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Research Experiences for Teachers (RET): Motivation, Expectations, and Changes to Teaching Practices due to Professional Program Involvement

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Abstract This study investigated teachers' motivation, expectations, and changes to teaching practices due to a 6 week summer professional development program involvement. Participants ($n = 67$) attended the Research Experiences for Teachers (RET) program within a major university in southeast. Surveys and interviews were used to collect data to answer the following research questions: (1) Who attends the RET program? (2) In what ways do elementary teachers differ from middle/secondary teachers with respect to their motivation for attending the RET program and their expectations about the program? (3) In what ways do elementary teachers differ from middle/secondary teachers with respect to implementing changes to their teaching practices due to RET program attendance? Survey results indicated significant differences between elementary teachers and secondary education teachers with respect to their expectations about the program, and changes to their teaching practices. Interview results provided support to survey findings. Implications for professional development and science teacher education are discussed in relationship with the current study findings.

Keywords Professional development · Teacher education · Motivation

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Introduction and Purpose

An ongoing objective of most professional development programs is to provide experiences that create change in classrooms and support standards-based inquiry classrooms (Loucks-Horsley et al. 2003; Smith and Southerland 2007). Research suggests that effective professional development experiences may help improve the quality of teaching as well as student achievement (Dana et al. 1997; Kardash 2000; Seymour et al. 2003). Therefore, creating valuable opportunities for teachers at all grade levels to engage in professional development programs and to develop knowledge of science is an important goal for educators (National Research Council 1999). Previous research (Akerson and Donnelly 2008; File and Gullo 2002; Tolman and Campbell 1991) indicates that, unlike undergraduate science majors and secondary science teachers, elementary teachers often lack adequate content preparation in science and they are rarely given the opportunity to get involved in science education professional development programs. At the same time, given the mandates of No Child Left Behind (NCLB 2005), specifically the requirement for highly qualified teachers, elementary teachers are expected to deliver standards based, content rich science education.

The National Science Foundation has supported Research Experiences for Teachers (RET) programs for decades and evaluation reports show that the programs meet stated objectives to provide teachers with real-world research strategies (Evaluation of RET Program, SRI International 2007). RET programs have been a staple of NSF funding for 20 years and there are now approximately 70 programs nationwide. Teachers (typically middle and high school educators) are placed in research laboratories to become immersed in the process of real-world science research. Some programs are quite small, placing one or two teachers in a university laboratory; some are quite large, placing 10–50 teachers in private industry laboratories and university laboratories. Some programs provide a great deal of support for translating the experience and have regularly scheduled sessions and workshops; others place teachers and have limited contact. One professor in one university laboratory might host one or two teachers but in contrast the RET program that was the basis for this research hosts 10–17 teachers at one national research laboratory. That all teachers are housed at one facility and yet work with very diverse areas of research is unusual. Further, the RET program where our study was conducted has embraced inclusion of elementary teachers from its inception in 1999.

Few studies have researched the impact of the RET programs on teachers' practices immediately after their attendance in the program (e.g., Dixon and Wilke 2007, Grove and Dixon 2008; Grove et al. in press). Furthermore, no studies have examined teachers' views long after their program attendance, nor have there been comparisons across grade levels. Our study investigated the views of Elementary Education (EE) teachers and Middle & Secondary Education (MSE) teachers with respect to participants' motivation for engaging in the RET program, their expectations about the program, and changes to their teaching practices due to program attendance.

Theoretical Framework

Research experiences generally refer to contexts in which teachers are mentored by scientists and conduct scientific investigations (Feldman et al. 2007, Fernandez-Esquinas 2003; Kardash 2000). According to Kardash (2000), research experiences embody a cognitive apprenticeship model. Situated cognition and social constructivist views of learning emphasize the role of context in a cognitive apprenticeship model to foster the development of thinking and knowledge by allowing individuals to develop within that specific context (Lave 1997). The concept of apprenticeship is used in this study as “legitimate peripheral participation in a community of practice that results in situated learning of the skills and knowledge needed to be working with a scientist” (Feldman et al. 2007, p. 2).

Apprenticeship models of learning can be found in a variety of contexts and to a certain extent have characteristics unique to the context in which they occur, but they all share some key commonalities. An important characteristic of apprenticeships is the indistinguishable nature of learning and the practice of work. Through cognitive apprenticeships, teachers play the role of the student in the learning process in order to acquire the skills and knowledge relevant to the practice of science. Moreover, teachers must find ways to translate this learning to their students and classroom teaching. Several works (e.g., Hashweh 2003; Supovitz and Turner 2002) outline components in teacher professional development programs necessary to the process of accommodative change, or changes to thinking and practice. Many of these components can be found in research experiences; for example, intrinsically motivated learners, critical thinking, active construction of new knowledge through inquiry, and a social climate conducive to collaborative learning.

Contemporary appraisal theories accentuate the role of expectancy-value in understanding the interplay of motivation and expectations as related to changes in behavior. Expectancy-Value theory (Wigfield and Eccles 2000; Wigfield et al. 2004) is based on the notion that a person’s motivation to perform a behavior is the product of expectations about his/her ability to perform the task (e.g., meet a goal) and the value of that goal to the person (Eccles Parson et al. 1982). Wigfield and Eccles’ (2000) research suggests that a person’s choice of tasks or goals, persistence on those tasks, and performance of those tasks can be explained by determining the individual’s expectancy and value concerning the particular task or goal. Other theorists in this area (Atkinson 1964; Eccles Parson et al. 1982) “argue that individuals’ choice, persistence, and performance can be explained by their beliefs about how well they will do on the activity and the extent to which they value the activity” (Wigfield and Eccles 2000, p. 68). The element of value may also indicate whether implementation of a change in teaching practices can occur. What teachers believe about their abilities and teaching practices may also influence their expectancies of making change (Wigfield and Eccles 2000).

