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Camille A. Goebel

Change over a Service Learning Experience in Science Undergraduates' Beliefs Expressed about Elementary School Students' Ability to Learn Science

By

Camille A. Goebel
Doctor of Philosophy

Division of Educational Studies

Robert J. Jensen, Ed.D.
Adviser

Robert L. DeHaan, Ph.D.
Committee Member

Magnia George, Ph.D.
Committee Member

Accepted :

Lisa A. Tedesco, Ph.D.
Dean of the Graudate School

Date

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Camille A. Goebel

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Bachelor of Arts, University of California Santa Cruz, 1974

Committee:

Robert J. Jensen, Ed.D., Chair

Robert L. DeHaan, Ph.D.

Magnia George, Ph.D.

An Abstract of
A dissertation submitted to the Faculty of the Graduate
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Doctor of Philosophy

Division of Educational Studies

2008

Abstract

This longitudinal investigation explores the change in four (3 female, 1 male) science undergraduates' beliefs expressed about low-income elementary school students' ability to learn science. The study sought to identify how the undergraduates in year-long public school science-teaching partnerships perceived the social, cultural, and economic factors affecting student learning. Previous service-learning research infrequently focused on science undergraduates relative to science and society or detailed expressions of their beliefs and field practices over the experience. Qualitative methodology was used to guide the implementation and analysis of this study. A sample of an additional 20 science undergraduates likewise involved in intensive reflection in the service learning in science teaching (SLST) course called Elementary Science Education Partners (ESEP) was used to examine the typicality of the case participants.

The findings show two major changes in science undergraduates' belief expressions: (1) a reduction in statements of beliefs from a deficit thinking perspective about the elementary school students' ability to learn science, and (2) a shift in the attribution of students' underlying problems in science learning from individual-oriented to systemic-oriented influences. Additional findings reveal that the science undergraduates perceived they had personally and profoundly changed as a result of the SLST experience. Changes include: (1) the gain of a new understanding of others' situations different from their own; (2) the realization of and appreciation for their relative positions of privilege due to their educational background and family support; (3) the gain in ability to communicate, teach, and work with others; (4) the idea that they were more socially and culturally connected to their community outside the university and their college classrooms; and (5) a broadening of the way they understood or thought about science. Women participants stated that the experience validated their science and science-related career choices.

Results imply that these changes have the potential to strengthen the undergraduate pursuit of science-related careers and will contribute positive influences to our education system and society at large.

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Dedication

To John Anthony Lennon, my soul mate, best friend, and husband. You are the music of my dance.

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This research reflects the influence and wisdom of many persons whose words and personal examples expedited the experiences and insights that led me to envision, implement, and complete this study.

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I have the privilege to have long friendships with and learn from experts in education, culture, and art. I thank Karen Falkenberg and Mari Roberts for their gracious gifts of time and advice, all of which helped to make this dissertation better. I am grateful to Kathryn Kozaitis for her professional contributions to the ESEP program and our stimulating conversations over the years. Her effort with the science undergraduates challenged them to intensively reflect on their experiences, a key to social change. And to John A. Lennon, who read my work and inspired me with care and humor, I give my deepest gratitude, for that was a gift of love. Without a doubt, I am indebted to all of my family and friends, both here and gone, who encouraged me to follow my intellectual passions. Finally, I will always appreciate and admire the science undergraduates who participated in this study and the hundreds of other ESEP college partners who, although anonymous here, taught me about the process of becoming a courageous and introspective scientist.

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CHAPTER 1. INTRODUCTION

This research is about change in science undergraduates' perspectives on elementary school students' abilities to learn science during the course of a service-learning partnership. I came to this study indirectly. This dissertation is part of a larger research study on the elementary school teacher and science undergraduate partnership experience. The pursuit of a science major is a daunting affair for many. As a science educator, I listened to undergraduates describe their college academic work in science as isolating and dreary. They contrasted their traditional courses to experiences and lessons learned from the students they worked with while teaching science in elementary schools as part of a science service-learning program. Their enthusiasm for the service learning in science teaching (SLST) course was stunning. What was happening to the undergraduates in a two-credit science elective called Elementary Science Education Partners (ESEP) to make it popular enough to be often repeated by individuals or taken as a schedule overload?

The undergraduate course was one of several components of an elementary school teacher enhancement program funded by the National Science Foundation that included (1) a manipulatives-based curriculum, (2) creation of a cadre of mentor teachers, (3) an in-service teacher empowerment and professional development component, and (4) an assigned undergraduate science-partner for each participating teacher. It was open to undergraduates who were at least second semester freshmen. The original objective of the ESEP program was to improve the abilities of K-5 teachers in local schools to apply guided-discovery instructional methods in teaching science and mathematics and to sensitize them to gender-equity issues. A pilot study provided evidence that through contact with the undergraduate science-partners, teachers became more eager to teach science and interested to improve their knowledge of science. (See Appendix A for ESEP program note and references.) An unexpected consequence was the enthusiasm that all participants, especially the undergraduates, had for the program.

The ESEP course was a big commitment of time and effort for the science undergraduates. College science-partners spent at least 33 hours a semester in urban public schools team-teaching inquiry-based science lessons with a classroom teacher (Appendix B). After 12 hours of formal instruction in inquiry science pedagogy, science curricula, and diversity issues, the undergraduates reflected weekly by writing journals and participating in one-hour-long focus-group discussions based on reading assignments and presentations. Twice a week, they taught children in the classroom using either a kit-based science curriculum, or when not available, a hands-on inquiry-based science lesson that they had prepared. On completion of the course, each ESEP Emory undergraduate wrote a reflection essay summarizing his or her experience and received a grade based on criteria used consistently throughout the six-year program (Appendix C).

From the beginning of the program, responses of teachers, school administrators, elementary school students, and undergraduates to the science-partnership service-learning (SL) course were positive. The fervor that undergraduate science-partners had for their experience was well documented on the Emory campus. When ESEP enrollment unexpectedly dipped one semester, the weekly undergraduate newspaper wrote an article of alarm and concern (Kelleher, 1998). One undergraduate wrote in her journal, “If I left [the university] without ever having taken ESEP, I would not have learned as much for my science career." Looking back over his college experience, an outgoing ESEP Student Council president reflected,

> As a Freshman at Emory I found that I was stuck in a sort of melancholy. I felt detached from myself and from the world around me. I was constantly engaged in the pursuit of academic knowledge but I always felt as if something was missing. The big change came about when I started working in the ESEP program. Suddenly I was able to put some of this academic knowledge to use. And suddenly, I was truly learning again.

After one term in ESEP another undergraduate wrote,

> … the greatest gift I received was a mini-education in science and humanity. My students reminded me that science was not about the mid-terms or the MCATs. Science was fun. It was about curiosity and trying to understand why certain things happen. In my own classes, I get so wrapped up in studying material that I forget to learn it. I think my ESEP kids helped me rekindle that curiosity I had had when I was younger. They reminded me that the questions a person asks are often times more important than the answers they receive.

My interest in the undergraduates' expression of their beliefs was sparked by their passion for the program. I saw undergraduates invest extra time in preparing to teach, take the initiative to learn unfamiliar science material, form and perpetuate an undergraduate student council to assist and inform their peers, and provide input regarding the organization of the program. After many one-on-one conversations and sitting through numerous focus group discussions in previous years, I was inspired to investigate the undergraduates' expressions of change that they saw in themselves, as well as the expressions of their beliefs about the elementary school students of science during the course of their SL experience. The undergraduates seemed to have a sense of ownership as they campaigned to enlist other science undergraduates in ESEP. The undergraduates seemed to care about what happened to the elementary school students in the years after they could no longer work with them on science. For these reasons, the main goal of this dissertation is to discover how science undergraduates' beliefs expressed about the ability of their elementary school students, in an urban and primarily African American school system, changed over the course of one academic year. I collected the data for this research in the context of the ESEP SLST program at Emory University.

The observation that science education can be a compelling activity for science undergraduates led me to consider the larger issue of science and engineering preparation and its critical role in the United States today.

Statement of the Problem

Attention to the education of undergraduates in the fields of natural sciences is critical because of the U.S. need for both an adequate number of highly trained scientists and a scientifically literate citizenry. Given that American institutions of higher learning recognize these needs, there is much concern about the retention of undergraduates in the science and engineering disciplines (S&E). On the national level, a S&E workforce crisis is emerging. Demand has exceeded the availability of technically trained workers for research and industrial laboratories, as well as qualified science teachers (DeHaan, 2005; National Research Council, 2003). In the past few decades, the S&E interests in the United States have been able to rely on qualified people from other countries (e.g., China, Taiwan, India, and South Korea) who received their advanced training in the U.S. and remained to fill positions. This trend is rapidly changing. More competition for foreign-born scientists and technologists now exists due to heightened S&E investments in education, research and development, and economic growth around the world (National Science Board, 2006). Of the bachelor's degrees earned between 1983 and 2002 in all fields by United States citizens and permanent residents, roughly one third were in S&E, which includes the social and behavioral sciences. Although current rates of S&E degree production have held fairly steady for two decades, the number of scientists and engineers available to the labor force will increase at a slower rate than the projected need. This is due to impending retirements and a rise in the mean age of S&E workers (National Science Board, 2004; National Science Board, 2006). That being said, my work is part of a broader issue. This crisis begins with science education in the early grades where elementary school students first experience science and develop their self perceptions as potential science practitioners (Conderman & Woods, 2008; Fulp, 2002), and extends through college where undergraduates are preparing for future careers (Wieman, 2007). The consequences of not meeting these national needs potentially include reductions in technology production, loss of momentum in medical and pure science research and discovery, and a shift in our place in the world economy.

In our research dependent and technologically complex world, it is imperative that colleges and universities work to enhance education to support and retain undergraduates interested in pursuing professions involving the sciences and technologies. According to research by Seymour and Hewitt (1997), undergraduates report changing out of their intended natural sciences majors due to what they believe are poorly taught and alienating science courses that stress academic knowledge with few practiced applications. Of the 25% to 30% of undergraduates who enter colleges in the United States intending to major in natural sciences, about one third change to other programs after the first year and fewer than half graduate with a S&E degree within five years. Only about one-third of S&E baccalaureates from 1999/2000 were still in S&E in 2001 in either graduate study or employment. In addition, African Americans, Latinos, American Indians, Alaskan Natives and women in general continued to switch out of S&E programs at a higher rate than other undergraduates (National Science Board, 2004). Disconnection and boredom found in large science lecture courses, impersonal communications with professors, and a sense of inadequacy and isolation are some of the reasons given for switching (Seymour, 1992, 2001).

To address the curricular and instructional issues in undergraduate degree programs in the sciences, the National Research Council (NRC, 2003) recommends the application of cognition research to inform science pedagogy. The NRC (1999a) outlined a number of reforms to enhance undergraduate education. These include incorporating learner-centered, active-learning, and inquiry-based instruction involving real-world problems into regular science classroom practices and curricula. Other suggestions aimed at improving undergraduate retention include interdisciplinary work and sustained community partnerships with schools (Committee on Undergraduate Science Education, 1999; Committee on Science and Mathematics Teacher Preparation, 2001) that provide learner-centered approaches and contextual teaching methods.

Among the most important of the practices designed to engage and support college students majoring in the sciences are problem-based learning (Olson, 2003; Sylva & Chinn, 2003), experiential and service learning (Conroy, Trumbull, & Johnson, 1999; Springer, Stanne, & Donovan, 1999), and research participation (Barlow & Villarejo, 2004; Frantz, DeHaan, Demetrikopoulos, & Carruth, 2006). Such enhancements and alternatives to traditional science coursework give undergraduates the opportunity to engage in interdisciplinary experiences that provide them a forum to work with others, develop openness to new ideas, practice, and apply their science knowledge, communication and leadership skills (National Science Foundation, 1998). Science-related experiences and courses that engage the undergraduate and promote practical knowledge such as tutoring and service learning in science involve direct interaction with people. Service learning can address some of the NRC recommendations such as interdisciplinary and active learning involving real-world problems within community contexts. The Elementary Science Education Partners (ESEP) program at Emory University employed many of these methods through service learning in science teaching.

Service learning is a pedagogy that engages students of any age in organized community-service praxes linked to academic learning. It utilizes reflective and critical thinking to stimulate civic awareness while addressing real community needs. This being said, what would indicate that science undergraduate development in the area of openness to new ideas takes place? Do the undergraduates connect with their community partners in ways that affect their own development as science practitioners? If so, what is the nature of their change? The urgency to better understand education practices that can help undergraduates connect the science and engineering disciplines to society and issues of the human condition prompted me to prepare a history of how service learning emerged as a pedagogy in institutions of higher education.

History and Characteristics of Service Learning

Experiential education is a term that encompasses a wide variety of programs that involve some type of experience in the field of interest at any educational level. The philosophical theory of John Dewey in the 20th century underlies and continues to guide such programs in the U.S. Similar to the Vygotskian notion of learning from observation and practice of higher-level functions than those that can be done independently (zone of proximal development), Dewey believed that a person is constantly developing in various ways (Bredo, 2003). He argued that the basis for good education involves a student's participatory interactions and reflection within a continuity of constructive experiences. Dewey (1916) reasoned that thinking is staged and does not happen in isolation from experience:

> The initial stage of that developing experience which is called thinking is experience… What is here insisted upon is the necessity of an actual empirical situation as the initiating phase of thought. Experience is here taken as previously defined: trying to do something and having the thing perceptibly do something to one in return. (p.153)

The initial proponents of community service-experience saw service learning and volunteerism as a way college students could immerse themselves in various career roles, see the world through other perspectives, and at the same time serve their country (Jacoby, 1996). In the late 1960s the term "service learning" came forth and the National Center for Service Learning was established. Since the 1930s, but prior to the establishment of non course-based service organizations such as the Peace Corps and AmeriCorps, a type of SL had been practiced in applied professional fields such as nursing, teaching, and social work.

One factor that inhibited the community service effort during the 1960s and 1970s was a blindness to the ideals of reciprocity and mutualism (Kendall, 1990). Although well intentioned service focused on community needs, taken with less consideration were the community strengths and value to society. The national organization, Campus Compact (Rhodes, 2007) was later started in the mid-1980s by a dozen college and university presidents to promote civic awareness and vision in undergraduate students through public service linked with academic coursework. Campus Compact was integral to the establishment of various federal programs and pieces of legislation such as the National and Community Service Act of 1990, the National and Community Service Trust Act of 1993, and the Community Service Provisions of the 1992 Re-authorization of the Higher Education Act (Corporation for National and Community Service, n.d.). Today the organization has a membership of over 800 campuses. With the passage of the 1993 Act, federal support for SL increased.

Service learning involves a partnership between an educational institution and an organization or agency within the community. Student participants range from elementary school pupils to graduate professionals such as medical students (Billig, 2000; Tarallo-Falk, 2000.) Typically, the community is local and off-campus; however, SL is not limited by community location. There are programs where service field-work is done in international settings, e.g., Myers-Lipton (1996a), or on the college campus, e.g., Bixby, Carpenter, Jerman, and Coull (2003).

Broadly, service-learning programs have at least three components: (a) a subject-based course, (b) service work in the community, and (c) reflective practices that serve to tie the two together. The hours of service, type of reflection, and applications of course constructs to undergraduates' service experiences can vary (Gray, Ondaatje, Fricker, & Geschwind, 2000). Eyler and Giles (1999) explain that the characteristics that compose "high quality" SL programs include: (1) placements involving interesting and challenging work that holds responsibility, (2) thorough integration of coursework with service that allows the application of knowledge, (3) challenging reflection and meaningful discourse on course and service issues, (4) community needs that are clearly identified by the community and SL participant, and (5) work with people of backgrounds different from that of the undergraduate participant. Other characteristics embedded in a well planned SL program are clear academic objectives and the evaluation of change in the various participants including the community members, undergraduates, institutions, and faculty (Kezar, 1998; Mintz & Hesser, 1996).

