RESEARCH EXPERIENCES FOR TEACHERS: INFLUENCES RELATED TO EXPECTANCY AND VALUE OF CHANGES TO PRACTICE

This qualitative study examines one professional development program and how this experience affects teachers' thoughts about planning and science teaching practices specific to the elements focused on during the program (Loucks-Horsley, et al, 2003). The program supports thirteen K-12 science teachers, selected from across the nation, to spend six weeks with a mentor scientist in a nationally recognized science laboratory. The Research Experiences for Teachers (RET) program features are specifically designed to encourage reflective planning based on teachers' understanding of inquiry, experimental design, the nature of science, process skills and communication.

For the RET program, expectancy-value theory (Wigfield, Tonks, & Eccles, 2004; Wigfield & Eccles, 2000) suggests that once participants acquire the belief that they are able to perform with their mentor scientist, they can transfer this experience to their own students. The element of value may indicate if implementation of a change can occur. What teachers believe may also influence their expectancies of making change (West & Anderson, 1976).

Crissie M. Grove, Graduate Research Assistant, Doctoral Candidate

Patricia Dixon, Ph.D

Center for Integrating Research and Learning: National High Magnetic Field Laboratory
Florida State University

Introduction

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, Love, Stiles, Mundry, Hewson, 2003). Research suggests that an effective experience may help improve the quality of teaching as well as student achievement (Seymour, Hunter, Laursen, Deantoni, 2003). This qualitative study examines one professional development program and how this experience affects teachers' thoughts about planning and science teaching practices specific to the elements focused on during the program (Loucks-Horsley, et al, 2003). The program supports thirteen K-12 science teachers, selected from across the nation, to spend six weeks with a mentor scientist in a nationally recognized science laboratory. The Research Experiences for Teachers (RET) program features are specifically designed to encourage reflective planning based on teachers' understanding of inquiry, experimental design, the nature of science, process skills and communication.

Results from a previous study suggested the following research questions: How does an RET program affect teachers' expectations and values about science instruction? How does an RET program influence teachers' practice as it relates to inquiry, experimental design, nature of science, process skills and communication?

In the past, science teaching was less of a concern for teachers (Dana, Campbell, Lunetta, 1997; Tobin, 1998) than teaching other subjects such as reading and math. Historical events such as the 1957 success of the Russian satellite Sputnik, however, sparked a major national concern for the teaching of science for K-12 students. The resulting "Space Race" (Dana et al, 1997) created a perceived need for programs funded by the National Science Foundation and major US corporations in hopes that American students would advance the country's science agenda (Dana et al, 1997; Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2003).

However, even in the time of curriculum reform, "neat tricks", kit-based science activities, and teacher-proof lessons were what many science teachers, particularly elementary teachers, relied on (Dana et al, 1997). Researchers began exploring the use of "canned" experiments and demonstrated their ineffectiveness regarding students' understanding of complex science concepts (Dana et al, 1997). Canned activities are still used by some science teachers today. These quick and easy activities claim to make teaching science effortless. However, productive science teaching does require planning, preparation, and reflection (Valli, 1997; Clark, 1988).

In 1996, the National Research Council developed the National Science Education Standards to provide an outline of research-based effective science teaching and to provide a powerful outlook at the future of science teaching. However, low confidence in science content or teacher unfamiliarity with the standards may make follow-through of these standards difficult for some teachers (Ross, J. R., Hogaboam-Gray, A, Hannay, L., 1999). The U.S. Department of Education study in 2000, *Before It's Too Late*, declared the need for high quality professional development in science and math to prepare teachers to encourage the next generation to pursue STEM (Science, Technology, Engineering, and Math) careers. This study supports other research (Rice & Roychoudhury, 2003) on the importance of high quality professional development, particularly for teachers of science.

More than just workshop style tricks of the trade, effective professional development needs to include meaningful trainings that impact teachers' perspectives and understanding of science (Dana et al, 1997). Teacher enhancement programs that go beyond the typical 1-3 day workshop provide experiences that can support standards-based inquiry classrooms. Research on effective professional development also points to teacher enhancement programs that help improve the quality of teaching and student achievement (Loucks-Horsley et al, 2003; Seymour et al, 2003).

When teachers attend professional development programs they often take on the role of a learner. If we consider teachers as learners, cognitive research tells us that we must consider prior knowledge of that learner in order for new information to assimilate to what is already known (Bell, 1998; Dana et al, 1997; Driscoll, 2005). Teachers often must "unlearn" (Rhoton & Bowers, 2001, p. 3) what they believe about effective teaching practices in order to be open to new ideas. This implies understanding what teachers believe when they enter a professional development program and how these beliefs may change as a result of the experience.

Research on designing of effective professional development for teachers of science and mathematics suggests including seven main components to ensure quality (Loucks-Horsley et al., 2003). The RET program was designed with these components in mind. By this definition, the RET program is an effective vehicle for learning by K-12 science teachers. The seven components follow.

1. Is driven by a well-defined image of effective classroom learning and teaching.

2. Provides opportunities for teachers to build their content and pedagogical content knowledge and examine practice.

3. Is research based and engages teachers as adult learners in the learning approaches they will use with their students.

4. Provides opportunities for teachers to collaborate with colleagues and other experts to improve their practice.

5. Supports teachers to serve in leadership roles.

6. Links with other parts of the education system.

7. Has a design based on student learning data and is continuously evaluated and improved.

In response to the professional development standards set forth by the National Research Council (1996), Research Experiences for Teachers programs provide meaningful, real-world experiences that may impact science teachers' understanding of science and teaching of science (Kardash, 2000; National Research Council, 1996; Seymour, Hunter, Laursen, & Deantoni, 2002). Typically RET programs place teachers in a university or industry laboratory for 6-8 weeks during the summer allowing teachers a look into the real world of scientific research. Immersion in real-world science research is an authentic activity that uses procedural knowledge that may be passed on to students in the classroom (Driscoll, 2005).