For the RET program, what participating teachers believe they can do with new ideas, and how much they value the new element, may indicate the extent to which changes are made in their classrooms. A teacher, for instance, may decide to include more inquiry in teaching science, more collaborative learning activities, or may implement an entirely new style of instruction as acquired knowledge from a professional development program is put into place. Similar to any learning experience, the goal is not only to gain new information, but to be able to transfer that knowledge to a new situation in the future (Woolfolk 2007). As a professional development program, the RET program also supports this transfer of knowledge for teachers to enrich their own science instruction in their classrooms. The RET program provides many opportunities for participating teachers to experience life in a research laboratory as modeled by their mentor scientists. Teachers are given opportunities to develop their own beliefs about the aspects of real-world science that may be important to incorporate into their own classrooms. Although formal and informal discussions helped the teachers sift through their experiences, each teacher constructed his or her belief about what is necessary for an effective science classroom.

Deci and Ryan (2000) emphasize the role of contextual factors in one's motivation to engage in a task. Context affects learners in their choice of performing a certain task and the degree to which learners have control in this process. Teachers participating in the RET program choose to apply. This choice may be linked to the teachers' intrinsic motivation to learn and acquire new science teaching skills, to wanting to attend a program in a new area of the country, or to earning a stipend. Moreover, the practice of allowing RET participants to collect their own meaningful experiences from the work with their mentor scientist and discussions, is supported by past research which has demonstrated this practice to be effective in professional development (Zubrowski 2007). When participants are able to relate the professional development to their own classroom and individual needs, they are more likely to be motivated to make changes to classroom practices (Deci and Ryan 2000; Loucks-Horsley et al. 2003) that may influence students' achievement.

Most research studies investigated the RET programs' outcomes and the nature of learning through a situated cognition or a cognitive apprenticeship approach. Also, research findings about professional development and teachers' learning involved in a research experiences program, or RET-like program have been documented for undergraduate and secondary teachers (e.g., Buck 2003; Feldman et al. 2007; Kardash 2000). No studies have examined aspects related to teachers' motivation for engaging in the RET program, their expectations about the program, and changes to their teaching practices due to program attendance. Moreover, no studies to date compared elementary teachers' views of the RET with those of middle and secondary teachers.

Research Questions

Research questions addressed by the present study were: (1) Who attends the RET program? We included this as a research question rather than strictly demographic information because the nature of residential RET programs attracts a certain demographic that may have implications for implementation of new content or use of new strategies. (2) In what ways do EE teachers differ from MSE teachers with respect to their motivation for attending the RET program, and their expectations about the program? (3) In what ways do EE teachers differ from MSE teachers with respect to implementing changes to their teaching practices due to the RET program attendance?

Method

Participants and Context

A total of 90 teachers from all grade levels (i.e., elementary, middle, and secondary education) participated in the RET program from 1999 to 2006 in a National Science Foundation funded RET program at a national laboratory within a major university in the southeast. Details about teachers' demographic characteristics are presented in the "Results" section to answer our first question "Who attends the RET program?"

The research experiences involved in-service teachers working with research scientists on a wide variety of projects in laboratories at the research facility. Teachers were typically paired with other teachers based on their levels of experience, and then assigned to a scientist with whom they worked for 6 weeks. All participants were required to present their research in a formal public presentation at the end of the program. Requirements for the culminating event changed over time as the program manager evaluated each year's results. Early in the program, teachers were required to identify lessons that translated their experiences to the classroom and were required to present a Power Point-based lecture describing the research. For 2 years of the program teachers were required to write a research article suitable for publication but this proved very stressful for teachers and was eliminated in favor of a poster session. Research projects were negotiated between the teachers and scientists with guidance from educators at the lab. This resulted in a variety of projects that ranged from assisting in ongoing research to special projects designed just for the teachers. Final products reflected individual research experiences in physics, chemistry, geochemistry, and optical microscopy.

Based on a Loucks-Horsley et al. (2003) model, goals for the program were set and included features that aligned with the context of the research experiences. Such program features included weekly sessions on writing in science, online journaling, colloquiums, content lectures, workshops, peer mentoring, and share fairs. While these elements of the program varied slightly in time, the basic structure remained the same with weekly seminars providing support for teachers to find ways to translate their experiences. During this time period (1999–2006), the program maintained the same structure for the research component, but some changes were made to program features based on evaluation conducted by educators at the facility.

Procedures and Analysis

This study was conducted in two phases, which are presented below.

Phase 1: Survey

An online survey was sent to 73 teachers, past RET participants from 1999 to 2006. One major challenge of this study was to locate as many RET participants as possible, since teachers attending the program were from different locations within U.S., and several teachers relocated after their RET participation. Of the 90 teachers, all the RET participants from 1999 to 2006, 73 teachers were located.

