

THE EMPIRICAL BASE FOR PROFESSIONAL DEVELOPMENT IN SCIENCE EDUCATION: MOVING BEYOND VOLUNTEERS

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ABSTRACT

A major component of reform efforts is professional development, and while there is a growing body of literature on what constitutes good professional development, the field still lacks a comprehensive research program. Research often fails to make the connection between professional development activities and what students learn as a result of teachers' participation. Another issue is that what we know is based on teachers' responses on "opinionnaires." Finally, volunteer groups of teachers view professional development differently than those who choose not to participate. In this review, we examine a selection of science teacher professional development articles to determine the rates of participation by volunteers and non-volunteers. Articles related to science professional development were culled from seven peer-reviewed journals from 1990-2000. Thirty-five articles were found, with three studies (8.6%) using non-volunteers. The research base in professional development is limited in that only teachers with similar characteristics and motivation participate. If we continue to conduct professional development research with volunteers, we may never come to understand how to design effective professional development for those non-volunteer teachers who may need it most.

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INTRODUCTION

The past decade has seen broad calls for the reform of science education from the major organizations that have a stake in this subject area (e.g. AFT, 1995; AAAS, 1993; NRC, 1996). Though the details may vary, all of the different reform agendas focus on teaching for understanding and the incorporation of an inquiry-orientation to learning for students. To reach these ends, the reformers call for new curricula, new organizational structures, new policies, and expanded professional development. Professional development is seen as especially key to the reform efforts, as teachers must change their practice in both scope and style in order to support the both the range of knowledge that students are expected to learn and the new ways in which students are expected to acquire and assimilate that knowledge (Supovitz, Mayer, & Kahle, 2000).

A key concern, however, is that there is little empirical knowledge on what constitutes “good” professional development. Wood and Thompson (1993) called for professional development based on research and best practice, but there does not seem to be much agreement in the field about what constitutes “best” practice. Six years later, Wilson and Berne (1999) stated that “what the field ‘knows’ about teacher learning is rather puzzling” (p.173). Currently, teachers’ opportunities to learn consist mostly of scattered, decontextualized events that occur throughout their professional lives, adding up to a hodgepodge of knowledge about teaching and learning that does not lead to a coherent vision or knowledge base to guide practice.

This paper examines one area where our knowledge base for professional development may be inadequate. In our reading of the research base for professional development we have conjectured that the corpus of research consists primarily of studies conducted with volunteer groups of teachers, and not with the general teaching population. Should this conjecture be supported, it is not immediately apparent what the implications of this may be for professional development, but there is good reason to explore this possibility further. The purpose of this paper is to determine the extent to which research on science teacher professional development reported over the last decade has focused on volunteers versus non-volunteers. In this context, we will then present potential areas of concern related to the empirical base upon which our understanding of professional development is constructed.

POTENTIAL ISSUES THREATENING THE VALIDITY OF PROFESSIONAL DEVELOPMENT RESEARCH

Considerable research indicates that professional development to enhance teachers’ personal commitment to teaching through opportunities to learn for their students is necessary for today’s teachers (Hawley & Valli, 1999; Loucks-Horsley, Hewson, Love & Stiles, 1998). The recent interest in professional development is fueled, at least in part, by the attention to school reform that has emerged at virtually every level of the American educational system. These attempts at reform are guided by standards developed by professional organizations and groups (e.g., AAAS, 1993; NRC, 1996). All of these documents include a call for professional development that will provide support for these changes. The American Federation of Teachers (1995) has written “without professional development school reform will not happen” (p. 1). Wilson & Berne (1999) put it best with their statement that, “Professional teachers require professional development” (p. 173).

Even though professional development activities have received increasing attention during the last decade, careful empirical research on teacher professional development lags far behind (Wilson & Berne, 1999). This is true for all disciplines, including science education. A National Science Foundation (1995) report supports this claim, stating that most professional development fails to “address the question of the linkage between participation in a teacher enhancement experience and student outcomes” (p. 22). Energy has been devoted to the enactment of a range of science teacher professional development, as recently catalogued by

Loucks-Horsley and her colleagues (1998). On the whole, however, knowledge about teacher learning is understood from a craft orientation.

