored two questions: 1) what challenges do science teachers face when they struggle to meet the increasingly high expectations set up for them by current educational reform? and 2) how does Problem-based Learning (PBL) as a framework support teachers in researching their teaching challenges in a year-long effort? Participants were 68 K-12 science teachers from a 3-year PD program. Multiple sources of data were collected, including worksheets, presentation posters, meeting notes, and reflections that teachers generated during a year-long process. Data analysis shows that science teachers struggle with a number of issues, including 1) lack of time, 2) lack of resources, 3) assessment, 4) using new instructional approaches to teaching a specific topic, 5) science process skills, 6) group work, 7) making connections between science content, and 8) making connections to real world experience. We also found that Problem-Based Learning as a framework holds great potential for supporting teacher research. Implications of this study for science teaching are discussed.

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> "It's like an age-old question. It's a constant battle. I battle it in reading. I battle it in science. I battle it in math. When do we as teachers pull back … from the 'teaching is telling' model on instruction … and when do you give more [instruction]? Why?"
>
> --Katherine, 2nd grade teacher

The quote above occurred in a discussion in a Professional Development (PD) workshop for science teachers, in which a group of elementary teachers analyzed and discussed a pedagogical problem of dealing with conflicting student ideas. Like Katherine, other teachers also expressed their questions, concerns, and challenges that have bothered them for a while in their teaching. These comments provided a window into the real challenges that science teachers face in their daily teaching. Understanding these challenges and providing corresponding support are critical for effective professional development. However, the field lacks a clear understanding about the teachers' needs. As a result, many PD programs are designed based on the assumptions that teacher educators have about teachers' needs, not the actual needs of science teachers. This might be a reason that explains the ineffectiveness of many PD programs in improving teachers' learning (Garet, Porter, Desimone, Birman, & Yoon, 2001).

Teaching well is difficult. Shulman (1987) asserted that a teacher must have three types of knowledge to teach well: 1) subject matter content knowledge, 2) pedagogical content knowledge, and 3) curricular knowledge. That is, a teacher not only needs to have sufficient content knowledge, but also needs to understand how to teach the content to specific learners using certain curriculum materials and activities. Recent science teaching reform further complicates the requirements for teachers. Teachers play a central role in the reform, because they must help students to reach the level demanded by high standards. Based on a content analysis of national standards (American Association for the Advancement of Science [AAAS], 1993; National Research Council [NRC], 1996), Davis, Petish, & Smithey (2006) identified five areas that teachers need to understand, including 1) the content and disciplines of science, 2) learners, 3) instruction, 4) learning environments, and 5) professionalism. The authors further concluded that "though the standards may reflect what teachers should be able to do, teacher educators, policymakers, education researchers, and administrators are not yet doing enough to help them meet those expectations" (p. 608). As a result, teachers are often left on their own to figure out how to meet the new expectations.

Given the high demand placed on teachers, teaching is inevitably challenging. Challenges, particularly unsolved challenges, may lead teachers to experience job dissatisfaction, which may in turn lead them to leave their job. The rate that teachers leave their job is disturbingly high. On average, there are 13%-15% of teachers departing their job each year, resulting in teacher shortages in many schools (Ingersoll, 2001). When asked about why they leave their job, teachers report job dissatisfaction as a major reason (Ingersoll, 2001). Our perspective is that understanding teachers' challenges and helping teachers address them can increase job satisfaction and reduce the high turnover rate, particularly in urban settings.

Teacher research is one approach to addressing teachers' challenges. That is, teachers conduct research on their own practice and find solutions for their problems. In recent years, teacher research has been playing an increasingly important role in science education community for two reasons (Roth, 2007). First, teacher research has great potential to enhance teachers' learning and develop reflective teachers. Through examining their own classrooms, teachers develop a better understanding about their teaching and become more reflective about their instructional decision-making. Therefore, teacher research is viewed as a promising professional development activity. Second, as an old educational problem, the huge gap between educational research and practice continues to exist. The traditional university-based research is rarely translated into classroom practice, as teachers rarely draw on research-based knowledge to inform their teaching (Hiebert, Gallimore, & Stigler, 2002). Teacher research, in which teachers serve dual roles of teaching and researching, can make a unique contribution to closing this theory-practice gap. Knowledge generated in teacher research is more likely to be used by teachers. The science education community can also benefit from teachers' investigation into their practice in order to understand what is actually happening in science classrooms and how innovative instructional approaches are interpreted and implemented.