Sixty-seven (67) teachers responded to the online survey (response rate 91.7%), and a small percentage (8.2%, $n = 6$) did not respond to the survey. The survey was comprised of a demographic questionnaire and three additional questionnaires (i.e., *Motivation to Attend the RET Program Questionnaire, Expectations about the RET Program Questionnaire,* and *Changes to Teaching Practices Questionnaire*). Participants were asked to rate each item based on a four-point Likert-scale (1 = "Strongly disagree"; 4 = "Strongly agree") to indicate their reasons for attending the program, their expectations about the program, and changes to their teaching practices due to RET program involvement. Survey items for all three questionnaires, along with statistical analysis results are presented in Tables 2, 3, and 4. Descriptive statistics (e.g., counts, percentages, means, standard deviations) were used to report the survey results. One-way analysis of variance (ANOVA) was used to determine differences in motivation, expectancies, and changes to teaching practices with respect to teachers' grade level.

Phase 2: Interviews

A total of 12 participants (4 teachers each from elementary, middle and secondary education) were selected from the survey respondents pool ($n = 67$) to participate in a telephone interview about their RET experiences (see Appendix for sample questions). Although middle school and secondary education (MSE) teachers are grouped together, we wanted to make sure all perspectives were considered. Interviewees were selected based on grade level, accessibility, availability, and diversity of location and year attended. These 12 participants were considered by the researchers to embody the best potential source of rich information for interviews (Lincoln and Guba 1985) by representing a variety of demographics (i.e., grade level, gender, age, years of teaching experience etc.). All survey respondents were asked if they would be willing to participate in a follow-up interview. Agreement from all 67 respondents was reached. Therefore, participants volunteered for the second phase of the study and consented to have their interviews recorded. To protect participants' anonymity and give them a sense of security, pseudonyms were assigned to each teacher. The in-depth, semi-structured interviews explored teachers' views about their RET experience with respect to motivation for attending the program, expectations about the program, and changes to their teaching practices due to program attendance. The content analysis technique (e.g., Merriam 1998; Creswell 2007) was employed to organize, code, and interpret the data gathered through interviews. Two coders independently coded the data; an initial interrater reliability was calculated (90% agreement), and the two coders discussed their disagreements until 100% agreement was reached.

Results

To answer our first research question, “Who comes to the RET program?” we first present results regarding teachers’ characteristics. Next, to answer our second, third and fourth research questions we present results from the survey and interviews regarding (1) teachers’ motivation for attending the RET program, (2) teachers’ expectations about the program, and (3) changes to teaching practices due to the program attendance.

Teachers’ Characteristics

Gender

Table 1 reports teachers’ demographic characteristics ($n = 67$). An analysis of the gender profile of the participants indicated that approximately 22.4% ($n = 15$) of the RET attendees were male, and surprisingly, the majority (77%, $n = 52$) were females (see Table 1). From an educational standpoint this is encouraging news. Most research in the science field suggests that females are usually less involved in science and frequently experience barriers to immersion into the culture of science as compared to males (e.g., Morse 1995; Bernstein et al. 1996).

Age

The ages of the 67 RET participants ranged from 19 to over 46. The majority of participants (37.3%, $n = 25$) were in the over 46 age group, according to their survey responses, followed by participants in the age group of 26–30 years old (21%, $n = 14$) and 36–40 years old (15%, $n = 10$). The smallest group (3%, $n = 2$) was comprised of teachers, ranging in their ages from 19 to 25 years old. Experienced teachers, especially those who regularly attend professional development programs might be more knowledgeable about opportunities and educational networks.

Teaching Experience

The largest group of participants (49%, $n = 33$) had between 0 and 10 years teaching experience (see Table 1), followed by teachers with 11–20 years of teaching experience (24%, $n = 16$). The smallest groups (equally distributed) were comprised of teachers within the range of 21–30 years experience (13%, $n = 9$), and over 30 years teaching experience (13%, $n = 9$).

Grade Level

EE teachers (49.3%, $n = 35$) made up the majority of RET participants. The combined group of middle and secondary education (MSE) teachers represented

Table 1 Demographic characteristics of all participants ($n = 67$)

Characteristics	EE teachers ($n = 35$)		MSE teachers ($n = 32$)		Total Participants ($n = 67$)	
	n	%	n	%	n	%
Gender						
Males	4	11.4	11	34.4	15	22.4
Females	31	88.6	21	65.6	52	77.6
Age						
19–25	1	2.9	1	3.1	2	3
26–30	10	28.6	4	12.5	14	21
31–35	5	14.3	3	9.4	8	12
36–40	5	14.3	5	15.6	10	15
41–45	5	14.3	3	9.4	8	12
Over 46	9	25.7	16	50	25	37.3
Teaching experience						
0–10	21	60	12	37.5	33	49.3
11–20	9	25.7	7	21.9	16	24
21–30	2	5.7	7	21.9	9	13.4
Over 30	3	8.6	6	18.8	9	13.4
Degree level before RET						
Undergraduate student	2	5.7	3	9.4	5	7.5
Bachelor's degree	24	68.6	14	43.8	38	56.7
Master's degree	9	25.7	14	43.8	23	34.3
Doctoral level	0	0	1	3.1	1	1.5
Degree level after RET						
Undergraduate student	0	0	1	3.1	1	1.5
Bachelor's degree	21	60	13	40.6	34	50.7
Master's degree	14	40	17	53.1	31	46.3
Doctoral level	0	0	1	3.1	1	1.5
PD hours before RET						
0–10	14	40	8	25	22	32.8
11–20	7	20	8	25	15	22.4
21–40	11	31.4	6	18.8	17	25.4
Over 41	3	8.6	10	31.3	13	19.4
PD hours after RET						
0–10	2	5.7	4	12.5	6	9
11–20	10	28.6	2	6.3	12	18
21–40	11	31.4	9	28.1	20	30
Over 41	12	34.3	17	53.1	29	43.3

n Number of participants; % percentage of participants

47.8% ($n = 32$). With respect to MSE participants, middle-school teachers represented 18% ($n = 12$) of the total participants, and high-school teachers represented 30% ($n = 20$) of the total participants. Interestingly, most RET programs focus on MSE teachers who are perceived as having greater content knowledge, therefore a higher percentage of MSE attendees could be implied. This particular program was one of the first known RET programs to include EE teachers.