Research on a similar type of program, Research Experiences for Undergraduates (REU), is based on a situated cognition in learning (Kardash, 2000). The RET program uses the effectiveness demonstrated for the REU programs and substitutes science teachers for undergraduate science students as part of this process. This situated cognition type of apprenticeship results in increased science content knowledge and real-world experience as opposed to the traditional academic tasks (Kardash, 2000; Dixon & Wilke, 2007).

Theoretical Framework

Expectancy-Value Theory is a motivational theory usually used to frame achievement in students. Developed by Wigfield and Eccles (2000), expectancy-value theory states that intrinsic motivation is affected by teachers' beliefs about choice, expectancy and evaluation (or value). As professional development programs take teachers and guide them through new learning, it appears appropriate to use learning motivational theories for "teachers as learners".

Choice

As suggested by Wigfield and Eccles (2000), choice is often related to intrinsic motivation in expectancy-value theory. Choice is the feeling of control over the situation and/or of one's behavior. When teachers enter a professional development training, purely by choice, their autonomy does not end there. The teachers also have to choose what practices and strategies they value enough to change. This choice is related to expectancy-value theory as the element of evaluation (value), wherein the teacher evaluates the choices to discover which costs outweigh the benefits.

Traditionally researched through the achievement motivation of students in the classroom, the expectancy-value theory provides a framework in which to understand the changes of teachers' beliefs and practices after attending the RET program. When teachers attend a professional development program they acquire new knowledge, which makes them learners. Research in understanding how learners acquire new knowledge allows professional development experts to develop ways to best help teachers as learners learn and implement new teaching practices due to professional development.

Expectancy

Expectancy refers to the anticipated beliefs about one's own ability. The attributions placed on this expectancy belief may also influence intrinsic motivation (Eccles Parsons, Kaczala, & Meece, 1982; Wigfield & Eccles, 2000). Expectations are the beliefs the participating teachers have concerning their own ability to perform (i.e. in the laboratory with their scientist when they begin the program) and that they have the ability to transfer this knowledge into their own science classroom (i.e. conduct science experiments with their students). Similar to any learning experience, the goal is to not only 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 of our teachers to enrich their own science instruction in their classrooms.

For the RET program, expectancy theory (Wigfield, Tonks, & Eccles, 2004; Wigfield & Eccles, 2000) suggests that once participants acquire the belief that they are able to perform with their mentor scientist, they can transfer this experience to their own students. The element of value may indicate if implementation of a change can occur.

What teachers believe may also influence their expectancies of making change (West & Anderson, 1976).

Value

When a participant believes that using a new approach to make changes in the classroom is the worth the cost in time and resources, it is considered valuable (Wigfield et al., 2004; Wigfield & Eccles, 2000). The value of the task may be specific or general, but will influence what is implemented in the classroom. A teacher may decide to include more questioning with previously used lessons, may restructure a reliable activity, or may implement an entirely new style of instruction as acquired knowledge from a professional development program is put into place.

For the RET program, what participating teachers believe they can do with new ideas, along with how much they value the new element, may indicate to what extent changes are made in their classrooms. Teachers may also feel limited by school or district mandates and may have to weigh the perceived costs versus the benefits of making instructional changes. Barriers to change include resistance from peers or unsupportive administration and may cause participating teachers to question the value of changes to their science teaching. However, our results suggest that changes to teachers' practices are often subtle and that often changes maybe easier to implement than it appeared at the end of the program and may even by less disruptive to the status quo than originally perceived. These changes may be seen as threatening to colleagues, but may provide the teacher with greater ability to teach science in more effective ways. Anecdotal evidence indicates that RET "graduates" often face this unanticipated balancing act when they return to their classroom.

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 as suggested by Deci and Ryan (1985) in their theory of Self-Determination. Deci and Ryan refer to this element of choice as autonomy, which is the feeling of control. This choice may also be related to the monetary reinforcement that comes with attending RET. However, our results suggest that even teachers who entered the program with few expectations for instructional ideas, identified a need to make changes to their science teaching after attending the RET program. Although intrinsic motivation theories are usually utilized in the context of students' learning, some professional development programs consider teachers as learners and the same motivational theories may apply.

To understand teachers' instructional practice, it is necessary to consider how a teacher plans for lessons. As part of the application process, RET applicants were asked to submit a science lesson plan. Some teachers submitted very detailed lesson plans, while others were very vague. New and pre-service teachers often write detailed lesson plans consisting of objectives, state curriculum standards, materials, instruction, assessment, and follow up opportunities. Experienced teachers may have a more general lesson plan that spans days or weeks with only a page number or activity written for guidance. Depending on the subject area or grade some teachers may have more freedom over others for planning lessons (Brown, 1993). If teachers participating in the RET program do not think about planning their science lessons differently as a result of the program, changes to instructional practices are unlikely. However, our results suggest that teachers may include subtle changes to their teaching before making radical changes to their lesson plans. This may be particularly true if the teachers' do not write out detailed lesson plans anyway.

This study investigated how teachers thought about their planning and how they made changes to their science teaching both at the start and at the end of the RET program. The teachers were interviewed at the beginning of the program concerning their current planning and reflection of science teaching practices. Post-interviews were conducted to determine what features of the program were most helpful for the teachers to gain a new sense of effective science teaching. After completing the program, lesson plans submitted pre-program were reviewed by the teachers to determine whether they would continue to use the plan as written, would make changes, or would not use the plan at all. Additional interviews and observations were conducted in the fall to determine if continued changes were made as the teachers returned to their classrooms. However, it became clear that due to the range of lesson plan writing, the lesson plans were not as effective at demonstrating a change in science instruction as interviews and observations revealed.

Expectancy. The RET program provides many opportunities for participating teachers' to experience life in a research laboratory as portrayed by their mentor scientists. How the teachers perceive their own ability to construct their classroom like that of a scientific laboratory may determine their intrinsic motivation to change. Along with their perception of their own ability, teachers are also left open to develop their own beliefs about the important aspects of real-world science in their own classrooms. Although formal and informal discussions and share sessions helped the teachers sift through their experiences, each teacher constructed his or her belief about what is necessary for an effective science classroom.