The following three examples demonstrate the diversity of characteristics and emphases placed on different service-learning program components. In the first example, the community was a college campus (Bixby et al., 2003). Undergraduates in an Environment of Earth course at the University of South Carolina tracked energy use at various campus sites two times in one semester. In laboratory reports and a final summary, reflection was limited to issues of energy conservation. The objective of the program centered on the service experience, data collection, and awareness of the need for energy conservation and waste reduction. In contrast, a second program emphasized a sequential move from the classroom to the community praxis. A Biological Engineering course at Louisiana State University that was intended to promote core-course objectives and retention of engineering undergraduates, used SL in a four-part process involving the design of a local community playground (Ropers-Huilman, Carwile, & Lima, 2005). The first half of the semester involved on-campus instruction by faculty and subject research by undergraduates on various playground designs. In the second part, the undergraduates developed and drew new playground plans using the community partners' input. Then, a panel of experts including the community partners evaluated the designs with the undergraduates present. Finally, undergraduates participated in one end-of-term focus group and a survey self-report to reflect on what they learned and to evaluate their SL experience. This last component allowed the faculty to assess the SL program according to the accreditation criteria of the Accreditation Board of Engineering and Technology. It appears that in this model, the reflective practice was limited to project related discussions with the community members, and one survey and focus group self-assessment of the usefulness of the service experience to achieve course learning objectives.

In comparison, the third program example uses reflection to emphasize the continual application and integration of course content with community service. The psychology faculty at Indiana University East developed the SL course, Emotional and Behavioral Disorders of Childhood and Adolescence, to help expedite undergraduate awareness of how individuals' lives are affected by disorders and the development of skills that undergraduates would need to interact with persons so afflicted (Osborne, Weadick, & Penticuff, 1998). Prior to the term, the faculty consulted and planned with community mental health agencies to mutually establish needs and expected outcomes in order to integrate course learning objectives with service and allow for the application of course content. Before the service, the undergraduates were oriented in small randomly assigned groups and allowed to choose potential activities they would perform. A faculty member or experienced upper-level undergraduate acted as a SL coordinator and liaison between the agency and the undergraduate groups assigned to that agency. The course syllabus explicitly articulated the course learning objectives.

The undergraduates performed ten hours of service that was weighted significantly compared to exams and reflection. Individual and group reflection integrating the experience and course content was promoted with six different practices for which undergraduates earned points. These practices included end-of-class exit-questionnaires, thought papers, essay questions on exams, progressive group-updates, a final group update, and final group presentations that were given to the participating community agencies. Lastly, to evaluate the effectiveness of the program with regard to retention issues, undergraduates were given pre and post self-concept surveys. Course evaluations provided faculty with feedback used to enhance the program format. In this program, the distinction between learning from field work and learning from class work was minimized through repeated and various reflective thinking practices.

Theoretical Framework

Currently educators continue to struggle with ways to strengthen the sense of a "learning community" through methods that promote a more caring and welcoming environment for undergraduates. Institutions of higher education have been slow to incorporate carefully designed service learning into the undergraduate science and engineering curriculum. Part of the problem arises from the traditions of teaching the existing truths and achievements, and passive methods of learning them (Ehrlich, 1996). Basing his theories in the Freireian ideal of student empowerment, Rhoads (1997) wrote, "Part of the solution clearly involves . . . closing . . . the division between "in-class" and "out-of-class" student experiences, as well as the separation of practical and academic knowledge" (p. 35). He argues that the catalyst for transforming social conditions and learning from service activity is reflective thought. Quality service-learning is an inductive and cyclic process of practice and reflection (Morton, 1996).

The theory of community service-learning is based on the principle that habits of emotional response developed from past experiences affect future experiences (Carver, 1997; Jacoby, 1996). The participant begins with a certain level of development (e.g., cognitive, psychosocial, ethical, identity, or career), and ends the experience changed in some way (Dewey, 1938; Eyler & Giles, 1999; McEwen, 1996). Reflection in discipline-based service-learning courses can stimulate undergraduate participants to consider themselves in a social context with discrete community members and to identify what effect they, as active agents, have on the community as a whole (Everett, 1998; Jacoby, 1996; Kendall, 1990; Radest, 1993; Rhoads, 1997). Additionally, reflection can generate a mindfulness of the tenet of reciprocity in service learning. In this way, reflective practice challenges the patronizing idea that the "community" needs to be corrected by one whose service mitigates a given problem. From a respectful perspective, undergraduates may reconsider their societal place and responsibility from within their extended community vs. from without. This involves an acknowledgement of the idea that changes in circumstances, knowledge, and beliefs can be mutual.

The nature and process of belief and concept change provide the theoretical framework of this study. Beliefs and conceptions, or knowledge, are intertwined. As James (1995/1907) metaphorically noted 100 years ago, "Truth lives, in fact, for the most part on a credit system. Our thoughts and beliefs 'pass,' so long as nothing challenges them, just as bank-notes pass so long as nobody refuses them" (p. 80). The term belief implies a truth-valued view based on judgment about a subject; beliefs are personal and hold an affective component. The term concept implies a more broad organizational idea of thought and learning (Strike & Posner, 1992).

Modern research refines the more global revelations of early cognitive theorists and reveals that beliefs and belief systems are complex and may underlie knowledge and knowledge systems. In his article on the construct of belief in educational research, Pajares (1992) helped to clarify the meaning and nature of beliefs that "… cannot be directly observed or measured but must be inferred from what people say, intend, and do…" (p. 314). Beliefs are understood to be a filter for the explanation of new information and experience, and so shape cognition. An important dimension of the knowledge process involves the influence of a person's epistemological beliefs used to determine what is true, as well as the validity of an explanation when processing new information (Pintrich, Marx & Boyle, 1993). Ideas compete for a place in the conceptual framework and those that triumph resolve discrepancies, and fit with the individual's beliefs about truth and the nature of knowledge (Bendixen, 2002). The beliefs that a person has about a subject influence their perception and behavior, and are acquired through cultural transmission (Pajares, 1992). Beliefs can be learned from and shared with others, or grown from direct experience. All beliefs are resistant to change, but those most central to a person's sense of self and incorporated early into their belief structure are the more entrenched. Recent beliefs are more tenuous.

The way individuals think about knowledge and knowing has been shown to have several stages or styles. After the early developmental work of Perry (1970), cross-sectional and longitudinal studies provided evidence that an individual's epistemic assumptions change from early adolescence to early adulthood. Early epistemic beliefs on knowledge are simple and dichotomous (either true or false). Beliefs progressively become relativistic. In that style, all truth is relative to the individual and the time and place in which one acts. Epistemic beliefs eventually can become evaluative for different points of view and reflective judgments begin with "…an awareness of uncertainty" (King & Kitchener, 1994, p. xvi). It appears that the methods used to justify or reflectively judge beliefs also progressively develop as individuals confront problems that cannot be resolved with certainty (King & Kitchener, 2000). It is possible for individuals to regress to a "lower" style in the face of a frightening or emotionally charged situation that challenges strongly held beliefs (Hofer & Pintrich, 1997). The reasoning of college students as it is influenced by their epistemic beliefs and affect plays a major role in the consideration of both beliefs and cognition (Schoenfeld, 1985). Schommer-Aikins (2000) wrote that epistemological beliefs mediate learning indirectly when used to determine what it means to learn. An individual who values the recall of externally sourced facts will develop differently from one who values critical thinking as a way to make useful assertions and gain understanding (Kuhn & Weinstock, 2000). A direct effect on learning would be a strong belief in the validity of certain knowledge, thus effectively filtering out alternative interpretations.

In her research on the role of doubt in epistemic belief change for adults, Bendixen (2002) found a four-stage systemic reaction to and processing of doubt that coincides with the Piagetian cognitive disequilibrium theory and parallels the four conditions needed for conceptual change. Doubt is first triggered by an exposure to difference, as in a discrepancy between beliefs and experiences, realizations and independent events. In the second stage, individuals feel confusion, fear and instability.

A resolution of doubt in the third stage is effected by taking control through reflection and educational experience to analyze the implications of their beliefs. Finally, new and more useful epistemic beliefs are developed.

Concepts and concept change are influenced by beliefs through the acceptance or conviction in the actuality of something as in statements connecting concepts about the world that can be judged to be true or false. The literature suggests that the conditions necessary for concept change and belief change are similar: a person experiences dissatisfaction with current beliefs; new beliefs must be intelligible; new beliefs must be applicable; and new beliefs must fit with other beliefs or conceptions and appear to further learning (Pintrich et al., 1993; Posner, Strike, Hewson, & Gertzog, 1982). The beliefs a person holds are used to judge the validity and use of solutions to a problem or issue. They can both help or hinder the acquisition of new and correction of pre-existing concepts. Pre-existing concepts are interrelated and change in one concept affects the way other concepts are considered. The more certain a person is of her understanding (i.e., believing it to be true), the lower the likelihood she will learn through an alternate conceptual framework. Piaget (1985) theorized that an individual either assimilates new information into existing belief structures, or when assimilation does not work, accommodates new information by replacing old beliefs and reorganizing the belief structure. Contextual, motivational, and affective factors are involved in the change process (Pintrich, 2000; Pintrich et al., 1993). The meaning individuals make of their experience depends, in part, on the nature of the cognitive dissonance they experience. A sufficient challenge to a belief resulting in instability and accommodation of new beliefs is less common than that for assimilation, even when contradictory evidence is present.

Reflection on experience enables students to construct meanings and transform experience into learning (Dewey, 1933, 1938; Schon, 1983). Conscious reflection or reflective abstraction on information from the environment and learning has long been considered an important component for cognitive development and equilibration (Piaget, 1985). Reflection and social interaction are critical to the resolution of epistemic doubt and a following change in beliefs (Bendixen, 2002). For example, a social context like a service-learning focus group provides the opportunity to examine critically and argue over preexisting beliefs in order to find a resolution to the discomfort of dissatisfaction with current beliefs (Giles & Eyler, 1994). Reflective and social dialogues are integral to the advancement of cognitive development (Bendixen, 2002; Moshman, 1998; Vygotsky, 1978).

Although linking coursework with community service through reflection can lead to an enhanced awareness or shift in beliefs about community partners, such as low SES and minority students, the degree and method of reflective integration appear to increase positive cognitive development (Eyler, 2002a). Unless service-learning undergraduates like other persons in positions of power, e.g., preservice teachers, are encouraged to reflect on their experience from an academically informed perspective, they rely on ingrained views or assumptions that have been influenced, in part, by media, societal norms, peer group perspectives, and limited experience with diverse others (Cone & Harris, 1996; Rhoads, 1998). For example, Standard English continues to indicate social class and education level (Chinn, 2005). Without mindful interaction and reflection by the SL participant, public school students using nonstandard English may be perceived as uneducated and perhaps less able to learn science.

In the face of growing evidence that sociocultural, historical, curricular, and economic factors influence student participation and achievement in science, many inservice and preservice teachers still believe that students need only to work hard to learn science regardless of their SES, language proclivities, gender, or ethnic background. There is ample evidence of resistance to change this type of belief or to teach in culturally responsive, socially relevant and gender-inclusive ways using inquiry-based and other stimulating pedagogies. Rodriguez (1998, 2005) calls for educators to implement sociotransformative constructivism as the theoretical strategy to promote teacher understanding and mindfulness of how sociocultural, historical, and institutional contexts mediate opportunities for students to construct meaning during science instruction.

In a SLST context, mindful teaching practices and challenging reflection alone may not be enough to facilitate change in beliefs. Boyle-Baise and Kilbane (2000), Giles and Eyler (1994), and Kahne and Westheimer (1996) wrote of the transformative influence of caring or companionship relations that can be established between the SL undergraduate and their community partner(s). The caring relationship involves a reciprocal investment in the gaining of knowledge about and personal expression between partners through both formal and informal communications. This process is an ideal of SL and helps to distinguish a caring-based relationship from a giving- or charity-based relationship (Kahne & Westheimer, 1996). Charitable volunteerism is a way for the good intentioned to provide assistance to a societal situation with little or no need for reciprocal change. The development of altruistic behaviors in undergraduates does not bar nor does it necessitate the practice of higher order thinking involved in the consideration of the reality and character of others in the context of their own lives (Noddings, 1984). The process of transforming deficit thinking views (the attribution of a person's or group's problems to internal or cultural deficiencies) may begin with the experiential and interpersonal components of a caring relationship and expedited by mindful and critical reflection on those components. A caring relationship in the SL context calls for more than warm and friendly exchange and fond liaison: "When we care, we want to do our very best for the objects of our care . . . it demonstrates respect for the full range of human talents," (Noddings, 1995, p. 676). These theoretical insights helped me to formulate the larger purpose of my study from the more immediate questions investigated in the research.

Purpose of the Study

My purpose in this study is to examine the change in science undergraduates' beliefs expressed, while in a course-based SLST program, about elementary school students' ability to learn science. Relevant to this effort is the SL learning outcome of the student's perspective transformation for social issues, or "questioning and overturning one's fundamental assumptions about society" (Eyler & Giles, 1999, p. 135). The service-learning literature indicates that participants can demonstrate a shift in racial, social, and cultural views. If the service learning in science teaching contributes to the enhancement of undergraduates' beliefs and attitudes toward the content of the service focus (e.g., the teaching and learning of science in an urban setting), then the experience may stimulate undergraduate engagement in science and strengthen science and science related career goals in work environments with increasingly diverse populations. Likewise, if the SLST experience can be associated with positive attitudes and regards toward community participants, then the influence may extend to the minority science students as they pursue their educational careers. By entering into a socially interactive context with elementary school students and teachers, science undergraduates may reconsider their beliefs about teaching, learning, and their own future role in society with respect to low SES students. As scientists, they may be inspired to take a role in the future as community education-partners.

To further the connection between the purpose of this study and the broader context of the works and ideas of others, I review the literature on attitudinal research set in the service-learning environment.

CHAPTER 2. REVIEW OF THE LITERATURE

Overview

Studies of community service-learning vary widely in focus, community institution, and participants (Eyler, Giles, Stenson, & Gray, 2001). This literature review is limited to the effects of SL on the attitudes and beliefs of undergraduate students. I reviewed the following types of documents in order of priority: (a) peer-reviewed empirical research, (b) peer-reviewed meta-analyses of literature, and (c) books and opinion pieces weighted for those that are based on the philosophy and work of widely published authors. (See Appendix D for a sample of search terms and databases.)

I examined 180 studies of higher education students involved in service learning pertaining to science and social science. Of these, there are 17 studies of service learning in the science and science-related disciplines. To supplement the more rigorous findings of the empirical research used in this review, I refer to some program reports in science SL that contain empirical findings. I also include, and note, three studies on graduate students in professional schools in science-related courses. Because recent studies are more relevant to the learning contexts and diversity of today's undergraduates, I limited my review of empirical research to works published within the last fifteen years. I read each piece critically for the findings relative to the question(s) investigated and research methodology used. For purposes of authenticity, I use here the terminology that the authors employed to present their work. I discuss 40 of the 45 studies that met my criteria for findings that concerned beliefs or attitudes with respect to society and the community. (See Appendix E for a tabular literature summary.)

Service-learning research ranges from longitudinal surveys of undergraduates from multiple academic terms, courses, and institutions on a national scale to studies within one institution and one course for one semester. Most research that investigates attitudes and beliefs uses pre and post survey self-reports, one-shot interviews, journals, or a combination of a few of these independent data sources. Additionally, most community populations and service activities are loosely defined. Overall, service learning has been shown to have a positive effect on undergraduate personal, social, and learning outcomes. Waterman (2003), however, argues that the number of studies with positive findings may be skewed because quantitative studies with nonsignificant learning outcomes are less likely to be published. If this were the case, however, it seems that there would be evidence of more nonsignificant findings in the longitudinal or meta analytical SL studies using large databases.