Professional Development Involvement

An analysis of the survey results regarding participants' professional development involvement before and after attending the RET program revealed an increase in number of in-service (continuing education) hours earned by teachers after their RET attendance. The majority of the RET participants (32.8%, $n = 22$) reported an average of 1–10 h per year of in-service hours *before* their attendance of the RET program. Thirty percent ($n = 20$) of participants reported an average of 21–40 h per year, and 43.3% ($n = 29$) reported over 41 h per year. Furthermore, interview findings indicated that overall, most teachers became more involved in various professional development activities after their RET attendance and were more willing to expand their professional roles (e.g., taking leadership roles in school, or in science workshops and conferences).

Motivation for Attending the RET Program

Table 2 presents results from participants' responses regarding the most influential reasons for their program attendance. Overall, survey results indicated primarily intrinsic motivators for teachers attending the RET program; 76.1% ($n = 51$) teachers (both EE and MSE teachers) indicated they wanted to gain new teaching ideas, to stay involved in professional growth (7.1%, $n = 47$), to gain more content knowledge (58.2%, $n = 39$), and to better understand how to implement changes to classroom teaching (5.7%, $n = 34$).

EE teachers' survey results indicated among the most influential reasons for attending the program were gaining new teaching ideas (82.9%, $n = 29$), for professional growth (77%, $n = 27$), understanding how to implement changes to classroom teaching (57.1%, $n = 20$), and gaining content knowledge (54.3%, $n = 19$). Similar reasons were expressed by the MSE teachers; the majority of participants (68.8%, $n = 22$) attended the program to gain new ideas for classroom teaching, for professional growth (62.5%, $n = 20$), and to gain content knowledge (62.5%, $n = 20$). A smaller percentage of MSE teachers (43.8%, $n = 14$) compared to EE teachers (57.1%, $n = 20$) expressed as reasons for attending the program "To better understand how to implement changes to my classroom." One-way ANOVA indicated no significant differences between the EE and MSE teachers with respect to their motivation for program attendance.

Participants' interview statements from the second phase of the study supported the quantitative results. Both EE and MSE teachers indicated that learning science in a real world setting, working with a scientist, incorporating applied science into teaching, building networks, and taking advantage of the summer professional development opportunities were predominant reasons for participating in the RET program. Laura, an EE teacher, expressed several of these reasons for attending the RET program in her interview:

Table 2 Participants' motivation for attending the RET program ($n = 67$)

Reasons	EE teachers strongly agree ($n = 35$)		MSE teachers strongly agree ($n = 32$)		Total Participants strongly agree ($n = 67$)	
	n (%)	*X* (SD)	*n* (%)	*X* (SD)	*n* (%)	*X* (SD)
1. To gain more content knowledge	19 (54.3)	3.49 (.65)	20 (62.5)	3.56 (.66)	39 (58.2)	3.52 (.66)
2. To interact with others (socialize)	11 (31.4)	3.11 (.79)	11 (34.4)	3.06 (.87)	22 (32.8)	3.09 (.83)
3. To better understand how to implement changes to my classroom	20 (57.1)	3.51 (.65)	14 (43.8)	3.25 (.80)	34 (5.7)	3.39 (.73)
4. To gain new ideas for my classroom	29 (82.9)	3.77 (.59)	22 (68.8)	3.56 (.80)	51 (76.1)	3.67 (.70)
5. Mandated (by school district)	0 (0)	1.29 (.45)	1 (3.1)	1.25 (.67)	1 (1.5)	1.27 (.56)
6. To get materials for my classroom	7 (20)	2.83 (.89)	9 (28.1)	2.78 (1.0)	16 (23.9)	2.81 (.94)
7. To obtain certification/recertification	0 (0)	1.80 (.86)	2 (6.3)	1.78 (1.0)	2 (3)	1.79 (.93)
8. To obtain an endorsement	0 (0)	1.51 (.612)	1 (3.1)	1.56 (.80)	1 (1.5)	1.54 (.703)
9. To impress my peers	0 (0)	1.63 (.73)	2 (6.3)	1.72 (.92)	2 (3)	1.67 (.82)
10. To keep myself involved in the professional growth	27 (77.1)	3.71 (.622)	20 (62.5)	3.44 (.91)	47 (7.1)	3.58 (.78)

n Number of participants; *%* percentage of participants; *X* mean; *SD* standard deviation

> There are [sic] lots of things, but I was always very interested in science. I've been to other similar programs and I thought what you offer is wonderful. The lab was wonderful, it was there, it was science, you had science kits; I said I'll take that to my classroom, the money didn't hurt, did not hurt at all, the fact that we worked with real scientists was wonderful….And we met a lot of people. Because when I was there I built my science network. Like right now I'm putting my science carnival together, mostly for the people who were there [in the RET]. We built this network.

Daniel, a high-school teacher talked about his lack of real life science experience. His primary motivation for attending the RET was to gain some experience working in a lab and use it as a foundation in his teaching.