However, the RET coordinators and researchers focus on five elements of science teaching and expect that participating teachers will understand these elements in new ways. In addition to this expectation, we expect participating RET teachers to implement some new science teaching strategies that align with these concepts. Although changes to lesson plans did not reveal many changes to teachers' planning, observations and interviews revealed that the participating teachers were making changes to their science teaching in the areas of science the RET program focuses on.

Confidence—Linked to Expectancy. A feeling of confidence by teachers has shown to be a key aspect to effective teaching in the classroom (Lloyd, Braud, Crebbin, & Phipps, 2000; Ross, Hogaboam-Gray, & Hannay, 1999). Although confidence can be considered a part of teacher efficacy (Bandura, 1993), the notion of increased confidence emerged as a theme in RET participants after the experience with scientists. One particular case study demonstrates increased confidence in science teaching due to participation in the RET program.

This feeling of confidence may be linked to the concept of expectancy. Self-efficacy by the teacher, as researched by Bandura (1993) has been considered to be related to the expectancy value theory (Wigfield et al., 2004). Self-efficacy is defined as feelings of ability to perform a certain task, along with the feeling of control over the situation in order to create change (Woolfolk, 2007). Feelings of confidence may be a sign of increased self-efficacy and expectancy which may come from more experience as a teacher, along with the RET experiences.

Value (Evaluation). Features of the RET program are purposely designed to encourage more reflective science teaching. Reflective teachers give consideration to the voices and opinions of the students, and contemplate the consequences of lessons and activities for their students (Valli, 1997). Research suggests that reflection of science teachers on key elements of science teaching promotes effective instruction of inquiry based learning and an understanding of the work of scientists in the field (Scharmann, Smith, James, and Jensen, 2005). Science teaching elements included in this RET program are supported by research (Lederman, 1998), by the National Science Education Standards (1996) and by Benchmarks for Science Literacy (1993). Therefore, the RET program coordinators and researchers value the elements within these standards and align the program to include these elements. Our desire is that participating RET teachers will also value these elements and implement changes in their science teaching to include these concepts to increase their students' understanding of science.

Program Features

This RET program focused on five elements of quality science teaching: inquiry, nature of science, experimental design, process skills, and communication. These five elements were chosen based on past research of the RET program (Dixon & Wilke, 2006, in press) and are considered key aspects of effective science teaching set forth by the National Science Educational Standards (1996). All five elements of the RET program were researched and commonly defined by both researchers involved in the data collection and analysis. The researchers negotiated working definitions for each element as follows:

Inquiry. A set of processes that scientists use to ask questions about the natural world. Students can pose such questions as well and then find ways to investigate the phenomena they are curious about, interested in, or motivated to look at. Inquiry-based activities are ones in which students develop a deep understanding of science concepts by making sense of it in their own way. Inquiry activities that are developed by teachers lead students through the process by allowing them to discover how science relates to other subjects and to students' own lives.

Nature of Science (NOS). The meaning of science, assumptions, values, conceptual inventions, method, consensus making, and the characteristics of knowledge produced, and considering this how students and teachers think about science and scientists. Understanding the nature of science indicates a view of the world as understandable, that ideas about the world are subject to change, and that the study of science is an intellectual and social endeavor (Project 2061) done by men and women.

Experimental Design. A set of actions and observations, performed in the context of solving a particular problem or question, to support or falsify a hypothesis or research concerning phenomena. The experiment is a cornerstone in the empirical approach to acquiring deeper knowledge about the physical world. Measurements are made objectively and all conditions can be kept controlled across experimental trials.

Process Skills. Measuring, observing, classifying, recording information, communicating, predicting, and drawing conclusions/inferring. They are specific, observable skills that are used to "do science." These skills are used by students and scientists as they observe the natural world.

Communicating about Science. Communicating about science, how scientists do their work and communicate about scientific discovery and research, describing how scientists work in the real-world

These five elements were used as the basis for a weekly colloquium discussion by the 15 participating teachers and led by a staff member. Two days after the discussion groups, an expert in the field discussed the topic with the participants. These five elements were used to frame the research and the findings from this study.

Methodology

This study began utilizing the five elements of the RET program as a focus for framing the results. However, after the collection of all data, the five elements did not seem to capture the complexity of the findings. The study began as a grounded theory qualitative study as no clear theory was used to begin the collection of data. After analysis of the findings, expectancy-value theory emerged as a motivation theory to frame the study. Traditionally used as a theory to frame achievement of students, in a professional development program, participating teachers *are* the students so the theory is a logical choice to help gain perspective on the research study and the findings.

Participants

Thirteen science teachers from around the country were selected to take part in a six week long professional development program with a mentor scientist. The participants included ten female teachers and three male teachers. The participants ranged from 1^{st}-12^{th} grade teachers, and teaching experience ranged from 2 years to 39 years, with a mean of 11 years of experience. Eight of the 13 participating teachers hold Master's degrees. Various ethnic and cultural backgrounds were represented by the participants and the student populations they represent range from Title I schools with 80% free and reduced lunch to affluent private schools. The teachers were selected based on their application, desire for participation, their potential for science education leadership at their school, and a videotaped lesson.

All teachers who were accepted to the program and indicated their commitment to participate consented to participate in the research study. Twelve participants drove from various cities or states and one teacher was local. The non-local teachers were housed in an apartment complex near the laboratory for easy access to the facility. Participants were paid a stipend that was not connected to the research study so honesty and openness were anticipated by all participants.

The data was analyzed in two ways. First, all 13 participants' responses to interviews were transcribed and coded through the framework of changes to thoughts about planning and changes to instruction specific to the five elements of the RET program. Numerous additional themes also emerged as a result of the interviews but will be considered as a need for additional research studies. In addition to quantifiable data recoded in organized charts, three case studies were focused on to provide further depth into changes to thoughts about planning and a desire to make instructional changes by RET participants. The three case studies focused on teachers demonstrating specific attitudinal and practice changes in science teaching, and an increase in science teaching confidence. Two of the case study participants are experienced teachers with over 42 years of teaching between them. The other case study participant is an induction teacher with two years of teaching experience. Two of the case study participants had attended the program for two years. The third teacher was a first time attendee during summer 2006. All three science teachers demonstrated changes in their thoughts about science lesson planning and changes to science instruction based on the elements of the RET program.