Most professional development is assessed through teacher surveys that ask teachers' opinions of the activity; we rarely know what impact the professional development activity had on student learning. Smylie (1989) commented that "much of what is known about the effectiveness of sources of teacher's learning comes from a limited range of studies that report teacher' opinions about a specific source or group of related sources of learning." This claim has been supported by Showers, Joyce, and Bennett (1987), who found that professional development assessments only take into account how participating teachers react to the activity. Moreover, Guskey and Sparks (1991) state that effectiveness of programs is usually restricted to self-reported changes in thinking, beliefs and what they do after going through some professional development activity. Simply put, teachers can only state what they think they know about professional development, not what they actually know (Fenstermacher, 1994). We do not know what people learn from professional development, we only know what they think about professional development activities. Other ways of assessing teacher's knowledge must be used.

In addition, Kennedy's (1998) literature review found 10 of 93 studies that assessed the effects on students of a professional development activity. Difficulties understanding the effects of professional development on students is exacerbated by the fact that student learning comes from many different sources, not just through a direct link through a teacher from professional development. The report from the NSF (1995) indicates that only one study used a measure other than self-report to assess student outcomes.

VOLUNTEERS?

Volunteers have certain characteristics that place them near one end of a spectrum that includes all teachers and their motivation to participate in the types of programs that are reported in the research literature. Volunteers tend to be innovators, actively seeking new ideas that challenge their present thoughts on teaching and learning. They do not see change as a flaw in themselves and are risk-takers. The teachers who do not participate, who we will call non-volunteers, may not be unwilling, but are likely unimpressed by the types of professional development currently offered them by research groups.

Supovitz & Zief (2000) studied the motivations and interests of those who repeatedly participated in professional development and those who did not. They found that the non-volunteers' view of professional development were traditional in nature. Non-volunteers preferred "one-shot" workshops where teachers are led through activities. This perspective is contrary to newer approaches to professional development that focus on students learning and collaborative partnerships among teachers. The non-volunteers noted that familial obligations precluded them from participating in extended professional development and seemed to be frequently motivated by personal rather than professional concerns.

Professional development that attempts to reach large populations of teachers in districts in an attempt at school and district reform has the burden of providing successful experiences for all teachers not just volunteers. Loughran and Gunstone (1997) illustrate the motivation of non-volunteers when they state that teachers "often approach professional development with a healthy cynicism as they 'wait to be convinced' that the time spent 'doing' professional development, and therefore away from their students, will in some way eventually be of benefit to their practice and their students' learning" (p. 159).

Work by Zucker, Shields, Adelman, and Powell (1995) indicates that 8% of teachers in states that have National Science Foundation funding for State Systemic Initiatives participated in professional development in 1994. Supovitz, Mayer, and Kahle (2000), in their report about Ohio's State Systemic Initiative, Discovery, claim that about 20% of middle school teachers *volunteered* to take part in professional development as part of the program. There are other systemic reforms happening in Ohio at different levels which will add to the number of teachers participating in systemic professional

development efforts. Even if that 20% were doubled through other systemic programs in the state, that still leaves 60% of Ohio's teachers not participating in some form of systemic reform

Systemic reform of this kind necessarily entails a professional development program to be scaleable, that is, it needs to be successful with the full range of teachers, not just volunteers. Systemic reform cannot be accomplished without scalability, but the opposite is possible: you can achieve scale without systemic reform (Blumenfeld et al., (2000). There are so many willing volunteers across the country that a program can have successful professional development with hundreds of teachers, and still not achieve systemic reform goals in large systems.

Therefore, this review explores the question: To what extent is our knowledge base about science teacher's professional development reliant on research involving volunteers versus non-volunteers? By understanding more about participants, better designs for professional development can be created. This will inform the science education community about new questions for the future of professional development of science teachers.

METHODS

Journal Selection. In order to systematically examine research on professional development in science, we decided to use common peer-reviewed journals that report research in science education, teaching or professional development as the basis for our review. The seven listed in Table 1 are the journals we felt would be most representative of the science education professional development community and encompass the greatest opportunity to find a wide range of research on professional development. The standards-based reform movement has entered the mainstream over the last decade, so the last ten years of these journals were used.

Article Selection. Depending on the journal and the title of the article, selection was conducted in a slightly different manner. In the science education journals, articles with titles that included some definite reference to research on professional development were included. Articles in these same journals that might report professional development activities were examined further to determine if they were based on professional development research. This was done by reading the abstract if they had one, or in many cases, reading the paper to the point where a clear understanding of the study could be attained. Teacher education journals were searched, looking first for any articles on science education, and then examined for professional development research. Articles that met the above criteria were included in this review.