> Last year I taught with some teachers; [they] had a lot of real-life experiences and they came back to teaching and were able to draw from all of these…And I just went straight from college to teaching; I felt like I missed out a lot—real world applications, what people are doing actually in the science out there teaching. And I thought it would be nice to have some sort of experiences to put it under my belt wear.

Expectations About the RET Program

Overall survey results regarding teachers' expectations about their RET program attendance (see Table 3) indicated that participants expected to get new ideas for classroom teaching (65.7%, $n = 44$), gain more content knowledge (61.2%, $n = 41$) and have a fun and engaging experience (61.2%, $n = 41$). EE teachers' reporting showed expectations related to gaining new ideas for classroom teaching (68.6%, $n = 24$), having a fun and engaging experience (60%, $n = 21$), understanding how to implement changes to classroom teaching (54.3%, $n = 19$), and gaining more content knowledge (54.3%, $n = 19$). MSE teachers' expectations were related to gaining more content knowledge (68.8%, $n = 22$), gaining new ideas for classroom teaching (62.5%, $n = 20$), and having a fun and engaging experience (62.5%, $n = 20$).

Additionally, one-way ANOVA results (see Table 3) indicated significant differences between EE and MSE teachers with respect to their expectation of interacting with others ($F[1,65] = 4.15$, $p < .04$), and their expectations about

Table 3 Participants' expectations about the RET program attendance ($n = 67$)

Expectations	EE teachers strongly agree ($n = 35$)		MSE teachers strongly agree ($n = 32$)		Total Participants strongly agree ($n = 67$)	
	n (%)	X (SD)	n (%)	X (SD)	n (%)	X (SD)
1. I had no expectations	0 (0)	2.89 (.75)	1 (3.1)	1.84 (.76)	1 (1.5)	1.91 (.71)
2. I expected to interact with others	6 (17.1)	2.89 (.75)	9 (28.1)	3.22 (.55)	15 (22.4)	3.04 (.68)*
3. I expected to better understand how to implement changes to my classroom teaching	19 (54.3)	3.54 (.50)	9 (28.1)	3.06 (.71)	28 (41.8)	3.31 (.65)**
4. I expected to gain new ideas for my classroom	24 (68.6)	3.69 (.47)	20 (62.5)	3.63 (.49)	44 (65.7)	3.66 (.47)
5. I expected to be an overwhelming and demanding experience	4 (11.4)	2.51 (.74)	3 (9.4)	2.38 (.90)	7 (1.4)	2.45 (.82)
6. I expected to be able to obtain certification/'recertification	2 (5.7)	1.97 (.89)	3 (9.4)	1.97 (1.0)	5 (7.5)	1.97 (.95)
7. I expected to gain more content knowledge	19 (54.3)	3.51 (.56)	22 (68.8)	3.66 (.54)	41 (61.2)	3.58 (.55)
8. I expected it to be a fun and engaging experience	21 (60)	3.60 (.49)	20 (62.5)	3.56 (.66)	41 (61.2)	3.58 (.58)
9. I expected to learn more so I can impress my peers (boss)	2 (5.7)	1.91 (.88)	0 (0)	1.75 (.76)	2 (3)	1.28 (.51)
10. I expected it to be boring and not at all fun	0 (0)	1.26 (.44)	0 (0)	1.31 (.59)	0 (0)	1.28 (.51)

n Number of participants; % percentage of participants; *X* mean; *SD* standard deviation

* $p < .05$ In comparing EE and MSE teachers (ANOVA)

** $p < .01$ In comparing EE and MSE teachers (ANOVA) understanding how to implement changes to classroom teaching ($F[1,65] = 1.2$, $p < .002$). MSE teachers expected to socialize more ($M = 3.22$, SD = .55) compared to EE teachers, ($M = 2.89$, SD = .75), and EE teachers expected to better understand how to implement changes to classroom teaching ($M = 3.54$, SD = .50) compared to MSE teachers, ($M = 3.06$, SD = .71).

Interview results, overall, suggested that both EE and MSE teachers had expectations that were not clearly defined, or they expressed general expectations only related to pedagogical aspects (e.g., creating lesson plans, integrate modern science into teaching, learn about special topics). One reason for this may be teachers' limited exposure to RET and RET-like programs. The concept of workshops may be so ingrained that anything related to professional development may be viewed as workshop-like.

EE teachers emphasized their desire to learn more science was due to their perceived lack of content science knowledge and lack of confidence in teaching science. Therefore, EE teachers were more eager to learn the science content and thought the RET program would help them overcome their perceived lack of content knowledge. When asked about attending the RET program, Michelle, an EE teacher stated that she "didn't really know what to expect", but she was "hoping to learn":

> I didn't really know what to expect. I knew that I would be assigned with a researcher there [at the Lab]. I had no clue what it might be, so I was a little bit nervous. Even thou my M.S. was in Science Education, I never felt like I had a strong "science" in that ground, because I've done a science class for so long. Science was never a high emphasis for me, I enjoyed it very much, but I didn't have the confidence to say I'm the person for the job, so I was drawn to it, but I wouldn't say that I was an expert…. I love the experience. I'm a very strong learner. I was going into it hoping to learn. I had the highest respect for all of the people there, and place myself lower than them because I wanted to learn from them. It was a wonderful experience and to see that real science, real applications, that was valuable for me.