The goal of this study is twofold. First, we seek to understand the challenges that science teachers face. Second, we want to understand how we can support teachers in solving the challenges as teacher researchers. Given the complexity of teaching, teachers may experience a wide range of difficulties. However, what problems concern teachers most? What are teachers' burning questions? Particularly, what issues bother teachers enough that they are willing to devote one-year's effort to solving them? How do teachers approach their challenges as teacher researchers? What kind of understanding do teachers derive from their research? How can PD support teacher research? In an effort to tackle these questions, we examined 3 years of data collected in a professional development program for science teachers. We explored two questions: 1) what challenges do science teachers face when they struggle to meet the increasingly high expectations set up for them by current educational reform? and 2) how does Problem-based Learning (PBL) as a framework support teachers in researching their teaching challenges in a year-long effort?

This study was situated in a professional development program for K-12 science teachers. This program consisted of two parts: a summer PD workshop and monthly year-long meetings. The two-week summer PD was designed to enhance teachers' subject matter knowledge and pedagogical content knowledge through problem-based learning. The first week was called *Professional Working Conference* (PWC), which focused on deepening teachers' science understanding through PBL applied to science content dilemmas related to the subject they teach. During the week, teachers also developed a unit plan that they were about to teach in the next academic year. Each year, there were approximately 50 teachers participating in the first week of PD. Then about 50%-70% of teachers chose to complete a second week of PD called *Focus on Practice* (FOP), in which teachers developed their pedagogical content knowledge through solving teaching dilemmas. These teachers continued to meet monthly in small groups to investigate their self-identified teaching problems using PBL approach throughout the school year. We adopted Problem-Based Learning as a framework to support teachers in researching their teaching problems. Because PBL emphasizes self-directed study and group collaboration in solving real world problems (Barrows, 1996), which exemplifies the essential features of productive teacher research, we reasoned that PBL has potential for supporting teacher research.

Method

Participants

This study focused on teachers who participated in the second week of the summer PD: *Focus on Practice* (FOP), and the year-long monthly FOP meetings. In total, 68 K-12 science teachers from a 3-year PD program were involved in this study. Approximately half of them were elementary teachers, including Kindergarten teachers, and half were secondary teachers.

Cohort 1 (Year 1). This cohort included 24 science teachers from local school districts. Among the 24 teachers, 8 were males, 16 were females, 3 were minorities, and 21 were Whites. On average, these teachers had 8 years of teaching experience and the average age was 38.8. Out of the 24 teachers, 16 participated in the year-long monthly FOP meetings.

Cohort 2 (Year 2). This cohort included 35 science teachers. Among the 35, 9 were males and 26 were females. On average, these teachers had 9 years of teaching experience and the average age was 37. Except for 1 teacher who was Native Hawaiian or other Pacific Islander, the remaining 34 teachers were Whites. In this cohort, 27 were new teachers, and 8 were returning teachers from Cohort 1. Out of the 35 teachers, 28 participated in the year-long FOP meetings.

Cohort 3 (Year 3). This cohort includes 28 science teachers and is the current cohort for this year. Among the 28 teachers, 4 are males and 24 are females. On average, these teachers have 12.5 years of teaching experience and the average age is 43.8. Except for 1 teacher who is Black, the remaining 27 teachers are Whites. In this cohort, 17 are new teachers, 6 are in their second year in the PD, and 5 in their third year. All of the 28 teachers plan to participate in the incoming year-long FOP meetings.

Data sources

Multiple sources of data were collected, including 1) interview data with 14 Cohort 1 teacher. The purpose of the interview was to understand overall the use of problem-based learning in the teaching and learning of science. In the interview, one of the questions that teachers were asked was: What major issues or problems are you facing in the teaching and learning of science this year? This question helped understand teachers' problems in general, 2) the written documents that teachers generated when developing their teaching dilemmas. These data illustrated the teaching problems that teachers chose to study in the school year, 3) notes generated during the year-long FOP meetings and videotapes of these meetings. These data helped us understand the process of teachers researching their teaching problems guided by the PBL framework, and 4) E-stories that teachers generated in the end-of-the-year presentation and reflection. These data shed lights on the understandings teachers derived from their research and their perspectives on how PBL as a framework to support teacher research.