Setting

The National High Magnetic Field Laboratory develops and operates high magnetic field facilities that scientists use for basic research in physics, biology, bioengineering, chemistry, geochemistry, and materials science. The Center for Integrating Research and Learning facilitates all educational programs, one of which is the NSF-supported Research Experiences for Teachers (RET) program. RET offers K-12 teachers the opportunity to conduct real-world science research.

Procedure

The following qualitative data were collected from the 13 participating science teachers.

- Written lesson plans (submitted pre-program)
- Videotaped lessons (submitted pre-program)
- Pre-program interviews
- Post-program interviews
- Revisited lesson plans
- Follow-up telephone interviews or personal interviews
- Classroom observations

Participating teachers were asked to submit a "typical" science lesson plan along with their application before beginning the RET program. The lesson plans were analyzed based on a mastery lesson plan design used by both researchers participating in the investigation of the study. Videotapes of a typical science lesson were submitted by each participant before beginning the RET program. The videotapes were analyzed using identical protocol for each videotape by both researchers to ensure validity.

Interviews were transcribed and coded by two researchers to ensure validity of the findings. Both researchers coded and analyzed the transcribed interviews separately and then met to ensure consistency. Common understandings were agreed upon as a result of a few differences in opinion; all analyses were agreed upon by the two researchers. Consistent use of identical interview protocol indicates the rigor with which the study was conducted. Both of the researchers played active roles in the collection and analysis of the data. All 15 participants were interviewed at the start of the program (within the first week) and at the conclusion of the program (within the last week).

Post-program observations were conducted on five of the 13 participants. Those five participants were chosen based on their proximity and availability to be observed by the researchers. For each observation, two researchers watched and wrote field notes. The field notes were typed as written accounts and were again coded and analyzed by both researchers. Following each observation, an interview was held with the teacher to clarify observations and provide researchers with an opportunity to ask more questions. In addition to these observations, phone interviews were conducted with as many teachers as possible.

Written lesson plans and videotapes of lessons were compared with the possible modification of those plans and observations indicating changes in the classroom post-program. The participants were asked if they would modify the submitted lesson plan after the RET experience. However, many teachers, particularly experienced teachers, don’t write out their lesson plans in full. Therefore, more insight into teachers’ changes to thoughts about planning and their changes to instruction were provided by the interviews and observations.

Colloquia focused on five science teaching elements: inquiry, experimental design, nature of science, process skills, and communication and teachers mentioned changes in their planning and instruction based on some or all of these discussions. However, additional themes emerged based on observations and interviews once the participants returned to their classrooms in the fall. These themes will be mentioned in the discussion and are not reported in the current study. This separation in time of the program and implementation in the classroom may help further demonstrate the significant changes made by these science teachers based on their experience at RET. Often times professional development programs produce initial claims of change by participants, but follow up research often demonstrates little change to practices in the classroom (Guskey, 2002). However, our results demonstrate that some changes were made to science teaching practices due to the RET program.

Findings

To answer the research questions: How does an RET program affect teachers' expectations and values about science instruction? How does an RET program influence teachers' practice as it relates to inquiry, experimental design, nature of science, process skills and communication? The data were organized into charts by element.

Five Elements of Program

The five elements of the program were not asked specifically in the pre-interview so as not to bias the participants into providing answers that were socially pleasing. However, throughout the pre-program interview, many of the participating teachers mentioned some or all of the five elements that matched, conflicted with, or could not be determined to match our working definitions.

The following chart (table 1) is the results of the teachers' responses to interview questions. The numbers indicate the number of comments made on a particular topic. As evidenced by this chart, the positive matches (comments matching the working definition) were greater in the post-program interview than in the pre-program interview. There were also less negative matches (comments conflicting with working definition) in the post-program interview.

Table 1

Teachers' comments regarding the five elements of the program

	Pre-program interview	Post-program interview
Inquiry: Positive	18	29
Negative	7	0
Neutral	2	5
Experimental Design: Positive	5	10
Negative	6	9
Neutral	8	4
Nature of Science: Positive	3	11
Negative	0	2
Neutral	3	5
Process Skills: Positive	2	8
Negative	0	1
Neutral	0	1
Communication: Positive	5	15
Negative	2	1
Neutral	2	2

There was an increase in the number of positive comments about all five program elements during the post-interview than during the pre-interview. These results indicate that some understanding of each of the five elements was gained during the RET program. Although some neutral comments still exist, this may imply that the participating teachers may still need additional information. However, the RET program allowed participants a way to explore these concepts with peers and experts.

Lesson Planning: Mandated by School, District, and/or State

The participants were asked about their mandates on lesson planning during a pre-program interview. Many of the participants mentioned very strict or somewhat strict mandates on lesson planning and curriculum elements during their pre-program interview. Some even mentioned being mandated on the timeline of teaching elements: "We have to teach certain content at certain times – it's all mapped our when we teach rocks and when we teach magnets…" when it came to lesson planning and diverging from those plans. Table 2 shows the results of participant's responses to mandates to lesson planning.

Expectancy. As the participants were asked about their mandates, they were describing how these mandates might limit any changes in lesson planning. Although some participants described more mandates than others during pre-program interviews, most teachers felt at least somewhat limited by the school, district, or state mandates.

Value. Despite strict mandates, many of the participating teachers mentioned a desire to make changes to their science lesson plans as a result of RET. These results demonstrate the value to which the teachers held aspects of the program (i.e. inquiry, etc.).