MSE teachers' expectations generally were related more to learning the science content, but from the perspective of classroom applications (e.g., to take back to classroom teaching their lab experience, science materials and resources). In their interview statements MSE teachers talked broadly about their program expectations such as their desire to work with a scientist in a lab. However, MSE teachers provided more specific content details than EE teachers when talked about their RET experience, or about program outcomes to be used in class (e.g., developing a curriculum package on superconductivity). Alex, a middle-school teacher expressed the idea of "taking something back to the classroom", and using the knowledge gained in her teaching:

> I just expected to be able to experience real word science; and I walked away with way more than I expected. I didn't realize that I would actually be doing hands-on stuff, instead of watching someone do it…We had to dig in, and that was awesome! Then we had the extra resources, materials, training, it was way

more than I expected. So I expected to come up there, be in a lab setting and be able to watch someone doing science, and learn from that; but it was even more exciting having the hands on experiences and all the additional things.

Changes to Teaching Practices After Attending the RET Program

With respect to changes to teaching practices, survey results (see Table 4) indicated that participants used more teaching activities requiring students to apply science in real-life situations (43.3%, $n = 23$), were more self-confident about teaching science (35.8%, $n = 24$) and were more excited about attending other similar professional development programs (35.8%, $n = 24$). EE teachers' survey responses indicated that the majority of them ($n = 19$; 54%) used more classroom activities requiring students to apply science in real-life situations and more experiments (42.9%, $n = 15$) after their RET attendance.

Table 4 Participants' changes to teaching practices ($n = 67$)

Changes	EE teachers strongly agree ($n = 35$)		MSE teachers strongly agree ($n = 32$)		Total Participants strongly agree ($n = 67$)	
	n (%)	X (SD)	n (%)	X (SD)	n (%)	X (SD)
1. I made some general changes to the instructional strategies and my teaching style	8 (22.9)	3.17 (.56)	3 (9.4)	2.72 (.81)	11 (16.4)	2.96 (.72)*
2. My class is more student-centered	11 (31.4)	3.23 (.64)	6 (18.8)	2.78 (.87)	17 (25.4)	3.01 (.78)*
3. I do more experiments than I did before	15 (42.9)	3.29 (.75)	4 (12.5)	2.66 (.82)	19 (28.4)	3 (.84)**
4. I do more hands-on activities	13 (37.1)	3.31 (.63)	5 (15.6)	2.72 (.85)	18 (27)	3.03 (.79)**
5. I do more collaborative activities	14 (40)	3.34 (.63)	4 (12.5)	2.66 (.86)	18 (27)	3.01 (.82)**
6. I include more inquiry into my teaching	11 (31.4)	3.23 (.64)	4 (12.5)	2.81 (.78)	15 (22.4)	3.03 (.73)*
7. I am more excited about attending other PD programs	14 (40)	3.26 (.74)	10 (31.3)	3.06 (.84)	24 (35.8)	3.16 (.80)
8. I cooperate more often and talk to my colleagues about teaching science	14 (40)	3.26 (.74)	5 (15.6)	2.84 (.80)	19 (28.4)	3.06 (.79)*
9. I am more self-confident about teaching science	16 (45.7)	3.37 (.69)	8 (25)	2.84 (.95)	24 (35.8)	3.12 (.86)*
10. I do more activities requiring students to apply science in real-life situations	19 (54)	3.46 (.70)	4 (12.5)	2.81 (.78)	23 (34.3)	3.15 (.80)**

n Number of participants; % percentage of participants; X mean; SD standard deviation

* $p < .05$ in comparing EE and MSE teachers (ANOVA)

** $p < .01$ in comparing EE and MSE teachers (ANOVA)

Additionally, ANOVA results(see Table 4) indicated significant differences between EE teachers and MSE teachers on each item of the questionnaire, except teachers' attitude about attending other PD programs ($F[1,65] = 1.02$, $p = .317$). Post hoc analyses suggested that EE teachers made more general changes to their instructional strategies ($M = 3.17$, SD = .56), used a more student-centered teaching approach ($M = 3.23$, SD = .64), used more experiments than before ($M = 3.29$, SD = .75), more hands-on activities ($M = 3.31$, SD = .63), more collaborative learning activities ($M = 3.34$, SD = .63) and more applied science in teaching ($M = 3.46$, SD = .70). Also, EE teachers reported the use of more inquiry in teaching ($M = 3.23$, SD = .64), and more self-confidence in teaching science ($M = 3.37$, SD = 3.37) after the RET attendance.

Interview results revealed interesting findings about the way teachers discussed changes they made to their teaching practices after attending the RET program. In fact, interviews provided a look into how teachers understand changes and also indicated how difficult it is for teachers to articulate how, or even if, they make changes to classroom practice. This may account for the fact that teachers reported little or no change to practices in survey responses, but their interviews indicated significant changes regarding their thinking about teaching science.

EE teachers frequently mentioned the idea of their RET involvement as a learning experience they wanted to take back to the classroom and transmit to students. Most EE teachers understood their RET participation as a life experience, and an opportunity as well to motivate their students to seek learning experiences outside the classrooms walls. Kelly, one of the EE teachers expressed this idea by explaining how she instilled in her students such values:

> I came out with several different lessons not just in my area, but in several other areas. They helped me to address situations like this to my kids. They [the kids] are mostly from the rural area, some of them never left the state of Kentucky, so I can could go back and talk to them about the magnetic field and things like that, and tell them that there are opportunities out there, to go and travel and experience things like this, to go find out about other things like this and tell me about it…It was more than just learning science, it was about opportunities.