Psychology, education, social science, and health were the most common course disciplines reported. Seven studies tended to focus on undergraduate gains in skills and subject knowledge (Bixby et al., 2003; Esson, Stevens-Truss, & Thomas, 2005; Juhn, Tan, Piessens, Grant, Johnson, & Murray, 1999; Miller, 1994; Ropers-Huilman et al., 2000; Tsang, Van Haneghan, Johnson, Newman, & Van Eck, 2001). The course disciplines of those seven were predominantly in the sciences (environment, chemistry, nursing, psychology, biological engineering, and mechanical engineering, respectively). I discuss only those with findings that pertain to perceptions and knowledge of community partners. There are six studies in the field of teacher education (Barton, 1999; Boyle-Baise, 1998; Boyle-Baise & Kilbaine, 2000; Boyle-Baise & Sleeter, 2000; Potthoff, Dinsmore, Eifler, Stirtz, Walsh, & Ziebarth, 2000; Wade, 1995). Of those, there is one study on service learning in science teaching and it focuses on multicultural science (Barton, 1999).

To structure the review of this broad and diverse body of literature, I placed each study into one of three organizing categories that refer to the service relationship of the volunteers and community member(s), or their relational "positions of expertise:" (1) the service-learning university student provides a certain expertise, (2) the community members and university student each had expertise, and (3) the community members had a certain expertise. I made a best fit of each study based on the information provided in the publication. This grouping is a response to my interest to manage one of the variables while looking at the data. In the case of category one, for example, one could reason that when undergraduates provide some expertise to the relationship, their learning may be have been affected in some way. Due to the irregularities in information provided by the authors, no category is exclusive and some studies may overlap categories to various degrees. Within each category, I discuss the particulars for the course and service contexts.

Category One: Studies Where University Students Provide Certain Expertise to the Service-Learning Relationship

There are 27 studies in the first category pertaining to programs in which SL university students volunteered certain abilities or expertise and community members provided them access to a situation or experience, e.g., tutoring students after school. University students volunteered to help mitigate a certain community need. For all undergraduates in SL courses, general college level knowledgeability is assumed. In certain SL courses more course-specific academic knowledge is also assumed, and when that was the case, this specific knowledge is noted (Table E1, Appendix E). In category one, any expertise provided by the community was either underplayed to that of the undergraduates or was not revealed. When reported, the university student race and ethnicity was predominantly European American (mean = 80% for nine studies, range = 43% to 93%) and the gender more often female (mean = 65% for twelve studies, range = 40% to 93%).

Twenty-two studies in this category reported on the beliefs or attitudes of the service-learning participants. When reported, the courses in these studies tended to be in the social science and health based disciplines. Although the SL studies used various terms to describe the change in undergraduate perceptions of community partners, I consider descriptors such as “confronted stereotypes,” “promoted racial understanding,” “enhanced tolerance and sensitivity to diversity,” and “empathy for others,” to be positive and related outcomes. Ninety-one percent (20 of 22 studies) found that service learning had, to various degrees, a positive influence on the views and knowledge that undergraduates had of the people they worked with.

Twelve studies in category one used quantitative methods (Astin, Sax & Avalos, 1999; Batchelder & Root, 1994; Eyler, Giles, & Braxton, 1997; Giles & Eyler, 1994; Gray et al., 2000; Kearney, 2004; Kendrick, 1996; Mabry, 1998; Markus, Howard, & King, 1993; Osborne, Hammerich, & Hensley, 1998; Potthoff et al., 2000; Vogelgesang & Astin, 2000), six used mixed or both quantitative and qualitative methods (Ames & Diepstra, 2006; Driscoll, Holland, Gelmon, & Kerrigan, 1996; Narsavage, Lindell, Chen, Savrin, & Duffy, 2002; Rice & Brown, 1998; Rockquemore & Schaffer, 2000; Steinke, Fitch, Johnson, & Waldstein, 2002), and two studies in this group used qualitative methods (Eyler, Root, & Giles, 1998; Hollis, 2004). According to Eyler et al.

(1998), undergraduates with long-term service-learning experience tended to conceptualize social issues with more sophistication than those with short-term experience.

Astin, et al. (1999) and Vogelgesang & Astin (2000) did seminal longitudinal research with large sample sizes (N = 12,367 & N = 22,236, respectively). The Astin et al. sample combined course-based service with "generic" community-service undergraduates and the authors indicated that many of the undergraduates surveyed were in the sciences. Although neither study detailed the undergraduates' specific perceptions of community partners, they did provide evidence that service learning is a strong predictor of a commitment to promoting the goal of racial understanding and a commitment to community activism, during and after college ($p < .001$). The literature that falls into category one also shows that service learning promotes undergraduate increases in awareness and knowledge of social issues (Astin & Sax, 1998; Batchelder & Root, 1994; Driscoll et al., 1996), capacity to identify and solve community based problems (Eyler et al., 1998; Batchelder & Root, 1994), and belief in the importance of helping others (Mabry, 1998; Marcus et al., 1993; Potthoff et al., 2000; Tsang et al., 2001).

Gains in knowledge of other races and cultures and the social environment that impacts them tends to accompany changes in participants' views of community partners (Ames & Diepstra, 2006; Eyler et al., 1997; Giles, Jr. & Eyler, 1994; Narsavage et al., 2002; Osborn et al., 1998; Potthoff et al., 2000; Rice & Brown, 1998; Steinke et al., 2002). For undergraduates with general college level knowledgeability in a required multicultural community course, Rice and Brown (1998) reported a positive significant change in their perceived understanding of the local community's issues, needs, strengths and capacities (*N* = 64; $p < .01$). Some of those university students had academic knowledge in women's studies and English as a second language. Service learning is predictive of tolerance of others, the ability to understand, and empathize with others' situations, and the ability to remain open to new ideas (Eyler et al., 1997; Narsavage et al., 2002). Eyler et al. used a quasi-experimental design to compare undergraduates in various service-learning venues and courses at 20 different US colleges to non service-learning undergraduates (*N* = 1535; $p < .001$). Narsavage used mixed methods for 79 graduate students in various SL nursing courses in the same program ($p < .0001$). The graduate students worked with the homeless, seniors, public school children, and hospice staff.

Studies in category one provide evidence that working relationships with members of the community allow undergraduates to develop first-hand knowledge that can prompt them to question their basic social presumptions about others different from themselves. Rockquemore and Schaffer (2000) noted three stages of development (shock, normalization, and engagement) for 120 "affluent" sociology and religion undergraduates as they began to ask questions about the causes of the social and economic problems of those with whom they worked. Becoming personally and emotionally engaged with community partners allowed SL undergraduates to gain respect for the people they worked with and to identify societal structures that contributed to their service clients' circumstances (Ames & Diepstra, 2006; Giles, Jr. & Eyler, 1994; Narsavage et al., 2002; Potthoff et al., 2000). Ames & Diepstra found that 73% of 63 undergraduates working with older adults of diverse ethnicities increased their appreciation for factors affecting their clients. Some of them identified and confronted their negative stereotypes about elders. Likewise in a study of 136 preservice teachers in a developmental behavior course, Potthoff et al. (2000) reported that after 50 hours of service, 91% of the undergraduates felt empathy and caring for disadvantaged youth as they developed an understanding of the risk factors affecting behavior and learning. The recognition of their relative position of privilege in the communities they served accompanied the recognition of their pre experience assumptions (Rice & Brown, 1998; Steinke et al., 2002). Giles and Eyler (1994) claimed that SL sociology undergraduates made some positive changes to their ethnic stereotypical views after only 24 hours of service.

A range of assertions has been made for the type of service activity and placement contexts. In a study of 153 undergraduates in various sociology, education, business, psychology, and religion courses, service venues, and durations, Steinke et al. (2002) found that the level of challenge and responsibility of the service activity did not predict positive outcomes. Some of the services that those university students performed involved tutoring, public relations, and fundraising. In contrast, in a study of 96 service-learning and traditional undergraduates from eight disciplines, autonomy at the service site placement predicted prosocial (concern with another's needs) reasoning (Batchelder and Root, 1994). Services performed by the 48 SL undergraduates included assisting at Head Start, tutoring students in literature, leading poetry workshops for seniors and prisoners, implementing an alcohol-abuse program, and investigating environmental issues. Similarly, Potthoff et al. (2000) found that developmental behavior undergraduates with teaching knowledge who were in placements that permitted direct interaction with community partners and those that provided exposure to varied family structures had a more powerful impact on undergraduate preservice teachers' attitudes (warm and caring) toward their clients. In that study, undergraduates did various services that included work with disabled persons and education, recreation, and skill-building assistance for preschool and adolescent students. The undergraduates in the Giles & Eyler (1994) study attributed their positive changes in ethnic stereotyping to their direct involvement with community members.

Others have looked at the reflective component of SL practice as one of the factors that mediate effects on undergraduates. Using qualitative methods, Hollis (2004) compared two service-learning formats in sociology: (a) SL in which the work with disadvantaged youth was closely integrated with a course that used an orientation, critical personal reflections, and discussions that linked the two experiences (structured), and (b) SL in which services were performed without a direct link to content and activities of the same course (unstructured). Service activities included tutoring, and coaching and supervising recreation. The undergraduates in the structured service-learning course expressed beliefs that connected social problems with factors of social structure. Participants in the unstructured course tended to blame the community partners by expressing cultural or individual explanations for social issues.

The results involving the structured SL course are supported by the findings of earlier studies that examined program practices that influenced civic attitudes and prosocial thinking outcomes. Batchelder and Root (1994) found that classroom instruction that integrated reflective course practices was positively related to prosocial reasoning. Likewise in a study of 144 undergraduates from 23 different SL courses, weekly in-class and ongoing and summative written reflections and discussions, and ongoing interaction with faculty and service-site supervisors had a positive effect on attitudes toward responsibility to solve social problems and help others (Mabry, 1998). Moreover, in an analysis of a one-time survey of 1300 undergraduates from 28 institutions, Gray et al. (2000) found that SL undergraduates reported a greater impact on their overall development in current and expected civic affairs and life skills when the service experiences were tightly linked to the course content, undergraduates discussed and reflected on the service in class, and they were trained, supervised, and served over 20 hours per semester. Steinke et al. (2002), however, found that although integrated reflection methods helped undergraduates to appropriate and process information and concepts and to develop spiritually and ethically, they did not predict intellectual development (based on Perry's scheme), or civic engagement for political involvement. The authors noted that the instrument measuring civic engagement was weighted for political associations and might not have adequately assessed other community activist features.

A loss of the belief in their ability to effect social change was found for undergraduate psychology students (Miller, 1997). Similarly, there was no change in personal efficacy for graduate pharmacology students in various service venues (Kearney, 2004). Notably, only the pharmacology students who had direct interaction with the elderly gained the ability to listen to and understand others. Both Miller and Kearney used pre and post survey self reports and quantitative methods of analysis. There was about a 6-year difference in the average ages of the undergraduate and graduate student participants. In contrast, other studies have found that service learning substantially influences undergraduates' beliefs that people can make a difference in community issues and self-efficacy to impact social problems (Astin & Sax, 1998; Giles, Jr. & Eyler, 1994; Rockquemore & Schaffer, 2000). Additionally, Juhn et al. (1999), Kendrick (1996), Osborne, Hammerich, and Hensley (1998), and Narsavage et al. (2002) found that SL undergraduates in nursing, sociology, pharmacology, and graduate nursing students (respectively) reported increased knowledge and confidence in their ability to work with and help people of other races and cultures.

In this service-relationship category where the undergraduate provides a certain expertise and the community provides the access, the majority of the studies claimed to various degrees, a positive influence on the undergraduates' views and knowledge of their community partners. There is evidence that the various SL program components, such as service-placement quality, reflective practices, and quality of integration of course content with service activities can have a strong but inconsistent influence. Victim-blame attribution arose and was sustained when course content and activities were unstructured and poorly integrated with service. Attitudinal outcomes, however, appear to be related, in part, to the quality of the overall program and the instruments used to measure change.

Category Two: Studies Where Community Members and University Students each Provide Certain Expertise to the Service-Learning Relationship

There are 13 studies in this category pertaining to programs in which community members and SL university students each had certain strengths and expertise, and they learned from each other as they worked together. Examples of such programs would be the Elementary Science Education Partners (ESEP) or multicultural education courses that tried to effect holistic social change. University students volunteered to promote a social cause. For all undergraduates in SL courses, general college level knowledgeability is assumed. In certain SL courses more course-specific academic knowledge is also assumed, and when that was the case, this specific knowledge is noted (Table E2, Appendix E). In category two, community members provided their expertise in the form of planning, training, or working with university students and faculty, or giving evaluative feedback. When reported, the college participant race and ethnicity in this category was predominantly European American (mean = 79% for six studies; range = 50% to 100%) and the gender more often female (mean = 75% for six studies; range = 55% to 98%). As in the first service relationship category, the courses in these studies tended to be in the social science- and health-based disciplines.

Eleven studies in this category reported that service learning had, to various degrees, a positive influence on the views or knowledge that undergraduates had of the people they worked with (Barton, 1999; Boyle-Baise & Kilbane, 2000; Boyle-Baise & Sleeter, 2000; Dorfman, Murty, Ingram, & Evans, 2002; Dorfman, Murty, Ingram, Evans, & Power, 2004; Eyler & Giles, 1999; Myers-Lipton, 1996a, 1996b; Nnakwe, 1999; Romack, 2004; Ropers-Huilman et al., 2005; Wade, 1995). In a quasi-experimental study for a 2-year civics program, Myers-Lipton (1996a; 1996b) used multivariate analysis, to compare a SL group with a randomly selected generic-service group and a group of college undergraduates in courses with no service. Using the Modern Racism Scale based on the theory of symbolic racism (McConahay & Hough, 1976), results showed a significantly greater reduction in racism and an increase in concern for social commitment for 225 SL undergraduates after over 200 hours of course-linked domestic and international service. In a smaller quantitative study (*N* = 34), Nnakwe (1999) also found that senior level nutrition and dietetic undergraduates showed an increase in concern for social commitment and activism attitudes related to homelessness and victims of hunger after only five weeks of service. The courses in these two quantitative studies ranged widely in hours of service. Both showed positive findings for social commitment, however, the Myers-Lipton study is statistically more credible due to its longitudinal format and a large sample size.

Ten studies in category two, five using mixed methods and five using qualitative methods, provide insight into the types of views that the SL participants had for their community partners. In a seminal summary of three large cross-institution studies (*N* = 1,535), undergraduates that were surveyed reported that SL influenced their tolerance and challenged their stereotypical views of those they worked with (Eyler & Giles, 1999). Contrary to the findings of Steinke et al. (2002) in category one, the quality of the service placement (level of challenge and responsibility) predicted almost all of the measures of tolerance, stereotype reduction, and positive change in attitude on social issues. Moreover, Eyler and Giles reported that the quantity and quality of reflection is associated with academic learning outcomes for undergraduates that include: (a) deeper understandings and better applications of subject matter, (b) increased knowledge of social agency, (c) increased complexity of problem and solution analysis, and (d) greater use of subject-matter knowledge in analyzing a problem. These findings are analogous to the findings of several studies in category one (Batchelder & Root, 1994; Gray et al., 2000; Mabry, 1998). Furthermore, positive changes in stereotypical views of elders and aging were described for SL undergraduates who held positions of high responsibility and worked on-site with experts to insure program success (Romack, 2004). In an upper division kinesiology and motor development course, SL undergraduates worked with nursing home staff to develop and execute activity and physical therapy plans to assist elders to become more independent and mobile. The category two type of service relationship that supports mutual expertise and learning may be a factor that influences the quality of the service placement and the undergraduate beliefs about their community partners.