Table 2

Teachers' comments concerning their mandates of planning and plans for changes to instruction

	Pre-program interview	Post-program interview
<u>**Mandates:**</u> limited (strict)	18	10
Somewhat limited (general guidelines)	13	
Not limited (little policy)	5	
<u>**Will make changes to plans:**</u> Many changes		24
Some		19
Little		2

As these results suggest despite strict guidelines mentioned in pre-program interviews, many of the teachers mentioned a plan to make many changes to their current science plans. Some teachers mentioned feeling extremely limited in their creativity in lesson planning and instruction due to identified mandates: “So, it has gotten real stifling like. You don’t have much leeway to do anything, do anything creative…”

Organizing the interview data into charts pointed toward a need to further investigate instructional changes of these science teachers. Seven teachers were interviewed by phone or in person in the fall; five were observed to get a better understanding of the changes made to science teaching after the RET program. Three of those observed and interviewed in the fall were chosen as case studies. Case studies provide more insight into the planning and instructional changes made to RET participants.

The research questions guiding this study focused on the changes made to thoughts about planning and changes to teaching practice based on attendance of the RET program. As previously mentioned, three case studies were chosen to produce a greater depth of understanding of these changes in the classroom. Five elements of the RET program were the focus of the instructional changes, so only changes to those elements are mentioned in the following case studies.

THREE CASE STUDIES: MARTHA, MAGGIE, AND WHITNEY
*NAMES CHANGED TO PRESERVE ANONIMITY

Martha, Maggie, and Whitney

Martha is an elementary teacher who teaches second grade in a middle-class socioeconomic status (SES) school in the southeastern United States. Martha attended RET for one year during the summer of 2006. Martha has taught for thirteen years, all in the first and second grades. Martha obtained her Master’s Degree and is certified to teach all elementary grades, including early childhood. Martha became interested in the RET program through a colleague who had attended the year before and recommended the program as a venue for learning about more effective science teaching. Martha demonstrated a great deal of reflection and need for changes to her science teaching by attending our RET program.

Maggie is a middle school science teacher who teaches eighth grade in a small, rural town in the southeastern United States. Maggie attended RET for two years, both the summer of 2004 and again in summer 2006. Maggie has taught middle school for 28 years and demonstrated a desire to continue to grow and develop as a science teacher. When this study began in June 2006, Maggie was already familiar with the RET program as a past attendee, and seemed open to acquiring new ideas to improve her science teaching.

Whitney is an elementary school teacher who teaches fifth grade in a middle-class SES school in the southeastern United States. Whitney attended RET for 2 years, during the summer of 2005 and summer 2006. Whitney has taught for two and a half years, all in the elementary. Whitney earned her Master's Degree in Science Education. This study focused on the RET program during the summer of 2006, although Whitney attended both the summer of 2005 and summer of 2006.

Martha

Five Elements

Inquiry. Martha mentioned her interest inquiry as a way to question her students and help them think about science in new ways. Martha mentioned wanting to change the way that she led her students, and wanted to give the students a chance to think through ideas and concepts for themselves.
During observations, Martha demonstrated a lot of questioning of her students to help them think through the concepts on their own. Martha has begun to incorporate inquiry through this use of questioning, which she has not done in the past.

Interview:

Interviewer: "You are just constantly asking them questions. And I could see…it was obvious that you do that a lot because they were ready to answer them, and they were responding. No one was just sitting there, I mean, some of them were at first, but they were really thinking about it and then giving you an answer.
Is that something you just started doing this year?"

Martha: "That is something I have started doing a lot more this year. I think I did last year, but I never really focused on it, it was something that we just do I think as a teacher. But, this year, having had that experience, it is something that I just do a lot more of now, a lot more questioning, and having them question and think! Asking them, "do you have a question for me?" And even when we do the KWL, and asking them, you know what are some things that you think about and want to find out? So, now I write them, I document them. And they are like, "yeah, I have to find out"."

Interviewer: "Do you think it has been effective? Do you think they enjoy the questioning?"

Martha: "I think so. I think they really like it."

Observation:

Teacher: "What will you see if they chop the trees down?"
Students: "Just the desert". "No plants or anything that has water." "no light." "Really hot". "No one can live there."

Teacher: "What else does the child need from the tree?"
Students respond: "Oxygen." "Food."

One student starts panting loudly: “There are no trees in this room!”

Nature of Science. Martha mentioned a desire to include nature of science in her classroom by having her students take on the role of a scientist. Martha encourages her students to research and investigate answers to their questions.

Interview:

…“this week we have been working on Research and Reference, so we will be using the computer a lot and we have been using the encyclopedias, we have been using other books and using all of those, all that is tied in…Because if we go back to the lesson on rainforest, I know my kids could do an awesome job. Because they’ll think about what they learned. Because it isn’t just about what we read and what we studied, but this has become real. This is now a part of what they now know. Not just what they read and studied to do the test. But is now a part of what they know. So, I think it is more effective for them.”

Experimental Design. In her post-program interview, Martha mentioned that she felt she did “all activities” before and not experiments. She mentioned a desire to change that practice with her students, and help them take a more active approach to learning science. When asked if she has made these changes are if she still does mostly activities she stated:

“Um, I still feel like I am a little bit…well it is also because of the group I have. Because they are so needy and they take such a long time to do everything. It’s not as easy I would have hoped it would have been, but I am doing them a lot more.”

Researcher: But, you still see that as something you want to do?

“I want to do more. I want to do more, I really do.”

Even these changes in beliefs by the teacher demonstrate that over time, perhaps she will incorporate more experiments and fewer activities in her classroom.

Process Skills. Martha was observed using many of the six process skills discussed during RET. Martha used the vocabulary to help her students investigate answers to their questions.

Observation:

Student: “No baby birds.” Teacher: “Great observation.”

Martha is using process skills vocabulary to point out the use of process skills by her students as discussed and focused on during the RET program.

Communication. Martha encouraged her students to share their journals, to write, and to draw their ideas and thought about the science concepts they were learning. Martha mentioned an importance of the students communicating with each other in this way.