MSE teachers emphasized the importance of transfer of knowledge and experiences to their students, and modeling in their teaching the relationships they had with the scientists. John, one of the middle-school teachers illustrated this idea when he talked about changes to his teaching practices after his RET participation:

> A lot of time I have the tendency to oversimplify things, and I remember when I would ask questions to scientists they wouldn't give oversimplified answers, they were staying very true to science. In my teaching, I stay away now from giving my students the oversimplified version, I try to stay very close to the actual facts of science. I tried to pair up my students that mach the ways I've seen the real scientists doing, how they collaborate. I take science more seriously. I try not to oversimplify something because at some point you lose the essence of what's really happening.

One of the most important aspects about changes to teaching practices as reported in both surveys and interviews by EE teachers was related to their feelings of self-confidence in teaching science. EE teachers reported anxiety at the beginning of the program because of their perceived lack of science content knowledge. Science was “a foreign language” to EE teachers, and they initially saw the RET program as more appropriate for the secondary teachers because they teach exclusively science. Interestingly, all EE teachers mentioned being more comfortable and confident with teaching science after their RET involvement. Nina, one of the EE teachers discussed her feelings of increased confidence after her RET attendance, stating that:

> Scared, scared… it was nail biting in the beginning, but later on more it became more comfortable. It was a wonderful place to be in. People were phenomenal at the lab and the partners I was paired with. The scientists did a very good job at making us feel comfortable and try to make us see what they are doing. I loved it. I would recommend to anyone. I’m trying to get other people to do it. I feel more confident teaching science now.

Discussion

The purpose of this study was to investigate views of past attendees of an RET program as related to their motivation for attending the program, expectations of the program, and changes to teaching practices. Several major findings have emerged from this research. An analysis of the demographic characteristics of the participants provided insights into who is interested in attending the RET program. Study results indicated that more EE than MSE teachers attended the RET program from 1999 to 2006, as did more females than males. This finding is significant for RET and RET-like programs, considering that most similar professional development programs are specifically designed for secondary science teachers. No known research in this area to date has explored gender or grade level representation and implications for attending the RET programs.

All participants indicated that the RET program was a catalyst for future professional development involvement and contributed to their professional growth. Past participants of an RET program found the research experiences extremely valuable as a foundation to their teaching, and they were more likely to increase their participation in similar professional development programs. This could be attributed to the value of immersion-type experiences as well as the use of research based professional development strategies and techniques (Guskey 2003; Loucks-Horsley et al. 2003). Also, most teachers participating in the RET program perceived the RET professional development program as a valuable opportunity to build a network, to work in a collaborative environment, and to share their learning experiences. For many teachers the opportunity to discuss their RET research experiences with others and ways to translate them into viable lessons for their students was an important aspect of their program participation. Participation in such collaborative learning environments helped teachers build a community of learners and most of the past RET participants maintained their collaboration with other teachers long after their program attendance.

Among the characteristics of an effective professional development cited by Guskey (2003) in a meta analysis of the 13 better known sources, the most prevalent features were: enhancing teachers content and pedagogical knowledge, promoting collegiality and collaboration, and providing sufficient time and other resources. Findings from this study indicated building a science network as the most valuable experience for past RET participants, and being able to continue their professional growth through this network (e.g., participating in similar professional development programs and science activities, participating in national and international conferences).

With respect to motivational aspects our study results indicated no significant differences between EE and MSE teachers. Both sub-samples expressed similar types of motives for engaging in the program such as learning the science content, getting new teaching ideas, and continuing their professional growth. Expectations about the RET program expressed by both EE and MSE were mostly generic (e.g., working with a scientist in a real-life science setting). However, EE teachers expected to better understand how to implement changes to classroom teaching and were more eager to learn, perhaps as they repeatedly stated, due to their perceived lack of science content knowledge compared to MSE teachers. According to Wigfield and Eccles (2000) the element value may indicate the extent to which an implementation of a change in teaching can occur.

Interestingly, with respect to participants' changes to teaching practices EE teachers indicated more changes to their teaching practices due to the RET involvement compared to MSE teachers. These changes were related to pedagogical aspects (e.g., delivering different types of science activities), thinking about science (e.g., teaching science in a different way), and increased confidence in teaching science after attending the RET program. MSE teachers perceived changes to their teaching related only to pedagogical aspects. Most MSE teachers in their interviews stated that no changes occurred in their teaching as a result of RET involvement; some teachers specifically stated *pedagogical changes*. If no immediate changes to their pedagogical style occurred, MSE teachers perceived it as no change to their teaching style. In this regard, MSE teachers differed noticeably from EE teachers about their understanding of what *changes in teaching practice* means. Research (Desimone et al. 2002; Fullan 1993) suggests that teachers often make slow and subtle changes to their classroom practices, but little research has been done on how teachers from different grade levels *perceive changes* in their teaching.

Our findings suggested that overall, for both the EE and MSE teachers, changes occurred in teachers' *thinking about teaching science*, and not necessarily in an immediate classroom implementation of the RET practices. Moreover, all participants reported that the RET experiences led them to teach science by modeling their relationship with the scientist and to understand the research process from a different perspective, such as taking a more inquiry approach (e.g., asking questions is more important than getting answers).

Similar research studies (e.g., Supovitz and Turner 2002; Schwartz et al. 2004) indicated that professional development activities that are longer than 4 weeks and conducted in authentic inquiry contexts are more likely to promote change in teachers' practices than activities of shorter duration. Other research (e.g., Shymansky et al. 1997; Hanuscin and Musikul 2007) suggested that classroom culture and teaching practices are most influenced by professional development activities of longer duration and based on a collaborative learning environment. The results of this study add to the literature documenting the positive effects on teachers' changes to their teaching practices and attitudes towards teaching science, due to a longer lasting professional development programs such as an RET-like program.