Using qualitative methods, three education course studies likewise found that many SL participants challenged their race-, ethnicity- and SES-based assumptions and stereotypes of their partners (Barton, 1999; Boyle-Baise & Kilbane, 2000; Boyle-Baise & Sleeter, 2000). In a study on multicultural science teaching, Barton (1999) used pre and post interviews, focus groups, observations, and journal data to argue that eight master's level preservice teachers learned to question their views of the marginalized members of society after teaching diverse students in a homeless shelter for seven weeks. The preservice teachers in this distinctive SLST study recognized and acknowledged the position of power, relative to the students' background, that the teacher has over the type of knowledge generated and methods used in science instruction. In contrast, Boyle-Baise (1998) reported that although 65 undergraduate preservice teachers in a multiculture teaching course felt more comfortable and willing to teach in culturally diverse classrooms after 20 hours of service, they did not think critically about inequities. Their various service activities included observing and assisting in community centers and churches in low SES and minority neighborhoods. In a later study for the same course, however, 24 undergraduates learned to think more equitably about community partners, change their deficit thinking views, and disrupt their stereotypical views about diverse youth (Boyle-Baise & Kilbane, 2000). In this case study, the shift may reflect an adjustment in course content and placement quality as well as better integration with, and opportunity for, reflective practices such as those found by Eyler & Giles, Jr. (1999) for this category and Batchelder & Root (1994), Hollis (2004), and Mabry (1998) for category one. In the first course, several preservice teachers perceived that the service was disconnected from the course, and some agency directors were found to have actually reinforced deficit views with their negative comments about families. Additionally, Boyle-Baise and Kilbane and Boyle-Baise and Sleeter (2000) found that the type of site placement made a difference relative to the impact of the SL experience on deficit notions and community awareness; undergraduates in placements where they could not observe supportive families and male role models tended to maintain their deficit type beliefs. This result is similar to the category one finding of a more powerful impact on the views of preservice teachers in who were in interactive placements with exposure to families (Potthoff et al., 2000).

Wade (1995) made a similar claim for the strong positive influence of direct interaction. In a study where 21% of the social studies preservice teachers were involved in interactive activities such as tutoring, compared to 79% who worked alone on projects such as recycling (N = 41), 82% of the undergraduates felt that they were able to effect social change. While these findings for preservice teachers substantiate the research findings of Potthoff et al. (2000), other results of the study were uneven. Although many of the preservice teachers reported they had strong personal connections and believed they increased their knowledge of others (72% and 67%, respectively), far fewer developed knowledge of social structures and concern for social issues, and dispelled assumptions they had for their partners (28 % and 19%, respectively). Likewise, Boyle-Baise and Sleeter (2000) found that most preservice teachers with multiculture knowledge partially changed their deficit thinking views and some maintained them, tending to blame the parents for the problems of the children they worked with. After 20 to 50 hours of service (N = 117), the Midwest undergraduates gained knowledge about social, cultural and economic factors affecting their clients, yet were unlikely to recognize systemic inequalities. The undergraduates with previous community service experience, however, more often made the connection between social issues and systemic social factors than those with only one semester experience with service learning.

These mixed patterns continue in health- and science-course research involving overall attitudes toward low SES elders. In a study using mixed methods, Dorfman et al., 2002 found more positive attitudes for 13 gerontology undergraduates compared to undergraduates in the same course without the 16-hour service component. The undergraduates, with knowledge in the aging process, science, and sociology, visited elders in nursing and assisted living homes, and took the seniors' oral histories. In a latter study (Dorfman et al., 2004) on five SL cohorts (N = 59) for the same course, only two cohorts showed a significant positive change in attitude toward the elderly and one was marginally significant (cohort 1 $p < .001$; cohort 2 $p < .10$). The authors suggested that programmatic and placement factors, such as less interactive older clients, and observations of negative things at the nursing home may have influenced the results. As noted, the evidence that the quality of the placement promotes changes in undergraduate views of those with whom they work is supported by other research (Eyler & Giles, 1999; Romack, 2004).

In this service-relationship category where community members and SL undergraduates each had expertise and they learned from each other, the majority of the studies reflect the claims of those in category one to various degrees. That is, that service learning had a positive influence on the undergraduates' views and knowledge of their community partners, a reduction in stereotypical and deficit views, racism, and an increase in tolerance and social commitment. Significant program components included the type of service activity, degree and length of interaction with clients, quality of integration of course content with service, and placement quality. Nonetheless, the changeable yet resistant nature of deficit thinking beliefs and victim blaming was evident when undergraduates' direct interaction with clients was limited to one academic semester compared to those who had more experience with community SL. This finding is different from the blame attribution in category one that was related to a service-learning course design in which service was not linked to classroom activities and course objectives. It is not, however, an absolutely clear relationship. As seen in a few studies, even when the course is integrated with the service experience, some participants who perceive they are able to effect and value positive social change, may not recognize systemic social inequalities and tend to maintain part of their deficit views.

Service activities and the mix of participant experience with the efficacy of reflective practices are considerable variables that can affect learning. In this category, there is strong empirical evidence that service learning positively impacted the beliefs of college participants who performed challenging and responsible services such as physically mobilizing elders, teaching multiculture science to homeless children, and helping the hungry generate ways to feed themselves. Arguably, category two SL programs that support mutual expertise and collaboration toward service and course objectives are better organized to expedite that process.

Category Three: Studies Where Community Members Provide Certain Expertise to the Service-Learning Relationship

There are five studies in this category pertaining to programs in which community members had a certain target expertise and SL undergraduates learned from them. Again, for all undergraduates in SL courses, general college level knowledgeability is assumed. In certain SL courses more course-specific academic knowledge is also assumed, and when that was the case, this specific knowledge is noted (Table E3, Appendix E). In category three, community members provided their expertise in the form of planning, training, or working with undergraduates, or giving evaluative feedback. Only one study in this category reported on the race and ethnicity of the undergraduate participants, which was 88% European American (Jones & Abes, 2003). As in the previous service-relationship categories, the participant gender was primarily female (mean = 85% for three studies; range = 75% to 94%). Two studies used quantitative methods (Bringle & Kremer, 1993; Reed, Jernstedt, Hawley, Reber, & DuBois, 2005) and one study used mixed methods (Green & Diehm, 1995) to measure the beliefs or attitudes of the service-learning participants. One study in psychology used mixed methods but focused on undergraduate grades and conceptual skills (Strage, 2000). Another investigation used case study methods to detail the undergraduates' expressed beliefs (Jones & Abes, 2003).

More so than in categories one and two, the degree of change in attitude toward community partners is mixed for the studies in category three. In a quantitative comparison of three psychology courses on aging (service learning vs. experiential seminar vs. no service), Bringle and Kremer (1993) found that after as few as six to eight hours of visitations with the elderly (some home-bound), undergraduates had significantly more positive attitudes toward African American seniors and gained knowledge and understanding of the culture and community service systems compared to those who did no service at all ($N = 44$; $p < .05$). In this program, community agents trained undergraduates, read their reports, and evaluated the program. No real difference was found, however, between the service-learning group (eight one-hour visits) and an experiential seminar group (two visits for three hours each). Apparently both psychology course formats with service shared many content and structural components, but it is difficult to speculate about what effect, if any, this had on the undergraduates' beliefs. As in the category-one study by Astin and Sax (1998), generic service also had a positive influence on undergraduate development. It is of interest to note that Eyler and Giles (1999) claimed that reflective practices of SL promote undergraduates to move beyond the immediate experience of generic service. In their study (category two), interviews revealed that SL undergraduates were able to link and apply personal and academic gains to their own life compared to the more limited personal and interpersonal growth acknowledged by undergraduates with non academically based or generic service experience.

The type of placement was a factor involving the shift of undergraduate attitudes in a study on education-policy undergraduates who were learning about HIV/AIDS and its prevention (Jones & Abes, 2003). The community agents trained, worked with and assisted the undergraduates with their presentations. They also gave evaluative and formative feedback on the program and the undergraduate volunteers. Case-study findings showed that all of the college participants gained knowledge and understanding of the disease and social factors affecting HIV/AIDS victims, but only those who had direct interactions recognized and challenged their own preconceived attitudes and stereotypes. The volunteers, who simply prepared and packaged meals without any face-to-face interaction compared to those who delivered meals and visited with HIV/AIDS victims, not only retained their stereotypical beliefs, but also blamed the sick for their condition. This is the first study in this review where victim blaming is tied to the lack of direct interaction with community clients. Those undergraduates who interacted with the clients in their homes or at the non-profit organization envisioned how they themselves could easily become victims of the syndrome.

In two other studies involving perceptions about the elderly, the duration of service and the opportunity for reflective practices was limited. After just 4 hours visiting seniors at a nursing home, a survey of 40 SL undergraduates in a junior level occupational therapy course showed that a reduction of stereotypical views was not statistically significant, $p = .237$ (Greene & Diehm, 1995). Fifty percent of those undergraduates, however, wrote that they believed they had reduced their stereotypical images of elders. In that program, the community agents paired the undergraduates with individual seniors and supervised them. The seniors taught the undergraduates about themselves and gave evaluative feedback. Although the undergraduates' reflection was limited to weekly journal writing, the perception that the elders' contributed to the undergraduates' education was significantly greater ($N = 11$; $p = .04$) for those who received written feedback from professors. Similarly, Reed et al. (2005) found that although SL psychology undergraduates ($N = 14$) reported that they were more comfortable speaking with a dying person after just two to four hour visitations ($df = 13$, t = 2.19, $p = .024$), they experienced no change in their sense of social responsibility ($df = 13$, $t = -0.63$, $p = .27$). It appears that the undergraduates were mostly observing institutionalized people who were near the end of life to apply course concepts about the learning process. Two post visitation sessions were used as the course reflective practices, one each facilitated by the care provider and the course instructor. The findings in these two studies strengthen the claim by other research that the quality of reflective practices and duration of service are important factors affecting the beliefs of undergraduates.

Of the three service-relationship categories, the findings in the studies in category three, where community members had a certain expertise and the undergraduates learned from them, reflect the least amount of change. This may be influenced in part by the more passive nature of the service relationship compared to categories one and two. Although most of the studies found that the SL undergraduates gained more subject knowledge, the results indicate that significant reductions of stereotypical views or gains in social responsibility were less prevalent. In one study, the recognition of their own stereotypical views arose only for those with direct client interaction. Blame attribution arose for other undergraduates when they had no direct interaction with their community clients. This independent variable related to blame attribution is different for the category one undergraduates in an unstructured service-learning course and the undergraduates in category two who had direct interaction with clients yet only softened their deficit views after one semester. In category three, non interactive and observational or more passive types of service, and limited service duration as well as reflective practices may be identified as probable factors involving findings of little or no change for some attitudes. As in categories one and two, the research results imply that the type, degree, and duration of interaction, and how meaning is made of it (as beliefs reflected on, discussed, and negotiated) are relevant factors that influence changes that undergraduates make in their attitudes about others.

Summary: Service-Relationship Categories

In each of the service-relationship categories, the research on social attitudes showed that service learning can positively influence the views of the participants toward their community partners. Highly significant findings based on large sample sizes predicted increased tolerance, empathy, and openness to new ideas. Findings that did not support the positive impacts of service learning may be explained, in part, by program and placement factors such as the type of service activity, level of responsibility involving community partners, and degree of service relevancy and integration with course content through intensive reflection (Barton, 1999; Eyler & Giles, 1999).

There is empirical evidence in categories one, two, and three that placements with face-to-face interactions more powerfully expedited undergraduates’ recognition and confrontation of negative assumptions about community partners (Mabry, 1998;

Boyle-Baise & Kilbane, 2000; Jones & Abes, 2003; Potthoff et al., 2000; Wade, 1995). Non interactive or solitary activities did not appear to assist undergraduates to connect social issues with the people affected by them. Moreover, ineffectively challenged views were associated with a tendency to blame individuals or their culture for social ills (Boyle- Baise & Kilbane, 2000; Boyle- Baise & Sleeter, 2000; Hollis, 2004; Jones & Abes, 2003).

Additionally, in all three service-relationship categories, the quality of reflection methods and integration of course content with service were found to be influential factors affecting attitudinal changes (Batchelder & Root, 1994; Hollis, 2004; Eyler & Giles, 1999; Gray et al., 2000; Greene & Diehm, 1995; Mabry, 1998). Although undergraduates' shift in views of the people they worked with has been claimed after one semester and with as little as four hours of service, there is stronger evidence that undergraduates with longer and previous cross-cultural service and service learning experience show greater change in attitudes about community participation and community members (Astin & Sax, 1998; Boyle-Baise & Sleeter, 2000; Eyler & Giles, 1999; Mabry, 1998; Myers-Lipton, 1996a).

Studies in categories one and two--the undergraduates provided a certain expertise, and both the community members and SL undergraduates each had expertise--reported evidence both pro (Batchelder & Root, 1994; Eyler &Giles, 1999; Romack, 2004) and con (Steinke et al., 2002) that the level of challenge and responsibility of the service placement influences greater positive outcomes in undergraduate change for attitude on social issues. However, the bulk of the evidence supports the expectation that direct and prolonged interaction with community members within the community setting can provide the SL undergraduate with lived experiences that engage and help them to gain knowledge about their partners and the social factors affecting them. The quality of the service placement has an additional meaning: When the activities are interactive, the type of people, e.g., family and gender role models in typical social contexts such as churches, can expedite a shift in attitudes about community partners. These findings were presented by several of the studies in categories one and two and reflect the strength of qualitative research methods to pinpoint important factors affecting the results (Boyle-Baise & Kilbane, 2000; Boyle-Baise & Sleeter, 2000; Potthoff et al., 2000). As a result of service learning, studies in categories one and two noted the university participants’ recognition of their relative position of advantage in the communities they served (Barton, 1999; Eyler & Giles, 1999; Rice & Brown, 1998; Steinke et al., 2002). Nevertheless, there was some evidence to the contrary because some undergraduates did not understand, or only poorly understood the causal complexities social issues (Boyle-Baise, 1998; Boyle-Baise & Kilbane, 2000; Boyle-Baise & Sleeter, 2000). With the exception of one study (Miller, 1997), SL enhanced the social self-efficacy beliefs of university participants with respect to the ability to help mitigate social issues (Astin & Sax, 1998, Boyle-Baise & Sleeter, 2000; Eyler & Giles, 1999; Giles, Jr. & Eyler, 1994; Kendrick, 1996; Osborn et al., 1998; Narsavage et al., 2002; Wade, 1995).

Not well represented in this body of literature are studies involving service-learning courses in the non-health related sciences. The bulk of the available studies of this type tend to focus on the success of the service project, or product and discipline specific skills and knowledge gained by the undergraduates. Clearly, more information is needed on science undergraduate attitudes in service-learning contexts to help colleges prepare them to be science practitioners who can work with people unfamiliar to themselves.

The process of breaking the SL literature into service-relationship categories, although in no way definitive, provides a new perspective on the empirical findings in this field. Positive change in undergraduate beliefs about their community partners is more frequent in categories one and two where the undergraduates appear to have more opportunity to practice their skills and apply their expertise toward social change. These findings, however, leave us with questions about the details of the service-learning undergraduates' beliefs. The qualitative and mixed method studies reviewed here provide some insight into actual beliefs expressed at the end of the SL courses. Except for the work of Rockquemore and Schaffer (2000), however, there is little information on the sequence of views over time. The need to triangulate observational data from undergraduates in field placements with the various self-report sources remains. As noted by Eyler (2002b), rich descriptions of what the undergraduate actually experiences will lessen the gap between the real impact of field-based learning and what the researchers speculate is happening. Boyle-Baise (1998) called for research that includes systematic observational data. For these reasons, an in depth and longitudinal examination of the progressive expressions of beliefs of individuals whose behavior is observed in similar service-learning contexts will be a significant contribution to the process of perspective change.

The use of the term "stereotypical views" is most commonly applied in the service-learning literature to describe the early views of undergraduates regarding their diverse community partners. The term “stereotype,” a form of oversimplified and often formulaic belief about a person or group of people, is usually vague as to meaning and historical development. In much of the SL literature concerned with change in participant views of minority community partners (e.g., Barton, 1999; Giles & Eyler, 1994; Greene & Diehm, 1995; Kahne & Westheimer, 1996; Myers-Lipton, 1996a; Rice & Brown, 1998) a sense of otherness is broadly defined. Terminology such as “negative stereotyping, negative and fearful expectations, blame attribution, assumptions, and racism toward community partners” is subsumed in this dissertation in terms of the deficit thinking model.