Data analysis

We conducted content analysis for the written documents generated during the year-long process, including the worksheets, posters, notes, and reflections described above to understand what type of questions that teachers asked and how they studied their questions. Videotapes were also viewed to understand the thought processes of teachers when they were presenting and analyzing their teaching problems. Categories and themes emerged from the data analysis. Examples and quotes were used to support the themes.

Results

Problems that science teachers face in general

When asked about what major issues or problems that teachers faced in the teaching and learning of science, except for one teacher who reported that "it's been a good year" and "I can think of any [problem]", other teachers reported different problems and issues, as shown in Table 1.

Table 1: Teachers' challenges (N=14)

Challenges	Occurrences
Lack of time	5
Working with new students	2
Lack of resources and support	2
Designing appropriate activities	1
Trying something new in curriculum	1
Giving students immediate feedback	1
Helping low academic students learn	1
Large class size	1
Old curriculum material	1

Among the challenges that teachers reported, lack of time is a recurring issue, as five teachers mentioned the problem. Teachers felt lack of time for a number of reasons. For Maggie, she often did not have time to wrap up the lesson at the end of the class.

> Maggie: Not enough class time. I don't have enough time always to. We get involved in the activity, and then my wrap up time does not happen that day, and it sometimes will happen the next day. That's the frustrating part. … Um, lack of time is just a big thing.

Lack of time was a constant problem for Leslie, because she was teaching four classes in one classroom, and the hands-on activities were time consuming.

> Leslie: Well, the one that I don't think is ever gonna go away is the time, because I have two classes for two grade levels in one classroom. Even though the science is taught together, I still run into difficulty working with some [classes]. The hands-on activities take a little bit more time, but on the other hand, I believe that it's, they're worthwhile. Trying to juggle the time constraints, that's the biggest problem and next year will be the same. That won't change for me.

Caroline was also frustrated with time and struggled with how to use the class time for best.

> Caroline: Um, you know, my biggest struggle this year, I would have to say is time. I'm just not doing very good this year when I, you know, either I run over on time or I have like five minutes at the end and I just hate that down time, and, you know, there's always something I could do but it's like, I didn't- I don't know, I guess it's a little bit of planning. I want to find a way to kinda, you know, use the fifty minutes I have to the best.

Another challenge was to work with students who are not motivated to learn. Although only one teacher explicitly mentioned the problem, it is a general problem for other teachers too.

> Marcus: Um, you know the main issues for me at the school I teach at are always getting some low academic students to succeed, and the kids could do well and really get everything in the classroom usually are going to do well, I think, with most teachers and so it's trying to get the handful of kids who don't want to be there, don't want to do anything, trying to make it so that they can understand the science content and do well and like what they're learning. And, you know, that's the hardest thing for me.

Teachers run into problems when they try to incorporate new changes in their teaching. Leah was a veteran teacher with 25 years of experience of teaching. She found it a constant challenge as she tried to make changes to her teaching each year and accommodated the needs for different students.

> Leah: I've been trying new things, so of course that's always a challenge, teachers don't want to find changing for the next year. And then I'm continuing to add to my content base because I think every year, no matter how prepared you are, you have a new group of kids each year and they all come with different needs and different questions and, um, I've, I have only taught this particular subject only my second year, within my twenty five years of teaching it's a change that I chose to make.

Other problems include lack of resource (e.g., in our building we don't have a lot of informational books for children) and designing appropriate activity for learning (e.g., what kind of activities can I do in the computer lab that best facilitates the learning of science?)

Problems that science teachers studied in teacher research

We analyzed the problems that teachers studied in their teacher research project. It appears that teachers are concerned about a number of issues. These issues frequently emerged from the research questions that teachers chose to study in a year-long effort. These issues fall into the following categories.

1) <u>Assessment</u>. How to find better ways to assess students' learning concerned many teachers. Specifically, teachers had trouble with a variety of assessments, such as pre-assessment, performance assessment, authentic assessment, formative assessment, and summative assessment. Examples included "*what to do and how to interpret pre-assessments so as to best fit my class when teaching new concepts*?"