Martha had high expectations in her ability to make changes in her teaching practices. She mentioned an awareness of doing all activities before RET and wanted to change that practice. Martha also includes more questioning and inquiry for her students and has confidence in her ability to perform those new elements in her science teaching.

Martha's responses to interviews demonstrated that she has evaluated various aspects of the elements learned at RET. Although not all of the elements produced significant changes in the classroom immediately, Martha did make some changes in certain areas. Martha valued inquiry and high level questioning as important elements to promote her students' learning, and made those changes in her classroom. Martha mentioned a desire to include more experiments and treating the students as scientists. These were valued by Martha enough to consider making changes to her planning and teaching of science. These changes may be subtle in some ways, but perhaps additional observation would produce more results.

Lesson Planning. Since Martha teaches all subject areas in her elementary class she was asked,

"Do you think that you plan differently for science then you do for your other areas?"

"Um, usually yes. Because we try to touch different areas, with math or language arts or reading, of course it is a lot of reading. But, just bringing in a lot of hands on things for them also. So, I found that since I have been back from Tallahassee, we have been doing a lot more questioning instead of just telling them."

Martha mentioned her desire to incorporate more questioning of her students as a way for them to think critically about their science learning. Martha also mentioned her desire to do more "hands-on" learning with her students so her science classroom becomes more student-centered.

Barriers to making changes. Change is difficult, especially for teachers who often feel a personal connection to their classroom and students (Fullan 1993; Guskey, 2002). Martha recognizes the difficulties involved in changing how she delivers science instruction and identified her primary barrier as her own colleagues. Martha thought there was the possibility of other teachers seeing her as a threat and making them "look bad". Even recognizing this as a possible outcome, Martha preserved.

"I don't blame them,…"

For many of the participants, the colloquia once a week, along with the expert speaking on the same topic, was the element of the RET program that helped them plan for science in new ways. Martha mentioned that the colloquium on inquiry helped her to realize that inquiry was something that had previously been missing in her science teaching.

“I think when we did that colloquium on inquiry. I think that was it for me. It was like ‘wow!’, this is the part that is missing, the part that we don’t do. Because we do an experiment we think we are doing science. But are we really doing science, are we really doing what we should be doing in science?”

Martha mentioned several expectancies concerning her lesson planning and barriers to those changes. Martha recognizes that she plans differently for science than for her other subject areas. Martha also seems confident in her ability to make changes to her science planning, despite the barriers that she has felt from other teachers and staff members who are questioning her motives.

Martha has placed a high level of value on modifying the science curriculum mandated by her school to make science the most effective and worthwhile for her students. Despite Martha’s peers feeling threatened by her taking the initiative to make changes to the plans, Martha has evaluated additional elements such as inquiry and experimental design and feels that these elements have enough value to require significant changes to science lesson plans.

Maggie

Five Elements

Inquiry. Maggie mentioned that she would like to include more inquiry as a part of her science teaching. She mentioned knowing about inquiry before, but the RET program made her reflect on her practices of including inquiry in a real way.

What elements of a lesson plan do you think about now that maybe you didn’t think about before attending the RET program this summer?

“I think more about the inquiry part of science. It was in the back of my head before, but I use it more now with planning.”

Have you been able to implement some of this inquiry into your classroom?

“I have been working on it and trying to. I have had some mixed reviews from students. Because they have for so long, they want to read through the book and I am going to find the answer. And they come up to me and say “the answer is not in the book!” And I say “it is in your brain.” And they are like….What? What book is that in! Where do I go find that!”

Maggie felt that she included some inquiry in her science teaching before attending RET. However, after her experience she realized that she had the ability to include more inquiry that was student-led as opposed to teacher-directed.

Maggie demonstrated a high level of value on inquiry to make changes to her classroom practices after assessing her own inquiry teaching. Despite the fact that Maggie felt she included inquiry in her science teaching before RET, she valued inquiry enough to include more in order to help her students reach their maximum potential in their science learning.

Emerging Themes

To address the research question for this study, Maggie was asked about any barriers she has encountered while making changes to her science teaching, such as implementing more inquiry. Maggie mentioned that the students have been somewhat resistant in thinking for themselves about the material, and also that she feels she does not have sufficient time during the school day to create an atmosphere of inquiry.

Barriers to making changes. Maggie was asked, "Have you encountered any other barriers in trying to implement more inquiry?"

"Time. Time is our enemy. And I have also traveled more than I ever have.
I went to Washington D.C. Within a month, I was in Washington D. C., twice getting national awards, which I feel honored, but I miss…but I had a great sub. She has a strong science background. So I could develop the lesson with them, and she could even do activities with them and take it the next step. So I think that…I would say time is…"

Maggie's school has a unique scheduling arrangement. One group of students work with one science teacher for nine weeks and another group with the other science teachers. The two groups of students than switch teachers and learn the material the previous group had learned. This has been difficult for Maggie and she sees the schedule as a barrier to implementing as much inquiry as she would like.

Do you think this new arrangement of your schedule or anything is any type of barrier? Or any change to your lessons in general?

"Yes, because by the time I get to know the talents of the students, then I lose them again. So I am hoping that next semester I can start to carry over…but I am not sure, I am not sure how I like it. We did it before, and I think our students did okay with it, but this is a total different group of students, who this type of change is not good for them."

Despite Maggie's desire to make changes to her science teaching by including more inquiry in her science classroom, she also has a realistic view of teaching in which the limited time allotted to creating a learning environment that allows her students to be actively engaged in the material. Maggie mentioned a lack of time for why changes in the classroom are difficult. Maggie has the confidence in her ability to make changes, but still feels limited by the schedule and restrictions within her school.

Maggie has already mentioned the high value she places on including inquiry in her science classroom. She has tried to plan for more inquiry in which her students answer high level questions and engage in the material in a more meaningful manner. However, the classroom schedule and lack of time has made significant changes difficult.

Whitney

Confidence

After spending two six-week summer sessions (summer 2005 and summer 2006), an increase in confidence in the teaching of science was evident for one elementary teacher. Although, Whitney had a Master's degree in science education, she made continual mention of how the RET program provided her with an increase in confidence to teach science, answer students' questions, and to take risks in her lessons.