The attribution of blame, (i.e., by teachers, administrators, and society members), for the academic underachievement of low-SES students who are from non dominant sociocultural and linguistic backgrounds to internal deficiencies has been documented and discussed (Delpit, 1995; Garcia & Guerra, 2004; Valencia, 1997). Related research shows that preservice teachers’ personal and professional beliefs about diversity are significantly associated (Pohan, 1996). Although empirical evidence provides a link between teacher beliefs, school practices, and student performances (Agne, Greenwood, & Miller, 1994; Garcia & Guerra, 2004; Irvine & York, 1993; Vasquez, 1988), there are few studies like Barton’s that have provided insight into community practices that influence science educators to develop openness to new ideas and perspectives.

The issue of deficit thinking has deep roots that were lengthened by the social and educational research communities predominantly in the 1930s through the 1970s. In an effort to find solutions to social problems, social science perspectives and practices regarding African American families and children were influenced by the theoretical frameworks of the Chicago School of Sociology, University of Chicago (Slaughter & McWorter, 1985). In the 1930s, researchers such as Franklin Frazier compared African Americans, whose families had migrated from of the South to escape economic and political subjugation, to the European American middle class norm. Inclinations to view African American families as weak and dysfunctional were reinforced by the Moynihan Report (1965) to the U. S. government. Although Oscar Lewis (1966) used the term “the culture of poverty” as a positive conceptual model for a type of Western subculture, the Moynihan Report helped to propagate the idea of a culture of poverty in African American communities as a self-perpetuated cyclic process that deprived children of educational resources. It reinforced the notion that African American students’ intelligence was tied to social class.

Mainstream developmentalists promoted this deficit thinking model supported by proponents of hereditary genetic deficiencies and environmentalists who suggested that African American children do poorly in school because they lack cognitive, linguistic, motivational, and social competencies due to distinct child-rearing practices, as compared to European American children (Ogbu, 1985). African American children and adults were considered impaired by social and economic conditions and in need of resocialization by, and assimilation into, mainstream norms and ethos (Bronfenbrenner, 1985). While ignoring the systemic forms of inequality that promote poverty, the perception of poor African American students was that they thought and behaved in problematic ways compared to middle-class America. Not until the 1970s did researchers begin to challenge deficit-oriented theories. Over thirty years later, Ng and

Rury (2006), and Valencia, Valenzuela, Sloan, and Foley (2001) argue that deficit thinking is an ongoing and real issue. As a result, social and educational programs, e.g., high-stakes testing, that are informed by this pejorative research tradition have contributed to a lingering legacy of misinformed perspectives that are blind to the diverse cultural and situational nature of learning.

Changes in attitudes and beliefs appear to be related to the combined characteristics of the entire service-learning experience, which subsume the three service-relationship categories (the undergraduate provides a certain expertise; the community members and SL undergraduates each had expertise; the community members had a certain expertise). Although the service relationship is a worthy perspective to take for future research, other factors such as the variation in treatment across these studies, multiplicity of instruments used to measure change, and the thin descriptions of course and service activity in most of the quantitative and mixed method studies make it difficult to categorize findings. Notwithstanding, there is empirical evidence that the nature of the service activity such as the degree of interaction (face-to-face vs. solitary), level of responsibility, as well as course relevant service integrated with content and intensive reflection influence undergraduate belief changes. What the literature does not provide is a rich description of sequential views that are triangulated with field observations. Although service learning is a pedagogy with the potential to provide undergraduates opportunities to develop many of the competencies and social attitudes needed by potential scientists and engineers, previous research infrequently focused on science undergraduates relative to science and society.

Using qualitative case study methods in this investigation, I help address gaps in the literature by focusing on science undergraduates in long-term placements of responsibility within the public school community. My research provides a longitudinal and in-depth examination of four science undergraduates' expressed beliefs as they progress through two semesters of a science teaching experience integrated with a science-related academic course (ESEP.) Instead of the presentation of beliefs expressed after the SL experience, I provide a sequential and comparative look at beliefs using multiple undergraduate interviews, journals, essays, focus groups, and community partner interviews and relate them to field practices observed in the course of the experience.

CHAPTER 3. METHOD

Research Questions

The research questions for this dissertation were generated by the emergent themes from data collected in a larger longitudinal study on the Elementary Science Education Partners (ESEP) undergraduate- and teacher-partnership experience. From early in the fall academic term of 2000 through the end of the spring term of 2001, I examined four cases composed of undergraduate- and elementary school teacher-partnerships. In that study, the data that I targeted included the undergraduates' expressions of beliefs about their motivation to serve as service learning in science teaching (SLST) partners, the general nature of their teaching experience, how their teacher partner had changed, how their elementary school students had changed, and the changes they saw in themselves. I did not explicitly ask for the undergraduate beliefs about the abilities of their students to learn science or the social, cultural and economic factors affecting student learning. However, in response to the questions: what evidence do you have that your students are learning science; what is the greatest barrier/help to learning science; how has that knowledge affected your understanding of them as learners; and what did you learn about your student's lives outside of school?, the respondents repeatedly and passionately referred to those abilities and factors throughout the study. Once the emergent themes became apparent, I set the new research questions for this study. The data regarding expressions of beliefs about student abilities and influential factors offers a unique record of change in deficit thinking views during a SLST experience. For this reason, I believe the thematic data and how the undergraduate partners' expressions changed over two consecutive academic semesters warrants the research foci of this dissertation.

Within the context of the undergraduates' SLST experience, I investigated the following research questions:

1. In what way did the undergraduate's expressions of beliefs about the ability of their elementary school students to learn science change during the course of the SLST partnership experience?
2. In what way did the undergraduate's expressions of beliefs about social, cultural and economic factors that affect their elementary school students' learning change during the course of the SLST partnership experience?

Definition of Terms

For the purposes of this study, I will use (1) long-term service learning in science teaching (SLST) partnership, (2) novice undergraduate science-partners, and (3) novice teacher-partners in the context of ESEP with the following understandings as to their meanings:

The long-term service learning in science teaching (SLST) partnership involved regular and formal contact between the undergraduate case participant who was taking the service-learning course in science teaching and a given elementary school teacher. Science teaching was incorporated into the normal classroom curriculum between the hours of 8:30 a.m. and 2:30 p.m. for a minimum of three hours per week for 22 weeks of two consecutive college semesters. This is equivalent to 66 hours or more of formal contact per year with a teacher and her or his class of elementary school students.

The undergraduate case participants in this study are alternately referred to as undergraduate science-partners, college science-partners, case participants, or when the meaning will be clear, just undergraduates. They had no previous SLST experience at the start of this study, and were SLST "novices." They taught science to elementary school students and modeled science teaching methods and scientist practitioners for both elementary school students and teachers. They collaborated with teachers in elementary science instruction. Throughout this study, I refer to elementary school teacher participants without previous science partnership-experience as novice teacher-partners. I also allude to them as teachers, teacher partners or teaching partners when it is obvious they are the same novice participants. I refer to the elementary school students associated with the study as students. (In their own words, the undergraduates and teacher partners often call the students "children.") Students are partners in the sense that they are associated with the undergraduates and teachers, but not in the sense that they have equal status in the relationship. My focus here is solely on the undergraduate science-partner experience.

The attitude toward science refers to a feeling or perspective based on experience or knowledge of a particular area of concern, e.g., with regard to science, (Webster's Revised Unabridged Dictionary, 1998), and involves the field of science, scientists and performing science (Lederman, Abd-El-Khalick, Bell, & Schwartz, 2002). In the context of a science lesson, a positive attitude toward science can include enthusiastic behavior or verbalized science descriptors such as "fun, cool, exciting, helping, or interesting." Likewise, a negative attitude toward science can include unenthusiastic behavior or verbalized science descriptors such as "boring, creepy, icky, scary, or ugly." A neutral attitude portrays no positive or negative behaviors or expressions toward science, scientists, or the practice of science.

According to Lederman, et al. (2002), the nature of science "… refers to the epistemology and sociology of science, science as a way of knowing, or the values and beliefs inherent to scientific knowledge and its development" (p. 498). The nature of science includes characteristics of the way scientific knowledge is derived some of which are: (a) there are various numbers and combinations of steps in investigation, (b) all scientific knowledge is subject to change, (c) science must be supported by empirical evidence and creative interpretation by scientists, (d) science stresses objectivity, but is necessarily subjective to some degree, and (e) science is testable (Grega & Peters, 1998).

For each lesson presented by the undergraduate science-partner and teacher partner, I observed and documented the teaching style, science lesson content, and scientific methodology guided by the definitions summarized below. I based the operational definitions of teaching style, lesson content accuracy, and general response of students on my own experience in science and teaching. The definition of scientific methodology was based on my own experience in science and teaching, and on the nature of science definition given here.

In this study, there are four lesson-accuracy levels. At level one, the lesson content is completely inaccurate and misinforming. Level two is a mostly inaccurate lesson that contains some accurate information, but the content can clearly be misleading. Level three is a mostly accurate lesson that contains mostly accurate information, but some relationships and applications of information can be misleading.

Level four is a highly accurate science lesson that contains no whole or partial misconceptions in an area of science. It is related to real-world and everyday events and applications. Exceptions and alternate interpretations are identified in context.

In this study, there are three levels that pertain to the elements of a science lesson relative to inquiry. At level one, the scientific method is presented as a finite and rote set of procedures with a definite beginning and ending. At level two, the scientific methods include the use of the some or all of the processes skills of inquiry but consideration of the nature of science is absent or de-emphasized. At level three, the scientific methods include a consideration of the nature of science and use of all or some of the following process skills of inquiry: posing questions, posing hypotheses, observation, classification, measurement, tool use, communication of results, analysis, inference, explanation, experimentation, and repetition.

In this study, I define three student engagement levels. At level one, "not engaged disruptive," the majority of students in a disruptive class are not engaged in the lesson. Student behaviors are distracting and not lesson related. At level two, "not engaged but not disruptive," a majority of the students are quietly off task and may be involved in activities like staring out the window or doodling. At level three, "engaged cooperative," a majority of students are involved and focused on the science lesson activities and questions. They can be talking with each other, moving about, or both. Most students show signs of pleasure in an enthusiastic class, e.g., students smile, laugh, and talk with one another or the teacher or undergraduate science-partner regarding the lesson subject or activities or both subject and activities.

Setting and Demographics

Public Schools

In this study, long-term science partnerships took place within four inner-city public elementary-school classrooms. The four elementary schools were located within a large school district that I call the Southern Public Schools (SPS) in a Southern capital city (Appendix F). I gave the schools the pseudonyms Crest, Peak, Ridge, and Summit. School building conditions ranged from worn to recently remodeled. At the time of data collection, the elementary students from Crest, Peak, and Ridge were 100% African American, the majority of whom came from families of lower socioeconomic status (SES) as determined by the percentage of students that qualified for free or reduced-price lunch (99%, 82%, and 96%, respectively). The students from Summit Elementary School were 1% Native American, 1% Asian, 70% African American, 2% Latino, 2% other, and 24% European American. Seventy-eight percent of the Summit students qualified for free or reduced lunch. At the time, the SPS recommended maximum class size was 18 students. On any given day, science class numbers fluctuated as a result of absences and special courses that some students attended. The teacher population of all the SPS elementary schools was predominantly African American and female.

Three of the elementary schools used external electronic door locks and video cameras for student, teacher, and staff security. Summit Elementary was never remodeled for security because it was scheduled to close the following year. The neighborhoods surrounding the schools varied. Typical nearby community facilities included a city park, an interstate freeway, and small businesses such as package stores and gas stations. Other community structures included low-income apartment developments and middle-class housing.

University Campus

The participant undergraduates attended Emory University, a private southern research I university. At the time of the data collection, Emory's undergraduate student body was 0.2% Native American or Alaska Native, 15.4% Asian or Pacific Islander, 8.7% African American, 3.2% Latino, 67.3% European American, 3.4% other U. S. citizens, and 1.8% foreign or non-resident alien. More than one quarter of the undergraduates were in-state residents (Appendix G). Middle- and upper-income apartments and houses, small businesses, shopping centers, radio and fire stations, and federal research buildings are adjacent to the campus. A hospital, health clinics and four professional schools are located on the campus.

A relative economic index for the undergraduate participants in this study can be taken from the freshmen surveys for the years 1998 and 1999 when they entered the university. In 1998, Emory University found that 30% of entering freshmen estimated their parental income to be more than $200,000 compared to 19% of freshmen at similar highly selective universities. In that year, both mothers and fathers of Emory freshmen were more likely to have graduate degrees than freshman parents at peer institutions (fathers 58% vs. 51%, mothers 39% vs. 33%). Additionally, 48% of Emory freshman reported having no concern about financing their education compared to 39% at analogous institutions (Frost & Teodorescu, 1998). The values for 1999 were similar (Teodorescu & Schaus, 1999). The senior and junior class participants in this study were respectively a part of the 1998 and 1999 cohorts of entering freshmen.

Participant Selection

ESEP Course Particulars

Typically, an average of 40 undergraduate science-partners were accepted into the Emory ESEP course each fall term; about 50% were returning partners from the previous academic year(s). To qualify for the course, undergraduate applicants were required to have had at least three college level science courses in which they received a grade of C or higher. This requirement set a baseline for the minimum of science experience an undergraduate science-partner should have. Additionally, the science partners needed to have an overall grade point average of 2.5 (on a 4-point scale) or higher and officially register for the two-credit course.

In the fall term of 2000, there were 38 ESEP undergraduates (22 female and 16 male). Of the female undergraduates, three were sophomores, seven were juniors, and 12 were seniors. Of the male undergraduates, two were sophomores, six were juniors, and eight were seniors. Forty-five percent of the fall term undergraduates were returning partners. Similarly in the spring term of 2001, there were 43 ESEP course undergraduates (26 female and 17 male). Of the female undergraduates, one was a freshman, four were sophomores, eight were juniors, and 13 were seniors. Of the male undergraduates, four were sophomores, five were juniors, and eight were seniors. Up from the fall term, 54% of the spring term undergraduates were returning partners.

Coursework involved at least 12 hours of preservice and inservice training, 11 one-hour reflective focus-group meetings, a weekly on-line reflective journal, a reflective experience summary at the end of each academic term, and a minimum of 33 hours of science teaching in the schools each semester. Prior to team teaching, the undergraduates were schooled in inquiry-based science pedagogy, the science-kit curriculum for their grade, and diversity issues (Appendix H). University faculty and staff, ESEP Student Council members, and local elementary school teacher-leaders helped to facilitate the various preservice, inservice, and reflective focus-group sessions.

In the guided weekly reflective sessions, undergraduates discussed inquiry-science teaching methods, assigned readings, their classroom culture observations, what they brought to the elementary school classroom, their opinions on how their presence affected student learning, and what they learned and gained from the experience (Appendix I). In addition to the time spent on coursework, undergraduate science-partners spent about two hours per week commuting to their elementary school sites.

Undergraduate and Teacher Participants

As the researcher, I did not influence study-participant selection. I responded to a combination of factors that determined the novice partnerships for this study. Those factors were the restrictions on my access to the schools and teachers that were imposed by the school system, my preference for novice SLST undergraduate- and teacher-partnerships, and convenience. The public school system mandated that each case study be conducted at a different school to minimize disruptions. They provided me with a list of 18 schools in low-income neighborhoods. First-time teacher-partner applications from those 18 schools constituted the source of my available teacher participants. Once the undergraduate science partners selected their teacher partner, I took the first volunteers for grades one through five as they walked in the door to their first reflection session.

I required that teacher participants demonstrate an interest in science teaching by attending a one-hour orientation program and applying to work with an undergraduate science-partner. The mandatory one-hour interactive workshop involved the expectations and responsibilities of an ESEP science partnership (Appendix H). Teachers also gained information on the ESEP partnership from presentations at school faculty meetings, and conversations with other teachers, school administrators, and the ESEP staff. The program characteristics and preparations described for undergraduates and teachers who participated in the ESEP science-partnership were consistent throughout the tenure of the program.