Implications

Professional development programs attempt to provide new ideas and innovative techniques for teachers. Many programs intend to create more effective teachers and, by extension, to improve student achievement and understanding of science. Implications for both research and practice are related to findings concerning how immersion types of professional development experiences, like RET programs, influence teachers over time. Although this study had a relative small number of participant ($n = 67$), further research that includes participants from other RET programs could be conducted to examine long term influences on past participants.

This study demonstrates the value of RET and RET-like professional development programs for teachers of science and points to a need for increased science professional development targeting elementary teachers. The research experiences model offers a powerful learning context. The study findings suggested that overall teachers were intrinsically motivated to participate in the RET program, were able to construct new knowledge through inquiry, and were able to apply the research experiences outcomes to their classroom teaching. EE teachers especially perceived their RET participation as a unique opportunity to situate their learning within a scientific community and increase their confidence for teaching science. Increased confidence of elementary teachers after participating in an educational science program, or a professional development program, is reported by other studies (e.g., Dixon and Wilke 2007; Lloyd et al. 2000). Future research can investigate the role of emotions in teachers' learning as related to their motivation for attending the RET program and changes to teacher practices with respect to grade levels. Contributions from such studies might help RET-like programs foster feelings of confidence that result in more effective teachers of science and build our future leaders as confident science learners.

Also of key interest is investigating teachers' understanding of scientific concepts and processes (e.g., law, theory, hypothesis, experiment, research methods) with respect to grade levels, and the ability of teachers to translate such concepts into classroom applications. Additional questions remain for future research: How do we create a model of science mentorship programs that will attract elementary teachers and what support mechanisms need to be in place to facilitate scaffolding of their understanding of science content, processes of science, and the nature of science? How should facilitators and deliverers of professional development design follow-up activities that both support and identify changes in practice directly related to the RET programs? RET and RET-like immersion programs provide a rich laboratory for educational research to attempt to answer the question, what happens when teachers return to the realities of the classroom? And, can we measure what happens when a teacher returns to the classroom rejuvenated, reinvigorated, and newly enthusiastic about teaching science? This research is a first step toward asking and answering these questions and providing funding agencies with evidence that the investment has been worthwhile, encouraging teachers at all levels to participate in such opportunities, and supporting reform-based activities in the classroom.

Limitations

The findings from this study may be limited due to a relative small number of participants ($n = 67$). As we previously mentioned, one major challenge of this study was to locate as many past RET participants as possible, due to relocation issues. However, out of 90 teachers, all past RET attendees from 1999 to 2006, we were able to contact 73, and 67 of them agreed to participate in the study.

A second limitation of this study is related to participants' retrospective accounts. Participants' responses could be constructed in a faulty manner due to cognitive composing processes, or can be somewhat altered by other events and similar experiences they had over the time. Reasonable, coherent, even captivating accounts are limited by problems of memory and reporting, and may be based not on recall, but on other cognitive processes such as knowledge construction.

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Appendix: Sample Interview Protocol

1. Please tell me a little bit about yourself, about your teaching experience (Probe: i.e., subject taught, grade level etc.).
2. You were one of the RET participants in ____ year. Can you please talk a little bit about your RET experience?
3. How did you find out about the RET program?
4. What motivated you to participate (engage) in the RET program?
5. Can you talk a little bit about what kind of expectations you had going into the RET program?
6. Were these expectation met? How? (Or if not, explain why your expectations were not met).

7. What do you consider to be the most valuable about your participation in the RET program?
8. In what ways the RET experience made an impact in your professional, social or personal life?
9. The following questions ask you about your *PD involvement before & after* attending the RET program:

   (a) What types of PD activities did you have *befor*e attending the RET program?
   (b) What types of PD activities did you have *after* attending the RET program?
   (c) What other *activities* (or PD related) did you have since attending the RET program and who provided these *opportunities* for you?
   (d) How many hours (average hours a year) of PD activities did you participate in *before* attending the RET program?
   (e) How many hours (average hours a year) of PD activities did you participate in *after* attending the RET program?

10. If there is anything else about your professional or academic involvement related to, or as a result of your RET participation, please feel free to mention (and provide details).
11. Please describe what *changes in your teaching practices* you made after attending the RET program and how the RET program provided the impetus for you to make these changes. (Probe: If you are not in the classroom consider any changes you made to your teaching philosophy after attending the RET program).
12. The following set of questions asks you more specifically about *your classroom science instruction*:

    (a) What types of *instructional science activities you are typically teaching* in your science class?
    (b) How much of the *total science instructional time* (approx) do students in your class spend in these activities mentioned by you above (Probe: i.e., do laboratory activity, do science activities, work individually on science assignments etc.)?
    (c) How much of your s*cience instructional time do you dedicate* to implement the following *elements*: inquiry, nature of science, experimental design, processes and skills, communicating about science. (Probe: Just an approximation for each, or at least mention which of the 5 elements are you implementing more in your teaching)

13. If there is anything else you would like to mention about changes you made into your teaching, or implementation of RET program to your classroom instruction?
14. In what ways does your school and district provide support for you to implement in your teaching the knowledge and skills you gained from attending the RET program?

15. In what ways does your school and district provide support for you to share with others (i.e., colleagues) the knowledge and skills you gained from attending the RET program?
16. What kind of *emotions* do you associate with your RET experience? How do you feel (what emotions you have) about your RET attendance?
17. Overall, how would you characterize your RET experience? Thank you for your interview participation and your great feedback that you provided!

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