Confidence and Expectancy-Value Theory. Confidence has been demonstrated to be a key aspect for an effective teacher (Lloyd, Braund, Crebbin, & Phipps, 2000; Rice & Roychoudhury, 2003). Confidence is also a part of self-efficacy of a teacher (Bandura, 1993). The amount of confidence felt by a teacher may influence the effectiveness of the teacher on the students' learning and achievement. If a teacher feels low-confidence in the ability to teach the students a difficult concept, the students will likely do poorly with the new material (Bandura, 1993). This confidence is also part of the expectations of expectancy-value theory. How much a teacher expects he/she can do in the classroom may influence to what degree changes are made to teaching practices.

Evidence of an increase in confidence was provided by the collection of three interviews. One interview administered pre-program, one interview administered post-program, and another interview conducted during the fall semester. An observation of Whitney provided further evidence of an increase in confidence in the teaching of science.

Pre-interview:

"Asking questions and so, my biggest fear, when it was my first year teaching was not being able to answer their questions, and so, I kind of got over it and realized that I don't know all of the answers. So, it is okay. And what do you do with it?
What do you do with your curiosity? Do we go to the internet and research it; do we get a book out? Or ask an expert in the field, you know, what do you do with it? How do we find some answers to it, so however I can tap into their curiosity? That is the emotion that I hope that science brings about in them the most."

During the pre-interview Whitney mentioned that when she first began teaching she was not very confident and was nervous about being unable to answer the students' questions. Now she realizes that she can work with her students to find the answers to their questions.

Post-interview:

(talking about inquiry)

"I think that it…I mean I took a class on inquiry in my master's program. I mean, you hear about it all the time through school, and even last summer here…Honestly, I think it takes teaching for a few years to get your feet wet, and do a little more each year. I think that this year I'll be a little more confident with it. So, I do think it will change it, to an extent."

"…I am very much a person that learns as they do, so I think that that will be harder for me…and as far as inquiry goes feeling more confident in it and I can start adding things to it."

During the post-interview, Whitney mentioned how her confidence has increased due to her experience at the RET program and also from continuing to try new teaching strategies within science.

Fall Observation and Interview:

Stickers were used to identify various animals and organisms in a forest food web. As the students came up to the front of the room, questions were asked about "What would happen if . . . ?" and "What if hunters came and shot a lot of black tailed deer?" The students were totally engaged and answered using the vocabulary of the unit: predator/prey, producers, consumers, decomposers, ecosystem, etc. They used them readily and easily. While there were many references to FCAT and tests and how the information they were discussing related to them, there didn't seem to be any urgency. Clearly the CONFIDENCE that Amanda reported after the first year in the RET program has enabled her to be flexible with how she handled the lesson and how the vocabulary was used in the context of science activities. There was considerable discussion of the role of fungi and insects in the food web as well as much discussion of hunters and how they affect the food web. When asked, "Who is the top dog?" students were unable to answer "humans."

Teacher: "Team 3, share with us one of your questions". Students read and answer. (good answers, complete sentences) Teacher is answering other questions, students answering from index cards. High level vocabulary between students and teacher (symbiosis). Teacher: "How do we classify a desert?" Students: "The amount of rainfall".

Interview:

"….And especially last week when we were at the Challenger Center they made a reference to the Maglab and they all turned around and looked at me.
And I talk about it a lot and I talk about how feeling dumb is a good feeling sometimes. And talking about how if you feeling like things are over your head means you are learning so much.
And so, I am learning to talk about being out of your element and being okay with that. And only being there for 6 weeks, it might take that entire time to feel okay about that. But we do talk about it a lot, but I think that my experience lends itself to…I talk about it in our language arts story yesterday our story was about comets and meteors. And two

years ago I would not have even known the difference between them. And now I could elaborate on every paragraph. And by no means am I an expert, but just from picking up over the summer, I feel much more confident. And that sparked a huge discussion of questions. And some of them I didn't know and we jotted them down, so…they might not always know the knowledge that I brought back for them, but I do use it and I do share with them a lot. Sometimes it comes out in different subjects."

After attending the RET program for two summers, Whitney's confidence (i.e. expectations) concerning her own teaching was dramatically improved. Although perhaps promoted by more experience in teaching, Whitney's observation demonstrated even greater confidence in the area of science teaching. Whitney mentions RET as assisting in the confidence building in her knowledge of science. This additional knowledge has led to Whitney's expectations for herself as a teacher to increase and allow her to take greater risks in her science lessons.

Whitney mentioned feeling intimidated upon her first few weeks of RET as she was unsure of her science knowledge. By the second summer (2006) Whitney realized that her own science knowledge was increasing and she valued this new confidence in science teaching.

Discussion

Research shows that teaching beliefs and practices do not always co-exist. A teacher may acquire new teaching strategies and change beliefs about teaching, but it may take years to integrate these into the classroom (Chance & Chance, 2001; Fullan, 1993). Teachers tend to make changes in the classroom gradually. Radical changes to teaching practices rarely occur, even after an effective professional development program or teacher training (Guskey, 2002). The participants in this study discussed changes to their beliefs, but some changes to practice were more subtle in the classroom than was mentioned in their interviews. This is to be expected, as teaching practices may take time to be reflected in the classroom. However, even small and subtle changes to practices demonstrate that the teacher is considering change and may intend on continuing to make additional changes in the coming years.

The use of expectancy-value theory as a framework for this study assisted in understanding some of the changes observed by the participants. If the participants believed they had the ability to make some changes in their classroom and valued a particular element, some changes were seen in their teaching practices. More changes may continue to be seen upon further study of these participants.

The three case study participants focused on in this study reflected some changes to their teaching beliefs, although only a few minor changes were seen in their classrooms. However, upon follow-up observations, perhaps additional changes would continue to be seen. One limitation to this study is the time constraints and inability to continue to observe these participants. A follow-up study of all past participants of the RET program is planned to combat this limitation.