2) <u>Using new instructional approaches to teaching a specific subject topic</u>. Many teachers wondered how they could move from traditional teaching methods to more innovative approaches to teaching a specific topic. These new approaches include inquiry-based learning, problem-based learning, and hands-on experience. Examples included "*do inquiry based activities increase students' ability to generate scientific questions, gain understanding, and increase retention of scientific concepts?"*

3) <u>Science process skills</u>. Teachers saw the importance of science process skills and wanted their students to develop these skills, such as asking thoughtful questions, making accurate observations, taking complete notes, and organizing

notes. These process skills are often embedded in a specific content area. Examples include *"how would increasing better critical observation skills allow students to see aspects of how multi-cellular organisms function and contribute to a marine reef environment and human life?"*

4) Group work. Group work was often used in science classrooms, but teachers were bothered by their observation that "one kid does all the work, and other kids just copy." Therefore, how to make group work effective was a common concern that many teachers expressed. Examples included *"when students are working in groups, how will I engage all students in the activity to increase communication and participation?"*

5) Making connections between science content. One challenge in science teaching is that students too often get stuck in details and fail to see the big picture and connect all the parts together, as a teacher stated, "*For many years I spent a considerable amount of time teaching the details of the process of photosynthesis and cellular respiration. Students never really saw the big picture*." Therefore, how to help students make connections between science content was a problem familiar to many teachers.

6) Making connections to real world experience. Science is often too abstract for students. For example, they cannot see atoms. The lack of connection to real world experience is a reason that science is hard to teach, as a teacher described, "*It has bothered me for several years that while teaching life science I have never connected any of the life science concepts with the outdoor environment by*

actually taking the students outdoors." Therefore, teachers wanted to make connections to help students see the relevance of science in real life.

Problem-based learning as a framework for teacher research: Three case studies

The problem-based learning model for teacher research includes several components: 1) driven by an authentic problem in teaching, 2) regular monthly meetings with group members in a school-year, 3) guidance of facilitators, 4) analysis of own video and student work, and 5) individual research. During the summer workshop, facilitators modeled the PBL processes for teachers and prepared them for their research in the year-long process. Teachers were scaffolded along the research process, including developing a researchable teaching dilemma, a testable hypothesis, analysis of video, and their research process. We present three case studies of teacher research that represented different topics that teachers were addressing.

Leah: Connecting life science with outdoor environment

Leah was a 7th grade life science teacher. Her issue was to connect the life science concepts (succession) she was teaching to outdoor environment. She recognized the importance of making connection with the outdoor environment in improving students' understanding of the concept. However, the idea had been difficult to implement. Her teaching dilemma was:

> It has bothered me for several years that while teaching life science I have never connected any of the life science concepts with the outdoor environment by actually taking the students outdoors.

She hypothesized that:

> If students were taken into the great outdoors, then it would connect the life science concepts with real world examples and improve their understanding of the concepts.

There were several reasons that had prevented her from taking students outdoors. First, it is difficult to manage 25-30 7th grade students and keep them on task outdoors. Also, it is challenging to take students outside within the 55 minute class period. In addition, uncertain factors like weather make it hard to plan for the outdoor activity. Moreover, it is not easy to find an area that is close enough to the school and yet relevant to the content and interesting to the students.

The experience in the PBL Project for Teachers helped Leah develop a lesson on succession that involved outdoor experience. Her inspiration was rooted in the first outdoor experience she had during the summer workshop.

> During the focus on content session my group went outside and participated in an outdoor scavenger hunt, which is how I practiced my first outdoor experience with my classes.

While Leah was pondering what content is suitable for outdoor activities, her facilitator played an important role in helping her develop the lesson of succession to include outdoor experience.

> While working on my unit involving the teaching of succession I remembered a PBL instructor who had talked about being able to observe succession with lichen on the exterior of buildings and it made me think about using the outdoors to teach succession.

The facilitator also helped Leah articulate the purpose of using outdoor experience, which she did not think through first when she had the outdoor idea.

> The PBL instructor helped by asking the question, "What is your goal when taking your students outside?" She made me think about what I hoped to accomplish because she said, "If it can be taught just as well inside as out, why do you need to go outside?" I felt she had a very valid point. There should be some sort of gain for the students if I was going to put the work into planning and use time throughout the year with outdoor experiences.

Leah felt the support from her FOP group was important by "making me willing to experiment with using the outdoors to help teach my unit." She also benefited from the research she had done on other's experience with outdoor field trips. She learned that "most of the research had been done regarding actual field trips with the help of chaperones and guides" and it is important to "connect the experience to the curriculum and have clear expectations and focus on the trip outdoors." She also found videotaping her lesson very useful because the video records allowed her to "observe my teaching and analyze it in a helpful way" and "see things that I would not have noticed otherwise."