On the partnership application, I asked teachers to provide information about their interest and background in science, and to indicate the time and days that they wanted to partner in science instruction with a science undergraduate. I did not require that the teacher partner have any science background in order to post her or his application.

In the initial preservice session, ESEP undergraduates self-selected a teacher partner who taught science during a time that worked well with the undergraduate's class schedule. The selection of a teacher partner determined the school and grade at which the undergraduate taught. Of those 18 novice teacher-partners, the novice undergraduate-partners chose seven. Once the undergraduates selected their teacher partners, there were seven novice partnerships potentially available to this study. The pool of novice partnerships was typically small because experienced teacher partners, who tended to list more flexible hours, were more attractive to the undergraduates. This made pairings of novice undergraduates with novice teachers less likely than pairings with experienced teachers. At the initial on-campus class, I asked the first arriving novice undergraduates who were partnered with novice teachers to participate in the study.

One novice pair, composed of a novice science undergraduate and a novice elementary school teacher partnering for two consecutive 11-week semesters of science teaching, forms the nucleus for each case. The undergraduate and teacher partner facilitation of science lessons for students in the classroom defined the main activity of each partnership. All of the participants discussed in this study are referred to by pseudonyms.

I collected data from four partnerships, one each teaching in the first, second, third, and fifth grades. Originally, there was a fifth partnership, composed of an African American female undergraduate and an African American female teacher of the fourth grade. I eliminated the data obtained from that case when the teacher partner permanently left the school system and the undergraduate partner withdrew from the course about midway through the first semester (see case and source summary Appendix J, Tables J1 for undergraduates, J2 for teachers, and J3 for classroom demographics).

Cases

First Grade Class

Anna is the undergraduate participant who taught in a first-grade classroom. She is a European American female who was a 22-year-old senior and psychology major at the time of this study. She described herself as a religious Christian Baptist from a middle-class background with traditional Christian values. She had graduated from a private Christian high school in the South. Her father retired as an engineer and sold real estate in his second career. Her mother was a high school teacher and athletics coach in the summer months. Anna liked sports and belonged to a sorority at college. She liked children and babysat for income. She also volunteered for her church, a hospital for children, the Jerusalem House (a charity for single homeless men, women, and children who have AIDS), and the Ronald McDonald House (a children's cancer rehabilitation facility). Anna arrived at the participant elementary school to teach at about one o'clock in the afternoon and taught through the end of the school day at 2:30 p.m. After teaching, she stayed to plan with her teacher partner. The class was composed of 13 students (African American (8) and European American (5)). A paraprofessional was present occasionally. Her teaching partner was Ms. Ellen.

Ms. Ellen is the teacher participant in the first grade classroom with Anna. She is a European American female who was approximately 50 years of age at the time of this study. With a master's degree in education, Ms. Ellen taught primary grades for six years prior to the partnership. Before that she was a stay-at-home mother. Ms. Ellen stated that although she liked science, she did not study science in college and did not feel comfortable in teaching science except at the first-grade level. She taught the science content for 30 minutes per day, the timeframe required by her school system. She liked structured teaching methods such as phonics lessons. Ms. Ellen stated that learning to teach inquiry-based science with Anna was an enjoyable way to overcome her concerns about letting the students make their own discoveries.

Second Grade Class

Badra is the undergraduate participant who taught in a second-grade classroom. She is an Asian American female of Pakistani-Indian origins, and was a 20-year-old junior and anthropology major at the time of this study. She described herself as a hardworking, caring, and religious Muslim from a blue-collar immigrant family. Her father took multiple and various jobs to support his family after he immigrated to the United States as a young adult. Her mother took care of the family. By Badra's description, her family lived on a low-class income. She had attended a public high school in the Southeast, a community college and an international university before entering Emory University with a scholarship. Badra had a seven-year history of volunteer work for hospital projects, homeless shelters, her mosque, and an educational tutoring program. She worked with children as well as with adults. Badra arrived at the participant elementary school to teach around 12:45 in the afternoon and stayed until 2:15 p.m. There were 14 students in her class; all of her students were African American. There was no paraprofessional present when she taught. Her teaching partner was Ms. Fran.

Ms. Fran is the teacher participant for the second grade classroom with Badra. She is an African American female and was approximately 30 years of age at the time of this study. She had taught Kindergarten for three years and second grade students for one year. Before that she was a businesswoman. She took basic biology and earth science courses in college, but said that she did not remember the material. Prior to her partnership, Ms. Fran taught science content for 30 minutes per day five days a week. Her lessons included very few "hands-on" methods. She stated that although she did not particularly enjoy science, after her experience with Badra she found it interesting and important. She described her teaching in non science subjects as “strict” and “concrete.” Ms. Fran said her work with Badra helped her to become less strict with the students during science lessons.

Third Grade Class

Chikara is the undergraduate participant who taught in a third grade classroom. He is an Asian American male of Japanese ancestry who was a 20-year-old junior and biology major at the time of this study. He described himself as not religious, from an upper-class family, and a person who values his friends, team sports, working with children, and enjoying life. His father was a medical doctor and his mother a nurse. He attended a private high school in the Northeast and was always on a sporting team. Because he played sports during the school year, Chikara volunteered for hospital projects and worked as a camp counselor for handicapped children in his junior and senior summers. In college, he also volunteered to work at a local hospital for children. In the first semester of ESEP, Chikara partnered with two different teachers and classrooms. In the second semester, he dropped one partnership and continued with the other for the full 22 weeks. Except in one comment when he made a relevant comparison of the two partnerships, all data in this case is derived from comments and observations from the partnership he maintained for 22 weeks. Chikara arrived at the participant elementary school to teach at about one o’clock in the afternoon and stayed until 2:30 p.m. There was an average of 12 students in his class; all of his students were African American. A paraprofessional was often present during science time. His teaching partner was Ms. Gail.

Ms. Gail is the teacher participant in the third grade classroom with Chikara. She is a European American female, and was approximately 30 years of age at the time of this study. She had taught elementary school for nine years. In college, she took the required basic biology and earth science courses. Ms. Gail stated that she liked science but without an undergraduate partner, she taught science mostly from a textbook for an average of 30 minutes per day. She noted that science and social studies were considered topics of the lowest priority by SPS. She said she learned some new lessons by working with Chikara.

Fifth Grade Class

Dawei is the undergraduate participant who taught in a fifth grade classroom. She is an Asian American female of Taiwanese ancestry, and was a 22-year-old senior and chemistry major at the time of this study. She described herself as a compassionate and thoughtful person from a Christian and middle-class immigrant family. Her parents were accountants. They encouraged her to study the Mandarin language on Saturdays. Dawei also studied dance, gymnastics, and music. She attended a high-achieving public high school in a predominantly European American community in the South. As a junior and senior in high school, Dawei intermittently volunteered for various community programs. As an undergraduate, she volunteered for hospital and educational programs on a regular basis. One summer she held a job with an industrial science organization. An accomplished musician, she played violin in the university orchestra for four years. Dawei arrived at the participant elementary school to teach around nine forty-five a.m. and taught two separate classes back-to-back. She usually left the school around 11:00 a.m. There was an average of 22 students in the class I observed. All of Dawei's students were African American. Her teaching partner was Ms. Helen.

Ms. Helen is the teacher participant in the fifth grade classroom with Dawei. She is a European American female, and was approximately 28 years of age at the time of this study. The study year was her first year of teaching for SPS through the Teach for America program. Although Ms. Helen was personally interested in and enthusiastic about science and held a master's degree in geology from Emory University, she preferred to teach non science subjects because those lessons were structured. Ms. Helen always began her daily 45-minute science class with a vocabulary drill and worksheet activity. She also found the time and effort needed for inquiry-based science instruction to be overwhelming. She stated that she did not have a strong background in chemistry and human biology, but learned more about those areas after working with Dawei.

Permissions

Prior to the collection of data, I obtained three forms of permission for this study. First, I obtained permission for the investigation from both the SPS school system and from the individual principals of the schools involved. Second, I secured approval of the study from the Social, Humanist and Behavioral Institutional Review Board at Emory University. Third, I obtained informed consents from each of the individual elementary school teachers and science undergraduates who agreed to participate in my multiple-case study (Appendix K). I explained to the undergraduates that their participation in the study was completely voluntary and they could withdraw at any time without consequence. Each participant signed the letter and received a copy. I retain the originals in my records.

Data Sources

In this study, I used three primary data sources collected during the fall, 2000-spring, 2001 academic year: (1) undergraduate interviews, (2) various undergraduate documents, and (3) classroom teaching observations. I also used two supporting data sources, (1) focus-group discussions, and (2) teacher-partner interviews. The characteristics of these data sources are specific to this study.

Table 1 contains my sources for the data that correspond to beliefs expressed by the undergraduate case participants about the ability of students to learn science and the social, cultural and economic factors that affect student learning. The undergraduate journal and summary documents, and interview transcripts provided substantial information about student ability and factors affecting learning. The undergraduate course applications and my classroom observations informed me indirectly by providing data on the undergraduates' motivations to participate in the partnership and actual practice with the students, respectively. The post-partnership teacher interviews helped me to check the validity of undergraduate statements regarding teaching methods and lesson efficacy. Moreover, they provided insight into teacher perceptions that may have influenced the undergraduates' attitudes about student ability to learn science and factors affecting that ability. I compared these sources to discern potential discrepancies between the various participant self-reports and actual classroom practice.

Table 1
Data Sources for Research Foci

Focus / Data Source	Undergraduate case interviews	Undergraduate case documents	Undergraduate case observ-ations	Undergraduate course application	Teacher partner inter-views	Undergraduate focus group discuss-ions
Ability to learn	√	√	•	•	•	•
Social, cultural, & economic factors	√	√	•	•	•	•

√ = directly informed; • = indirectly informed.

The focus group data allowed me to examine the four case-study undergraduates in the broader context of other SLST undergraduates not in this study. From the comparison, I interpreted how typical the experience and beliefs of my study participants were for the SLST undergraduates as a whole.

Interviews

Using semi-structured protocols, I made four one-on-one interviews with each of the undergraduate partners at the 4th, 11th, 20th, and 23rd weeks of the partnership. Once the partnerships were confirmed, I was able to do the first formal interview. The 11th and 23rd week interviews took place at the end of the fall and spring terms, respectively. The 20th week interview was selected in response to questions generated from my ongoing data review. Multiple interviews allowed me to better follow the process of change in the expressions of undergraduate beliefs. The use of a semi-structured open-question format is appropriate because it allowed me to respond to the emerging views of the participant (Merriam, 1998).

Prior to the start of the interview, I reviewed the purpose of the study with the respondent and emphasized that there were no right or wrong answers. Whenever needed, I used follow-up questions, or probes, to clarify the meaning of the responses. All undergraduate interviews took place on the university campus at a time convenient to the undergraduate partner. At their request, this took place in the ESEP program office. When the partnership was over, I interviewed the teacher partners after school in their classrooms. Each interview lasted approximately 60 minutes. I audio recorded all interviews and described the tone and setting of the interviews in my researcher's journal.

Using the interview protocols, I asked the undergraduates to respond to broad questions about their views of the elementary school students' learning, such as what the undergraduates learned about how their students learn, the students' attitude toward learning science, and how they themselves had changed in response (Appendix L). Two colleagues reviewed each protocol for clarity. To amplify the responses, I probed the undergraduate respondents for details on the emerging themes concerning student learning ability and what they meant by student learning.

I used the interview data to compare the teacher and undergraduate views on undergraduate change and to illuminate classroom practices. The teacher and undergraduate partner responses helped me to clarify the perceived efficacy of the science teaching methods and the partnership experience.

All interviews were transcribed according to set criteria (Appendix M). I compared the transcribed manuscripts to the recorded interviews. I then asked the informants to examine the transcripts and give me insights useful for data interpretation (member check).

Documents

All undergraduates who applied for the ESEP course were asked to write briefly about their desire to become a partner. I used the undergraduate participants' course applications as a supplementary data source. Once accepted, every SLST undergraduate made a weekly entry into an on-line journal and submitted an end-of-term reflective summary as part of the course requirements (Appendix N). The undergraduate participants in this study made 18 to 22 journal entries throughout the year and wrote two end-of-term summaries. I examined and compared all primary and supplementary documents on a case-by-case basis.

Observations

Data from the field activities are thinly represented in the service learning research literature. To contextualize the participants' belief expressions, I collected seven categories of data from eight classroom observations throughout the year, four in the fall and four in the spring terms for each case. The seven categories are: (1) role(s) taken relevant to instruction, (2) attitude toward science, (3) teaching style(s), (4) accuracy of the lesson, (5) elements of the lesson, (6) student engagement level, and (7) student interest level. In this way, I addressed the evolution of the teaching praxis over 22 weeks of the SLST experience. I examined the science content and lesson pedagogy strictly for the each undergraduate partner's contribution and from this made inter-case comparisons. I also examined the data for any association of teaching methods (lesson elements and style) with the undergraduate's expressions of beliefs about the effect of inquiry science teaching methods on student learning. My observation reports included the activities and interactions of the undergraduate, students and teacher during normal science instruction. This type of data extended my understanding of the teaching relationship between the undergraduate participant and students. I recorded my observations in notation and checklist format in order to objectively organize what I observed in the science classroom (Appendix O).

With the teacher's permission, my visits were occasionally unannounced. Unannounced visits allowed me to observe the informal and natural characteristics of the partnership that might have been obscured if the participants planned the lesson with my visit in mind. My role was that of a complete observer; I did not interfere with or participate in classroom instruction or discussions (Merriam, 1998). Inevitably, there was some participant-initiated interaction with me during the lesson. I noted any interactions and circumstances that might have influenced the data.

Focus Group Discussions

To add validity to the internal generalizability of this dissertation, I analyzed a sample of four reflective focus-group discussions after completing all work on the case participants. I selected the focus groups with the greatest number of undergraduate participants and equality of gender. Two groups were recorded during the fall (week 11) and two in the spring (week 22) semester. The undergraduates were different individuals in each sample for a combined total of 20 ESEP college science partners. The case participants were not included in this sample. As part of their reflective work, each ESEP undergraduate participated in 11 hours of weekly one-hour focus-group discussions led by various university faculty, doctoral students, ESEP Student Council members, and ESEP teacher leaders. Composed of both first-time and repeating undergraduate science partners, the goal of the reflective focus groups was to stimulate the undergraduates to think critically about what they were doing in the elementary school classroom, as well as about the potential impact of their work on all program participants including the undergraduates themselves. By the last reflective session, group identity and trust was well established. The focus-group participants had met and interacted regularly with each other throughout the term and on two previous occasions with the moderator Dr. Kathryn Kozaitis, a cultural anthropologist from Georgia State University. The topic of the final focus-group discussion was how the undergraduate partners perceived that they had profoundly changed as a result of their SLST experience.

I audio recorded and transcribed verbatim the moderator and group members' dialogue. For clarification, I assigned a gender and numerical pseudonym to each undergraduate member, e.g., M for male, F for female, #s 1, 2, 3, … and so on. In this way, I was able to determine which of the autonomous undergraduates responded to the various questions.

The moderator asked the undergraduates in each final reflection session to first write down and then speak about their most important impressions and how they most profoundly changed based on their SLST experience. Not everyone addressed each issue. Some people commented often on an issue, others once, and a few not at all. Additional issues besides those relating to the study topics were discussed. The fall sample included 13 undergraduates, six males and seven females, of whom six males and five females spoke to the study topics. The spring sample included 11 undergraduates, five males and six females, of whom four males and five females spoke to the study topics.

Time Schedule

After securing the participants, I began the study early in the fall term with the initial interviews, journal review, and classroom observations. Research was suspended during elementary school and university holidays as well as during the week of elementary school student testing in the spring. I continued the classroom observations through the last day of classes for undergraduates in the spring term, 2001. In May 2001, before the end of public school classes, I completed the post partnership interviews with undergraduates and teachers. After nine months, I ended the data collection for this study.