Another possible limitation may be due to the brief, six week session of the RET program. How much change can be expected from a teacher who has taught for over thirteen years? Even when participating teachers realize the value of certain elements of science teaching that could be improved demonstrates a significant outcome of this RET program. The importance of including inquiry, considering the difference of activity versus experiment, and increased confidence were major components of the three case studies influenced some teaching practices. These changes to teaching beliefs indicated how valuable an immersion experience for teachers can help positively influence science teachers planning and reflection in their classrooms.

Finally, the participants for this study were all self-selected. All the attendees to the RET program must apply, send in personal statements, and get letters of recommendation. Sending in a complete application is timely for the teachers. The teachers who attend the RET program may already be more motivated and more likely to modify teaching practices based on this self-selection.

References

American Association for the Advancement of Science. (1993). *Benchmarks for science literacy*. New York, NY: Oxford University Press, Inc.

Bandura, A. (1993). Perceived self-efficacy in cognitive development and functioning. *Educational Psychologist, 28 (2),* 117-148.

Bell, B. (1998). Teacher development in science education. In B. J. Frasier and K. G. Tobin (Eds.), International Handbook of Science (pp. 129-151). Great Britain: Kluwer Academic Publishers.

Brown, D. S. (1993). Descriptions of two novice secondary teachers' planning. *Curriculum Inquiry, 23 (1)*, 63-84.

Chance, P., & Chance, E. (2001). *Educational leadership & organizational behavior: Theory Into Practice*. Larchmont, NY: Eye on Education.

Clark, C. M. (1988). Asking the right questions about teacher preparation: contributions of research on teacher thinking. *Educational Researcher, 17 (2),* 5-12.

Dana, T. M., Campbell, and Lunetta, V. N. (1997). Theoretical bases for reform of science teacher education. *The Elementary School Journal*, *97 (4)*, 419-432.

Deci, E. L., & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behavior*. New York: Plenum.

Dixon, P. and Wilke, R. (2007). The influence of a teacher research experience on elementary teachers' thinking and instruction. *Journal of Elementary Science Education*, *19 (1),* 25-43.

Driscoll, M. P. (2005). *Psychology of learning for instruction, 3rd ed*. Boston MA: Pearson, Ed. Inc.

Eccles Parson, J, Kaczala, C. M., & Meece, J. L. (1982). Socialization of achievement attitudes and beliefs: classroom influences. *Child Development*, *53 (2)*, 322-339.

Fullan, M. (1993). *Change Forces: Probing the depths of educational reform.* Levittown, PA: The Falmer Press.

Guskey, T. R. (2002, April). Linking professional development to improvements in student learning. Paper presented at Annual Conference for American Educational Research Association, New Orleans, LA.

Guskey, T. R. (1986). Staff development and the process of teacher change. *Educational Researcher*, *15 (5)*, 5-12.

Kardash, C. M. (2000). Evaluation of an undergraduate research experience: perceptions of undergraduate interns and their faculty mentors. *Journal of Educational Psychology, 92 (1)*, 191-201.

Lederman, N.G.: 1998, 'The State of Science Education: Subject Matter Without Context', Electronic Journal of Science Education **3**(2), [WWW Document]. http://unr.edu/homepage/jcannon/ejse/lederman.html.

Lloyd, J. K, Braund, M., Crebbin, C., Phipps, R. (2000). Primary teachers' confidence about and understanding process skills. *Teacher Development, 4 (3)*, 353-369.

Loucks-Horsely, S., Love, N., Stiles, K., Mundry, S., & Hewson, P. W. (2003). *Designing Professional Development for Teacher of Science and Mathematics, 2nd edition.* Thousand Oaks, CA: Corwin Press, Inc.

The National Committee on Science Education Standards and Assessment. (1996). *National Science Standards*. Washington, DC: National Academy Press.

National Commission on Mathematics and Science Teaching for the 21st century. (2000). *Before It's Too Late*. A report to the nation.

National Research Council. (1999). *How People Learn*. Washington, D.C.: National Academy Press.

Rice, D. C. & Roychoudhury, A. (2003). Preparing more confident preservice elementary science teachers: one elementary science methods teachers' self study. *Journal of Science Teacher Education, 14 (2)*, 97-126.

Rhoton, J. & Bowers, P. (2001). *Professional Development Planning and Design*. Arlington, VA: National Science Teachers Association

Ross, J. R., Hogaboam-Gray, A., Hannay, L. (1999). Predictors of teachers' confidence in their ability to implement computer-based instruction. *Journal of Educational Computing Research, 21 (1)*, 75-97.

Scharmann, L. C., Smith, M. U., James, M. C., Jensen, M. (2005). *Journal of Science Teacher Education, 16, (1)*, 27–41.

Seymour, E., Hunter, A. B., Laursen, S. L., Deantoni, T. (2003). Establishing benefits of research experiences for undergraduates in the sciences: first findings from a three-year study. *Wiley Interscience*, www.interscience.wiley.com.

Tobin, K. (1998). Issues and trends in the teaching of science. In B. J. Frasier and K. G. Tobin (Eds.), International Handbook of Science (pp. 129-151). Great Britain: Kluwer Academic Publishers.

Valli, L. (1997). Listening to other voices: a description of teacher reflection in the United States. *Peabody Journal of Education*, *72 (1)*, 67-88.

West, C. K. & Anderson, T. H. (1976). The question of preponderant causation in teacher expectancy research. *Review of Educational Research, 46 (4)*, 613-630.

Wigfield, A. & Eccles, J. S. (2000). Expectancy-value theory of achievement motivation. *Contemporary Educational Psychology, 25*, 68-81.

Wigfield, A., Tonks, S., & Eccles, J. S. (2004). Expectancy value theory in cross-cultural perspective. In *Research on sociocultural influences on motivation and learning* (pp. 165-198). New York, NY: Information Age Publishing, Inc.

Woolfolk, A. (2007). *Educational Psychology, 10th ed*. Boston MA: Pearson Education, Inc.