As Leah reflected on what she had learned after experimenting with her dilemma, she was pleased that she had taken the risk to test the idea and learned that good planning is essential when planning for outdoor activities.

> It was important that I take a risk to see if taking the students outdoors was worth the time it took out of the year, otherwise I would always wonder about it. But along with taking the risk came good planning. I went on a practice run to check out the areas that I wished to take the students to and even then I wasn't sure we

> would be able to do it in the 55 minute periods. Keeping the whole group in sight and having specific rules and behavior expectations was especially important.

Leah used multiple data sources to analyze whether or not her outdoor field trips were successful. First, she compared a post test for this year’s students with last year’s students, who read succession in books and had classroom discussion without outdoor experience. She found that although last year’s students were able to use examples from the book in their answers, some students confused succession with food chain and some did not realize catastrophic events were not necessary conditions for succession. On the other hand, she found this year’s students had a better understanding about the concept of succession and did not show the misconceptions that last year’s students demonstrated. Leah also asked her students whether or not they felt the outdoor experiences helped them to learn the information better. The majority of students said they enjoyed the “hands-on” experiences and being able to “see” real life examples of the concept, although a few said they disliked the cold and some felt like it was “boring.”

Overall, Leah was pleased with the outdoor experience, because “there were enough positive responses along with the quality of their answers on their post tests that I feel it was a worthwhile experience.” The successful experience also gave Leah confidence to continue to use the outdoor approach in her future teacher.

> I want to think about how maybe “adopting” a certain area around the school and really getting to know it might help increase outdoor awareness. I also think that trying to time lessons to match what is going on with our seasons might be helpful too.

Cassidy: Using PBL to teach cell structure to urban school students

Cassidy was a 10^{th} grade biology teacher. She worked in an urban high school in which 68% of the students are eligible for free lunch. The urban city faces the challenges of job loss, decreasing population, poverty, and decline in student enrollment. Cassidy realized that her students were not well prepared for tasks that require high level thinking skills. She found her students "worked best when given dittos; just look up the answer in the book, not much output from their end." Many of her students were struggling learners, as she discovered:

> This idea of the lack in learning connections being assimilated really struck me one day when a student who was looking up answers in the index got half way down the page before realizing that she had been writing the answers in Spanish, as the vocabulary contained both English/Spanish versions. She was not the only student who had done this.

Having experienced PBL herself in the PBL for teacher project made her think PBL might be a solution for the problem she was facing with her low performing students. She stated her rationale:

> If I engage my student in more PBL dilemmas then I can condition them into formulating their own thinking processes because PBL dilemmas will force them not only into thinking on their own but into higher order thinking as well.

During the unit development session in the summer PD workshop, Cassidy designed a PBL lesson focused on cell structure with an emphasis on the mitochondria. The problem that drove the lesson was, why are some people able to run faster than others? Students started the investigation by having a race in the hall. To examine the effect of the Cassidy compared students' test score from pervious years to this year and found students' average test scores increased from 33% in previous years to 59.4 % this year. The improvement in learning is even more significant when taking into account the fact that she had more special education students in her classes this year, 20-30% per class.

Cassidy was satisfied with the experience she had using PBL in her teaching. In her reflection at the end of the school year, she stated:

> This whole experience has caused me to understand that often times as a teacher I am in one place and my students are in a different place. My aim is to bring us to the same place so that we, teacher-student, can get the wheels of learning and understanding moving forward. An effective way of doing this is to have students verbally describe in their own words or draw what their understanding of a certain topic is. In order to have PBL become more effective for my students, I have to condition them by offering more group work, research opportunities, ethical issue discussions, and student to student interactions. Whereas before I only threw the information out at them, now I have to stop and ask them to show me what their understanding is.

Amaya: Inquiry-based learning in Kindergarten

Amaya was a Kindergarten teacher. She was interested in using inquiry-based learning model in teaching her kindergarteners science. Her teaching dilemma was:

> Do inquiry based activities increase students' ability to generate scientific questions, gain understanding, and increase retention of scientific concepts?

She hypothesized that:

> If students use inquiry to gain information to support a big idea in Science, then they will be able to generate scientific questions, gain understanding, and increase retention of the big idea because they will participate in many activities to give them experiences to analyze to support the same major scientific concept.