Data Analysis

Guided by my research questions, I analyzed the interview, document, observation, and focus group data, in depth with data-grounded coding (Boyatzis, 1998; Maxwell, 1996). For each case, my first level of analysis involved category construction and the creation of a code book based on emergent themes (Appendix P). I used *NVivo 2* qualitative research software (QSR International, 2002) to organize, code, and analyze all data sources. I then searched for themes, created memos with text extractions, and recoded. This enabled me to tabulate and review the incidence of specific themes with respect to the data source and timeframe of the study. To examine for change, I reevaluated the coding a third time by extracting statements into matrices for each data source. Throughout the analysis, I checked and rechecked the coding of the raw data for accuracy and consistency.

The quotations that I selected for the findings section, from interviews and documents, best represent all statements for the emergent themes. To provide a context for the perceptions of each undergraduate in the study, I created a summary of the undergraduates' thematic motivations (initial and continuing) to participate (Appendix Q).

To place the case participants' belief expressions in the context of their service-learning field activities, I first used descriptive statistics to reduce each of the observation categories. From the classroom observation form, I first determined the frequency, teaching style, accuracy, lesson elements, student engagement and interest levels of the inquiry-based science lessons taught by the undergraduate participant. I did the same for the undergraduate's attitude toward science. I coded and analyzed my records for the presence of the discrete lesson components, traditional approaches, science methods skills, integration with other subject areas, applications of previous knowledge and skills, and interactive student work. Furthermore, I examined my researcher's notes for conversations and behaviors that may be associated with the undergraduate's perceptions of student ability to learn science. This helped me examine the course of the undergraduate's teaching practices over the first and second semesters for changes in individual behaviors, and similarities and differences between case participants to inform my understanding of their belief statements.

From these data reductions, I wrote my interim reviews and summaries for each case. In my second level of analysis for all data, I looked for clustering and change by charting the findings in a data chronology consisting of the time across the top and the themes along the side. My interpretation of the data was an ongoing process assisted by code definitions that documented the rules for the decisions I made (Miles & Huberman, 1994). I used the themes that emerged to build categories for each case. Finally, I compared all cases for commonalities, patterns, and dissimilarities to contribute to a theory for undergraduate science-partner belief change.

I coded the sample focus group discussions separately for patterns relevant to my study questions and compared the findings to those of the undergraduate case-participants (Schensul, LeCompte, Nastasi, & Borgatti, 1999). An examination of the beliefs expressed on the part of non study SLST undergraduates provide a useful point of reference from which to determine how typical or atypical the four case-study participants are of the larger science-partner group. Due to the consistency of the fall and spring data, I present the findings together.

<u>Reliability and Validity</u>

To establish reliability and validity, I triangulated on the results using a variety of sources, methods, individuals, and settings. The range of my data sources (interviews, classroom observations, focus group discussions, applications, journals, and summary documents) and my comparison of the findings of the four cases from four different grades is a form of validity testing that reduces the risk of chance associations and biases (Maxwell, 1996). It also adds robustness to the findings (Yin, 1993). Furthermore, I referred to a peer examination of a sample of the data, analysis, and interpretation.

To establish internal validity, I compared the interview transcriptions to the audiotapes, and used member checks. Additionally, I asked two colleagues with experience in qualitative data analysis to analyze the eight primary data sources (initial-, mid-, near end-, and post-interviews, and fall, and spring journal and summary documents, or 32,089 total words) for one case participant using my investigator-generated codes based on categories that emerged from my first level of analysis (Table 2). They examined the data for participant references to the ability of the students to learn science, student will and volition to learn science, student difficulties in learning science, and student disability and developmental factors that affect learning. For interrater reliability, I compared the intercoder agreement to the standard of greater than 70% agreement. Considerable consistency is shown in the range of agreement for coders A and B (80 % to 97 %) and for coders A and C (91 % to 98 %) when agreement above 70% is considered necessary for qualitative work (Boyatzis, 1998). To strengthen validity, I asked a colleague to review the data displays and interpret a set of my findings.

Table 2
Sample for Scores and Percent Agreement on Presence of Data (Boyatzis, 1998)

Themes	Total coder A	Total coder B	A & B agree	2(A & B agree)/ A+B	Total coder C	A & C agree	2(A & C agree)/ A+C
Ability	58	50	46	0.85	54	53	0.95
Willingness	61	57	54	0.92	59	58	0.97
Difficulty	54	54	52	0.96	56	54	0.98
Disability	6	4	4	0.80	5	5	0.91
Development	18	18	17	0.97	17	17	0.97

Note. Whole numbers represent the number of comments identified by the scorer that relate to each theme.
The themes used for the intercoder agreement test are defined as: Ability = student ability to learn science; Willingness = student will, or interest and volition to learn science; Difficulty = student difficulties in learning science; Disability = disability as factors that affect students' learning of science; and Development = developmental factors that affect students' learning of science.

As I analyzed the different data, I looked purposefully for contrasts between the cases. Case comparison helped determine any commonalities between cases that may transfer to similar participants in similar settings (Miles & Huberman, 1994). The within program cross-case analysis and the case-by-case comparisons to non study Emory ESEP undergraduates in focus groups allowed me to better assess the typicality of the participants and the explanations I developed to approach a working theory of the transferability or generalizability of the study findings (Krueger & Casey, 2000; Lincoln & Guba, 1989; Maxwell, 1996). As one form of qualitative research validity, the generalizability of these findings is based on my development of a theory that may be applied both internally by me and externally by the receiver of this research for the degree of fit to a second situation (Maxwell, 1992). To strengthen internal validity, my analysis of reflective focus-group discussions for undergraduate partners not in this study allowed me to illuminate how typical the participant undergraduate partners are of other ESEP science undergraduates. Externally, others can use this as a point of reference to compare processes and findings for SLST undergraduates in similar contexts. I suggest beneficial ways in which the research results may be interpreted and utilized in similar settings with comparable participants and SL course characteristics. Most justifiably, these case studies can be used to explain the experience of other science undergraduates in ESEP at Emory.

My indirect questions about student ability and the factors affecting learning permitted candid responses from the undergraduates because they were at liberty to address their most compelling issues. Direct and logical transformations of the research questions often draw uniform, limited, and expected answers from respondents (Maxwell, 1996). In interviews and discussions, undergraduate and teacher partners may have exhibited some agency relative to possible feelings of inadequacy toward their science knowledge or science pedagogy. This is a possibility because the expectation of the partnership is science teaching and scientist modeling. To mitigate potential concerns, I assured them anonymity and designed a wide range of interview questions that allowed flexibility of response. I made it clear that there were no right or wrong answers, nor would anything they did or said impact their academic or professional careers. I made sure that the undergraduates were aware that in my role as ESEP science-partner coordinator, I merely compiled the externally generated components that made up their final course grade. Additionally, they were welcomed to examine their grade records if they had concerns. I believe that my general interview questions and probing offset any type of threat to internal validity such as when respondents withhold information or lie, e.g., giving a politically correct statement (Schensul, Schensul, & LeCompte, 1999).

Threats to internal validity are also addressed by my use of observational data to substantiate statements. Although my presence in the classroom may have initially influenced participant behavior, the undergraduates quickly became absorbed in their work and ignored me due to the multiple demands of classroom teaching. To enhance objectivity, my methodology minimizes researcher involvement with the participants and classroom phenomena (Yin, 1993).

Limitations

I am aware of the researcher's tendency to generalize from too few data (Miles & Huberman, 1994) and pointedly seek to avoid committing that error. My familiarity with the various fields of science, experience with the local teachers' culture, and knowledge of the objectives of the ESEP program prompted me to contrast the program ideals with the actual implementation in the classroom. This study is not, however, a program evaluation. Although I coordinated the undergraduate science-partner component of ESEP Emory, I sought to diminish any influence that I might have had on the case participants. My earlier study of experienced partnerships (Goebel, 2001) may have influenced any expectations that I held for this study. To challenge potential researcher bias, I actively looked for discrepant events and unexpected outcomes in the field and when I interpreted the data.

There are various course characteristics that may have influenced the changes that I found in the beliefs expressed by the undergraduate case participants. The ESEP course was administered and staffed by personnel of various races and ethnicities, who brought perspectives based on their own diverse experiences and who expressed a variety of opinions throughout the course toward social issues. As a part of the ESEP course content, the undergraduates were also asked to read and discuss various documents and publications selected by the faculty and staff regarding social innovation, learning, and inquiry-based science teaching methods. Rather than attempting to isolate from the course the extent to which the elementary school classroom experiences influenced the undergraduates to change their expressed beliefs, in this study I consider the impact of the service learning in science teaching experience as a whole.

The research strategy that I utilized is the foundation of my study findings. As noted, my intention for this study is a contribution to the body of knowledge regarding the effects of community service-learning in science teaching on undergraduate beliefs expressed about society and learning science. As is appropriate for qualitative studies, a goal of this investigation is to raise important questions and issues for future research that might apply to more experimental, quantitative, and large-scale methodologies. A compilation of the findings for the four cases and supportive data from the ESEP undergraduate focus groups follows.

CHAPTER 4. FINDINGS

In this chapter I describe the findings for each case participant. To acquaint the reader with the undergraduate, I first present a summary of the motives that the participant stated were responsible for their involvement in the Elementary Science Education Partners (ESEP) program. I then synopsize the circumstances and actions of the participant in their field praxis as observed during the course of eight classroom visits. To facilitate my data interpretation, I next report the interview and document findings for the four case studies within the specific thematic categories that emerged during the initial data analysis phase. After multiple levels of analysis, these final categories characterize the greatest number of beliefs expressed by the four participants and subsumed some earlier initial categories, such as, “disability” and “development”, that contained too few remarks to be helpful as separate categories in the final analysis.

For research question one--In what way did the undergraduate’s expressions of beliefs about the ability of their elementary school students to learn science change during the course of the service learning in science teaching (SLST) partnership experience?--the common categories that emerged are: (1) student ability to learn science (ability), (2) student will, or interest and volition to learn science (willingness), and (3) student difficulties in learning science (difficulty). For research question two--In what way did the undergraduate’s expressions of beliefs about social, cultural and economic factors that affect their elementary school students’ learning change during the course of the SLST partnership experience?--the process resulted in the following common categories of data: (1) home, community, politics and schools, (2) culture of teaching and learning, (3) SES and student opportunity, (4) comments by the teacher partner, and (5) the undergraduates' views on self change. For each case, I end with a table summarizing the chronology of change in expressed beliefs relative to research questions one and two (Tables 3, 4, 5, and 6). At the end of the chapter, I present the findings for beliefs expressed by the fall and spring undergraduate focus-group discussants. These focus-group discussions provide a sense of the degree of typicality that exists between the beliefs expressed by the case participants as compared with the ESEP undergraduate cohort in general.

Case One: Anna (First Grade Class)

The first case participant was a 21-year-old woman who taught science in a first-grade elementary school classroom during her senior year at the university. Anna taught science with Ms. Ellen for the entire academic year.

Motives

In response to questions regarding the reasons that she elected to participate and stay with ESEP, Anna identified several incentives. Of 94 motivational references, 59% concerned her relationship with the students. Her expressed motives to help students learn science and to gain experience with children were voiced less frequently (approximately 12% and 9%, respectively). Other motives noted were the pride she derived from seeing her students learn, teaching as a break from college, and the opportunity to apply her science knowledge (7%, 6%, and 5% of responses respectively).

Classroom Observations

Anna's lessons covered a range of topics suitable to the first-grade curriculum of Southern Public Schools. The average lesson was 56 minutes long with a range of 32 to

68 minutes. Although early in the fall term Anna assisted her teacher partner more than she led the lessons, she assumed the role of lead teacher for 73 % of the time across the eight lessons that I observed. Ms. Ellen did the majority of the behavior management for the lessons with an average of five interventions per lesson compared to an average of three by Anna. Anna tended to use a combination of teacher- and student-centered teaching styles. Most commonly, she used some inquiry process skills without reference to the nature of science. On two occasions, however, she included elements that explicitly taught the nature of science. As expected for first grade, all eight lessons integrated components from other areas such as language arts. Students were seen to apply previous knowledge in four out of eight lessons and interact with each other throughout one lesson. Anna's first-grade students were always engaged and enthusiastic about the observed science lessons. Anna's attitude toward science was consistently positive and the content of her lessons was usually accurate (Appendix R1).

Anna was prepared for all of the observed science lessons, which indicated a sense of responsibility and care toward the students. She teamed with her teacher partner to move the students through a progression of age-appropriate science activities and discussions. She and her teacher partner consulted with each other weekly to plan lessons that integrated language arts with science skills. In the second lesson that I observed (week seven), Ms. Ellen and Anna discussed the students' abilities and backgrounds before the students came into the classroom. They noted that a few were "smart," but "all" were from "difficult" home environments. One student, they discussed, was in trouble for stealing.

During the eight observations that I made, Anna increased her use of the students' names in whole class and individual conversations. Anna's orientation in the majority of lessons that I observed was to directly answer individual student questions, making her a source of information. She frequently, however, combined this with question and answer discussions to involve all of the students in conversations about science (15 discussions in eight lessons). These mostly involved the direct recall of information and experiences. In the last lessons observed (20^{th} and 22^{nd} weeks), Anna asked a few questions that stimulated them to think more critically about what they learned recently and apply that to what they learned in previous lessons. These involved individual student demonstrations and brief attempts at teamwork. She used positive behavior, such as smiling and positive language about science and student performance. Anna also used the whole class discussions to elicit student knowledge and instruct prior to, during, and after inquiry-based activities. She verbally introduced new material while sitting or kneeling with them. When they were busy at their tables, she took small physical examples around to each of the students. When the object(s) was large, e.g., a terrarium, she called student groups over and rotated groups and individuals so that they could all observe. When she modeled a writing assignment, definition, or procedure, Anna made sure that every student could see her. She encouraged every student to politely voice an opinion or share a creation when they wanted to be heard. She also made a special gift of a guinea pig to the classroom and ultimately to the teacher so that the students could practice care giving.

The students were fond of Anna. They cheered and ran to hug her whenever she came into the classroom. Moreover, during the lessons several students would hug her and tell her about things that they did or liked. Some told her that they loved her. She returned the sentiment. Over the course of the observations, Anna increased her individual contact with more of the students. She supervised their progress and volunteered assistance when needed. Her manner was gentle and careful throughout the partnership. In one case she took the blame for a student's awkward action so that Ms. Ellen would not scold him. During the seventh observation (week twenty), Anna was skillfully engaging the few students that were previously not participating in the lesson.

Anna helped the students in response to their questions and requests. They were comfortable with her. Their questions ranged from how to spell words to why magnets repel each other. During the fifth observation (week seventeen), her explanations were more in line with the level of the students' experience and understanding than were her earlier responses. Two African American students requested more of her attention than any of the others. One was a boy who struggled with most tasks (Darin) and the other was a boy who had a penchant for all things science (Roby). Anna often told Roby how smart he was, but she pointed out both boys' accomplishments to the class. After helping them, she returned her attention to the other students. Her treatment of the students was consistent throughout the lessons that I observed. Anna supported all of the students' participation in science.

Research Question 1: Anna's Perceptions of her Elementary School Students' Ability to Learn Science

Student ability to learn science (ability). During the course of her teaching experience and in 79 out of 204 coded comments, Anna expressed concern with her students' difficulties in learning science. She stated her concerns about the students' abilities and willingness to learn almost as frequently (65 and 61 comments respectively).

As she reflected back on her pre partnership expectations, Anna stated in her final summary that she had believed that the SPS students would be less able to learn than other students she had known. She wrote, “I expected to find poor, lower class, unintelligent, misbehaved, uninterested students…” In the fourth week of her experience, Anna expressed the belief that although a few of her students had some ability to learn science, they started the year below the first-grade norm in skill. This was her first experience with students of low SES in a science-teaching situation. She referenced her previous experiences with children and young students, the expressed opinions of her teacher partner, and the low expectations of the age-appropriate school curricula that she was teaching in support of her belief. Anna was an experienced babysitter and Ronald McDonald House volunteer. During the fall semester, she stated that although some of the students were “bright” or intelligent, most were “less creative than children I have previously encountered at their age.”