It is important to note that there are innovations where small groups of teachers are working in conjunction with researchers on a myriad of projects with a major component of professional development. This work, however, is not frequently published in the journals chosen for this study. If it were included, it would only further support our claims regarding the use of volunteers in research studies on professional development.

Table 1. Peer-reviewed journals used in this review and the number of articles found.

Journal	Number of articles found
International Journal of Science Education	4
Journal of Education for Teaching	2
Journal of Research in Science Teaching	10
Journal of Science Teacher Education	11
Journal of Staff Development	5
Science Education	2
Teaching and Teacher Education	1

Factors considered for this review. Was the professional development conducted with volunteers or non-volunteers? The determination of volunteerism was made in the following way. If the authors stated that participants volunteered or teachers applied for and then were selected to take part, or if they enrolled in a course, they were considered volunteers. They were considered non-volunteers if the program was across the whole school, or if the authors claimed the sample was representative of a wide range of teachers.

How many teachers were used? Teachers are the only ones included in this value. Other professionals or support persons were not included.

What kind of activities made up the bulk of the professional development program and how long did these activities last? Adapted from Fishman et al.'s. (2000) professional development design elements, and informed by Loucks-Horsley, Hewson, Love and Stiles' (1998) book on science and mathematics professional development, we developed a scheme that indicates the site at which each set of professional development activities takes place. The list of possible sites is in Table 2.

Table 2. Sites for professional development.

Site
Action research-teachers as researchers in their own classrooms
Course-designed as a unit and usually taken for some kind of credit with specific meeting times and place
Full-day session-activities that take up a full day during the week or on Saturday
Ongoing meetings-repeated sessions over time that are an integral part of the activities
Online interaction-communication takes place over the Internet or email
Partial-day sessions-professional development activities lasting a few hours in length usually as a follow up to a summer institute
Professional or presentation-when a group of teachers see and hear an expert of some kind either at their school or someplace else
Summer institute-extended, full-day activities generally lasting from 1-3 weeks
Visiting classrooms-using teacher's experience in a classroom as basis for dialogue

Adapted from Fishman et al., (2000)

RESULTS

Thirty-six articles were found to meet the above criteria. Two of the studies pertained to the same research, so only 35 were considered. Table 3 shows the articles reviewed, separated by whether the teachers were volunteers or non-volunteers.

Overwhelmingly, professional development research reported is conducted using volunteers. There were only three studies (9%) that used non-volunteers. The number of participants ranged from a low of 6 to a high of 1595. Eighteen (51%) of the studies used a summer institute as a major component of the program, while eleven (31%) utilized full-day sessions, and eight (23%) used some form of partial-day session, and seven (20%) provided a course as part or all of the professional development program. (More than one site could be coded per study, hence the percentages add to more than 100%.) Only one study (number 21) reported using electronic communication as a component of professional development.

Table 3. Articles reviewed.**Articles reporting professional development done with volunteers**