Amaya taught several inquiry-based lessons in various Science units. For example, one of the inquiry activities she used was to ask students to use many different colors without brown to paint a brown bear, thus students need to try different color combinations. She also embedded "science talk" activity in the lessons. Amaya's observation led her to believe inquiry-based teaching was a useful approach:

> Throughout other Science units, such as Weather, Seasons, and Lifecycles, my students used inquiry and looked forward to participating in our "experiments." They were enthralled at becoming Scientists and took their role very seriously.

Based on the positive experience, Amaya planned to use more inquiry-based lesson in her future teaching in order to make a shift from "teacher led science to student led science." At the same time, she also realized that it is important to strive for a balance between the two different approaches, as she stated:

> It is still hard for me to know when to step in and correct misconceptions and when to let my students figure things out for themselves. Teaching Kindergarten can make this more complicated, as they often do not have as many life experiences to draw from and virtually no prior science instruction to lean on for analyzing data and creating new ideas.

Amaya's experience with previous research was a mixed one. On one hand, she was able to use the 5E model that she found on inquiry teaching to create her own inquiry lessons. On the other hand, she was frustrated that she could not find much information about when to step in and when to let students figure out, as she stated:

> … though it was a learning issue for us nearly every month we could not find a significant amount of research on young children and inquiry. I would like to know more about this subject, as I believe it will help to enhance my future science teaching.

Overall, the majority of teachers reported positive changes in their students' learning, based on evidence of increased test scores, improved student work, and enhanced student motivation and participation. In addition, the Problem-Based Learning approach appeared effective in helping teachers learn to analyze and solve their problems. After going through the process, most teachers became more reflective about their own practice, expanded their visions as teachers, and gained new perspectives on teaching. Teachers also hold a positive view towards the PBL framework for teacher research, as Emma, a sixth grade teacher, stated in her reflection at the end of the school year:

> It is possible that I might have changed my approach to teaching moon phases (and other units) without experiencing problem-based learning, but I firmly believe that is the combination of inquiring into my teaching, filming lessons, getting feedback from colleagues and spending time analyzing students' work that has propelled me to redefine how I teach science, and more specifically how I use questioning to help students learn how to observe and make inferences. I rarely have enough time to reflect deeply on my teaching and consequently cannot

always take the steps necessary to make changes, to grow professionally, and to see a positive impact on my students' learning. Sharing the PBL process with colleagues and science education mentors pushes me to do the kind of exploration, observation and inquiry that I want my students to engage in. The nested boxes of learning, experience and teaching are wonderful to take apart.

Discussion

High standards on student learning call for effective science teaching. Thus, it is critical to provide science teachers with opportunities for high quality professional development. We believe that professional development yields promising results when it is designed based on authentic needs of teachers, rather than assumptions of teacher educators or conventional wisdoms. This study sheds light on some of the challenges science teachers face in their daily practice. The findings of this study help teacher educators and administrators make informed decisions in developing high quality PD in preparing effective science teachers. Understanding and responding to teachers' challenges also helps to retain teachers in the profession.

The challenges that perplex science teachers in this study are important pedagogical issues in science teaching. Helping teachers understand these issues not only has implications for the individual teacher and her immediate learning group, but also for a broader community of science teaching. This study reveals areas in which further research is most needed to improve science teaching. For example, empirical research is needed to understand when teachers should provide information to students and when teachers should let students discover, and how the instructional decision making should be mediated by class time, curricular constraints, and the developmental level of students.

In addition, this study reveals that Problem-Based Learning as an innovative PD approach holds great promise for teachers researching their challenges and improving their learning. Particularly, teachers emphasized the usefulness of two components in the PBL model to help them research their teaching dilemma: video analysis and learning community. In a review of 78 studies of science teacher research, Roth (2007) found that only 12% of the studies used videotapes as evidence. In this study, except the 8 teachers in Cohort 1 were intentionally selected to use written records in order to compare with teachers who conducted video analysis, all the remaining teachers (more than 80%) used or will use video records to examine their teaching practice. Teachers also highly valued the opportunity to get feedback from other teachers with various backgrounds, as Nina, a sixth grade teacher, stated, “This year was an amazing journey. ... The process of FOP forced me to deeper analyze my teaching and the effect on my students learning. An opportunity to meet across grade levels and buildings was therapeutic.”

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