	Author (year)	N	Site	Duration
1	Ross (1990)	64 classes	Partial-day session	3-2 hr. sessions over 1 year
2	Tillema et al. (1990)	156	Ongoing meetings	5 sessions of 3-4 hrs each
3	Crawley (1990)	50	Course	5 wk. courses meeting 6-10 hrs wk
4	Baird et al. (1991)	11	Action research	Over 2 years
5	Butler (1992)	21	Full-day session	9 1/2 days across 1 year
6	Abell & Pizzini (1992)	22+22 control	Summer Institute	3 weeks
7	Yerrick et al. (1997)	24	Summer Institute	2 weeks
8	Loughran & Gunstone (1997)	6	Partial-day session, Visiting classrooms	1 year
9	Parke & Coble (1997)	19+11 control	Summer Institute, Partial-day session	Not stated
10	van Driel et al. (1998)	12	Full-day session	5 meetings across unit
11	Parker & Heywood (1998)	89	Full-day session	10 days
12	Watts & Jofili (1998)	12	Full-day session, Action research	2 weeks, followed by action research
13	Luft (1999)	13	Summer Institute, Full-day session	10 months
14	Radford (1998)	90	Summer Institute, Ongoing meetings	3-week summer and then 1 year of meetings
15	Flores et al. (2000)	12	Course	18 months
16	Kahle et al. (2000)	18	Summer Institute, Full-day session	6 weeks
17	Janas & Gurganus (1993)	20-course/24-institute	Course, Summer Institute	3 hour course, 1 week institute
18	Morehouse et al. (1991)	15	Course	5 weeks
19	Keyser (1997)	17	Summer Institute, Full-day session	2 weeks, 1 day 10 months later
20	Carter et al. (1998)	75-100	Summer Institute, Partial-day session	Not stated
21	Thoresen (1997)	20 mentors/20 mentees	Online interaction	2 years
22	Clermont et al (1993)	8	Summer institute	2 weeks
23	Shymansky et al. (1993)	42	Summer Institute, Partial-day session	1 year
24	Van Koevering et al (1992)	1595	Professional or Presentation, Full-day session	3 hour or full-day presentation
25	Long et al. (1992)	32	Course	Summer 1-8 weeks; Summer 2-6 weeks
26	Barman & Shedd (1992)	18	Partial-day session	6 sessions over 2 1/2 months
27	Jacob et al. (1991)		Course	28 hours of class time
28	Taylor et al. (1994)	215	Summer Institute, Partial-day session	1 year
29	Scharmman (1994)	43	Summer institute	2-2 week sessions w/different groups
30	Stannard et al. (1994)	20	Summer institute, Partial-day session, Full-day session	1 year
31	Ridgway & Bowyer (2000)	210	Summer institute, Course, Full-day session	Extended over 1 year
32	Anderson (1993)	73	Summer Institute, Full-day session	1 or 2 weeks

Articles reporting professional development done with non-volunteers.

33	Yager, & Weld (1999)	133 +48 control	Summer institute	Not stated
34	Wilson (1997)	35 schools	Professional or Presentation	Not stated
35	Tobin et al. (1991)	Teachers in 5 schools	Summer institute, Ongoing meetings	20 day institute followed by in-school events

IMPLICATIONS

1. *Insofar as we test innovative professional development with volunteers, we lack the empirical base regarding its effectiveness with groups of teachers who most likely need it.*

Volunteers see professional development and the world differently than those who do not volunteer (Supovitz, & Zief, 2000). This has serious implications for the future of professional development. Professional development needs to resonate with the beliefs and attitudes of more than just the volunteer population of teachers. Professional development needs to reach out to those teachers who have differing beliefs.

Blumenfeld and Marx (1997) argue that enhanced motivation leads to greater learning by guiding learners' cognition. So, if teachers are more motivated to participate in professional development activities, they are likely to become more cognitively engaged in these activities, with the result that they gain more from professional development. If only a small part of the teacher spectrum is motivated by the current offerings of professional development, then only those few will benefit. We need to take into account a broader range of motivation for doing professional development when we design opportunities for teachers in order to engage a wider range of teachers. The extended, time-intensive nature of many of the professional development opportunities reviewed lead to engaging teachers at one end of the spectrum—those who are motivated and able to participate.

While we are beginning to understand the kinds of teaching we would like to see all teachers practicing, we are only coming to understand how to professionally develop a small portion of the population that is ready to learn about different teaching methods. There is a large proportion of the teaching population that has yet to understand educating students the way many researchers have. If professional development for ALL science teachers is to play a productive role in systemic reform, then we must look closer and understand more about those teachers who choose not to participate in our efforts at teacher change.

2. *If we cannot get broader participation in professional development, then we will not be able to use professional development to reach our reform goals*

Reforming teacher practice to reflect our new knowledge about learning entails professional development that is scaleable; that is, it needs to be successful with all types of teachers. Systemic reform cannot be accomplished without scalability, but the opposite is possible: you can achieve scale without systemic reform (Blumenfeld et al., 2000). There are so many willing volunteers that a program can have successful professional development with hundreds of teachers, and still not achieve systemic reform goals in large systems.

3. *There might be large-scale professional development with non-volunteers that are not represented by the research base*

None of the studies reported research conducted about districts' attempts at professional development, which is where most of the non-volunteer population takes part in professional development. Most of what we hear about the professional development within districts is that it is piecemeal, fragmented and is not individualized to fit the needs of teachers. This lack of empirical research is a serious lacuna in our understanding of professional development.

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APPENDIX A

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