Believing that most of her students needed more care than they got at home or at school, Anna initially stated that part of what she provided was individual attention to “build up their self esteem.” She expressed the belief that this helped them to learn. When asked what indication she had that her students were learning science, Anna’s responses included the following type of evidence: (a) correct memory of and depth of thinking about facts and experiments, e.g., “The children seemed to really be into this and even remembered many of the things we had learned in the first session,” (b) relevant questions asked and answers listened to, (c) general degree of engagement in lesson, e.g., "I feel like they have greatly improved in their abilities to complete them [assignments]," (d) skills gained by students, e.g., work cooperatively with each other on science activities; ability to make observations.

In the first semester of her teaching experience, Anna's perspective on student learning in science was based on what she felt she needed to do to encourage the students to perform basic (in her words) "innate" skills or "[What] we were born knowing." She explained, "Well, first it was really hard for me to adjust to them because I didn't realize that they did not know how to observe. Because observing, describing and analyzing are things that we just know how to do."

In her fourth-week interview she said, "But I've had to work around that [lack of basic skills]" and "I can bring in science to give them attention." By the end of the fall term, Anna began to recognize instruction as a process of enabling teacher-student and student-student interactions vs. predominantly teacher-to-student action. She realized that her students' ability to learn science was enhanced when they generated their own questions from observations they had made. In her eleventh-week interview she said,

> … the best that they learn is when they ask questions of me and I feel like that not only does that help them learn but then when I am answering questions, I am answering their questions they actually want to know. So they are listening.

In her post interview, Anna noted that toward the end she learned that her students were able to think critically about what they learned in science when they were asked to work with each other and demonstrate their ideas.

Anna's initial perceptions of her students' inabilities to observe, compare and describe conditions and objects such as, plants, animals, and habitats, she said, particularly concerned her. She referred to this situation 19 times throughout her partnership. As observed, teaching those science skills was the foundation of Anna's effort in the classroom. Student learning difficulties challenged her beliefs about "innate" versus developed abilities. They also stimulated her to think about her science teaching methods. After one term of teaching practice, I observed some change in Anna's thinking about student ability to learn. She seemed to acknowledge that skills are developed when she said,

> So, that's been challenging. It's just strange to go back and go like wait, I didn't know how to observe at one point in my life. And that's very interesting. So, it's very, it's very educational for me how important this stage is for those children. So it's, for me it seems innate… Being able to observe that the desk is brown. Like when you say to them "What color?" they don't know what that means. You have to specifically say, "What color is it? What does it look like? What does it feel like?"

After 22 weeks, Anna wrote that she found the students to be "…sweet, intelligent, and enthusiastic and moderately well disciplined for first graders." Although she continued to maintain that her unique and caring attentions helped to motivate the students to like science, she believed they had become "smarter" and "more capable" of learning science because of her "fun," inquiry-based lessons.

Student will, or interest and volition to learn science (willingness). Initially, Anna expressed the belief that most of her students seemed disinterested and unfocused on learning in all subjects due to her perceptions of their unsupported out-of-school lives. However, after eight weeks Anna stated that she believed that most of her students were willing to learn science and the students' willingness developed from two sources: (1) their enthusiasm for the science lessons and (2) the unique caring relationship she had with them. She maintained this conviction throughout the rest of her tenure as an ESEP science-partner. In her spring summary she wrote, "They differed in their degree of enthusiasm towards learning science, but this reflected a general attitude towards learning in general. As the year and my relationship with the children progressed, they became more and more enthusiastic about our lessons." Student enthusiasm, Anna said, led her to view her effort to prepare and expedite "interesting" and "fun" science lessons to be responsible for the students' willingness to learn science. She maintained this belief through the spring term. Anna wrote in her spring journal, "I have seen firsthand how much my time with the kids has motivated them to learn about science."

Student difficulties in learning science (difficulty). Initially, Anna perceived many of her students as having "low" knowledge and skill levels and attributed this to inadequate parental investment or guardianship. In the first eleven weeks, Anna referred to two boys who, she believed, represented opposite extremes in students' abilities to learn, one she believed to be gifted and another learning disabled. The range in their performances caused her to think about adapting her lessons to include all students. As she got to know her students during the course of the year, she realized that some of what she first understood about their abilities was reflective of what she perceived as the limitations of their previous educational experience and their brief experience with formal public education. Anna wrote in her spring summary,

> … as the year progressed I realized that these children did not have any inquiry skills, lacked the ability to observe, to analyze, or to compare and contrast. This was partly due to the fact that they had just started first grade and most, if not all of the children had never received any type of formal education.

By the end of her partnership experience, Anna's belief about the ability of her students to learn science shifted but did not acknowledge the natural developmental stage of six-year-olds. She felt that there were factors that influenced their learning besides the prenatal or home-life conditions. Some of those factors, she believed, involved the students' learning style preferences. Other influential factors, she said, were student motivations as well as social, cultural, and economic effects. She wrote in her spring journal, "I have very slow children, I have very smart children, and I have very unmotivated smart children." She viewed the will of the child to learn as a struggle against unsupportive and often destructive factors in the students' environment.

Research Question 2: Anna's Perceptions of Social, Cultural and Economic (SCE) Factors that Affect Student Learning

Of her 97 expressions involving social, cultural and economic factors that affect student learning, 41% of Anna's comments identified the effects of home life and school politics. Twenty-seven percent of her comments referred to the culture of teaching and learning, and thirty-one percent referred to the affects of SES.

Learning factors: Home, community, politics and schools. Initially Anna referred to information from college courses, her teacher partner's comments, and her observations of the students' manner of speech and behavior to form her understanding of students' home situations. In her fourth-week interview, she singled out "poor home life" as the main cause of their learning difficulties. For example, Anna stated,

> I know [this] from my language acquisition class. We've been talking about like how children, especially at age 6, they don't have that much life experience and that most of the way they speak reflects their parents or whoever reared them. And I know from talking to my teacher, that some of them have a very bad home life.

Anna came to believe that the students who were not learning had severe learning disabilities because they were "drug babies," or they had suffered neglect and abuse at home.

In her initial interview, Anna identified several specific social factors that had immediate influences on her students' in-class behaviors, physical health, and motivation to learn. These were single parent families and exposure to "parental and sibling death, drugs, violence, and broken marriages" Anna stated, "And most of them have single parents…. one little girl was beaten the other day. She had a big black eye. I know that there's a little drug baby." Toward the end of her experience, Anna perceived that such social factors and the single guardian family exacerbated the economic situation of the lower class and weakened community support for the elementary education of her students. In her 20th week interview she explained,

> Like I have compassion for them for like how their future is going to be because of the trend in our society is you tend to stay where you start. I don't know. I feel like they are not relegated to become educated. And it is so important to having a happy and successful life.

Anna used Roby, whom she perceived as an academically outstanding student, as an example of how students' families can disserve talent. She related that he lived on welfare with an elderly aunt who did not read to, or challenge him educationally. She believed that Roby and his siblings had experienced abuse, parental neglect, and familial death. She said that he related to her that he avidly watched TV programs about science. Yet without practicing science in school, Anna believed that even he would not reach his academic potential because his family did not support his education. Her awareness of his abilities led her to anguish as she expressed doubts that a child such as Roby would go to college. In her spring summary document she wrote,

> Once he even told me I need to bring harder stuff for him to learn because he already knows about what we are learning. I cry when I think of this poor, sweet boy who will, unless some miraculous intervention occurs in his life, never rise above his surroundings. He has just as much potential as I had at his

> age, but will probably never have the economic means to ever have the opportunity to pursue further education.

Anna identified with what she believed were Roby's innate learning abilities. By the end of the partnership, this allegedly exceptional student became her flagship for the education potential of the other students in her classroom.

Anna started her partnership by expressing a general belief that the Southern Public Schools was doing a poor job providing science education for elementary school students. Her thoughts about the deficiencies of the SPS evolved as she encountered a lack of basic resources such as paper and pencils in her school. Anna said that to her shock, teachers and assistants sold snacks every day after school to raise money for supplies that she believed should have been standard in every classroom. She believed, however, that the physical school environment was old but adequate for learning. By the end of the year, Anna stated that the SPS was a "bad" system, not because of any internal characteristics, but because it was under funded due to a larger political disregard for the education of low SES students. In her spring summary she wrote cynically, "Why encourage the poor if they'll never get out of this current economic situation anyway? This rationale infuriates me and leads to my anger towards the political systems that control funding for the [Southern] Public Schools."

Anna interpreted what she saw as a careless disregard by society and politicians toward the mitigation of the negative effects of poverty and pathological home lives on students' learning. She expressed the belief that this disrespect served to maintain a low educational and social status quo for the students. In her spring journal she wrote,

> Granted, why would some big shot in the state government want to provide funding for an elementary school in one of the worst areas of [the city] where the children have no hope of a future anyway? Why waste money on the

> education of welfare children with single, unwed mothers when they couldn't possibly end up being the future leaders of America anyway? I think this is one of the main attitudes that is hurting our society and preventing areas like the one around Summit from improving and bettering its community.

Toward the end of her partnership experience, Anna's belief formed the basis of her new political outlook on education. She expressed her belief in the existence of a political tendency for the social regulation of low SES students through the underfunding of public education that slowed upward social mobility.

Learning factors: Culture of teaching and learning. In response to the question: What is the greatest barrier to learning science?, Anna initially identified an unsupportive teaching culture. At that time, she expressed the belief that a combination of low teacher skill and interest in science as well as a lack of necessary resources prevented students from learning science. Subsequently during her first eleven weeks, Anna reversed herself when she wrote in her journal that she found her original belief to be not entirely accurate in that her particular teacher partner seemed "overly qualified" to teach science to first-graders and there were enough technological resources, i.e., computers, available to the students. Then, after 20 weeks, Anna reverted to her original belief that most elementary school teachers are incompetent to teach science. She perceived that Summit staff and faculty were hard working and dedicated to teaching the students science, but the teachers taught science less effectively because they were not willing to change to more appropriate methods such as inquiry-based lessons using hands-on activities. In her post interview she said, "I think that teachers have their teaching styles. And that is their teaching style. And they don't change it for like, 'Oh, it is science time, let's do [teach] it differently'."

It is clear that Anna valued learning. From her initial interaction with the first-grade students, she expressed the belief that they did not value learning like she did as a child. Based on what she perceived was the influence of their home culture of learning, she reasoned that learning difficulties and educational development is impeded when support from caregivers is lacking. She believed that her students' parents were not involved enough with their children's education and this, she said, was the basis for a child's educational success. In her fall journal Anna wrote, "… culture plays a huge part in determining the quality of education, obviously, but it also significantly affects the children's willingness to learn and their creative intelligence." By the end of the first eleven weeks, Anna felt that most of her students received little education outside of the school environment. In her mid interview she reflected, "From knowing that they have not such a stable home life, you realize that most of the educational input or help they receive is going to be in the classroom, not necessarily at home." In her 20th week interview, she compared her reaction to schooling to that of her students when she said,

> …their behavior and their lack of motivation is, I mean, they get excited about science but in general they don't care about being at school. I loved school. I was always in a learning environment. And I don't think these children are in a learning environment at all outside of school. So that school seems so boring to them, not somewhere that they want to be… For me, I just liked school, even if school is tough. And I liked to learn. I think that they need motivation. And this is their first year in school and they are already not into it at all, which is sad. So I think it is a reflection of their home life and a lot of them need stability at home. And that is like a problem.

Anna saw this as a learning culture phenomenon. At the end of her partnership, she expressed the belief that a social tendency of the her students' low SES families, and others like them in the SPS system, toward a lifestyle of crime led to a de-emphasis on education at home, disrespect of teachers, and ultimately low student motivation to learn. Anna stated,

> And I think a lot of it has to do culturally as far as people who are involved in like illegal crime and stuff like that. Those are like shortcut ways to get money and it's like taking an emphasis off of education. I think people are trying to find shortcuts and little kids are seeing that from television and from a lot of the resources [media] what society is like, I guess mostly television. Like children are being set in front of the television, so why not imitate [behaviors depicted on T.V.] that. So education is not as focused on…Like in my [childhood] class, no one would talk back to the teacher, people did their work just because that's what you did and most of us had parents who supported our education. And when I went home, my mom made sure I did my homework and that was just what was expected.

From the first documentation at 11 weeks, Anna linked the culture of teaching and learning with student performance. Thereafter, she maintained her belief that home life was the dominant and negative influence on the students' perspective on learning in general.

<u>Learning factors: SES and student opportunity.</u> Anna began her partnership with a general belief that the students had compromised opportunities to learn science. She believed this for two reasons. First, she felt that the educational services available at SPS were some of the least proficient in the country. As a science undergraduate, she expressed the belief that she could provide her students with the needed science experiences and lessons. She used her own science education as a point of reference to gauge what was a "decent" educational background. Second, Anna felt that the students had few opportunities to learn that science is something anyone can do because they were isolated within their own community of learners and neighbors. In her initial interview she stated that she wanted to expose the students to the idea of continuing

education beyond high school, using herself as an example of an older science student. She said,

> …my expectations were to hopefully have a bond with these children and be able to actually affect their lives, both like in learning science and learning about the world in general. But also just like having them see what college kids are like and see other [students], 'cause I feel like these children are all from a set environment and they're all from like in their neighborhood …

By the end of the first term, Anna stated that she had emotionally connected with the students. At that time, her belief regarding the educational opportunity that she was providing the students included the care she had for them as individuals. She felt that she was providing not only an opportunity to study science, but the influence of a social model of an "older" science student who valued them as individuals. In her mid interview Anna said, "I think it is very important for them to see someone who is coming in to help them; who cares about them; who is going to sit and talk to them."

After she had more of a chance to see some effects of her science lessons on the students, Anna expressed the belief that exposure to science would stimulate student thinking. At mid partnership she recognized that her students' ideas typically emerged from their experiences when she said, "I think that is a lot of what I am realizing. It is only things that they haven't been exposed to that it has never even occurred to them to think about." Anna indicated that without those opportunities, the students' educational progress would have been inadequate. She also expressed the belief that the academic and interpersonal growth in her students was based on the opportunity to study science, an opportunity that she expedited with materials, science expertise, and her individualized teaching efforts. As she was leaving at the end of her partnership, however, Anna expressed the pessimistic view that those gains of her students would not have a positive impact on their future. She said, "I know from experience that it is going to be so improbable for them given their current situation with single parents and like the socio-economic situation that they will have a successful future."

Comments by Anna's Teacher Partner

Anna's teacher partner, Ms. Ellen, reported that Anna was upset to learn about the social and economic factors that affect student learning. In support of Anna's perception that her students' guardians did not value or promote their children's education, Ms. Ellen explained that only one individual occasionally went on field trips with them or spent time in the classroom. Otherwise, she said that there was no parental participation or feedback on anything done in the classroom during the course of the entire year. At the end of the partnership she elaborated,

> … especially in inner city schools, the children have their own set of problems that they come to school with. That may probably be the most surprising to a college kid who is not expecting that. I think that was the most surprising to Anna.

Ms. Ellen stated that the students learned science skills and vocabulary as a result of the enjoyable and engaging lessons that Anna brought to the classroom. Additionally, Ms. Ellen indirectly addressed the relationship that Anna had with the students when she said, "Well, they are all little scientists now. I think that having Anna here just naturally made them more inquisitive about science."

Views on Self Change

By the end of the term, Anna stated that the SLST experience had influenced her development in several ways. She stated that she had learned that the students' socioeconomic status and school could potentially "…hold them back from having the type of opportunities that I've had." Anna identified two key factors that she believed were instrumental to her understanding of a connection between the social stigma of poverty and the educational under service to low SES students. Those factors were (1) the relationship that she developed with the students, and (2) her science teaching experience. In her near-end interview, Anna stated,

> I think that it is being in that situation as opposed to being removed from it. Because when you are removed from a situation and you don't have firsthand experience you can be empathetic and compassionate towards it, but not as compassionate when you have faces to put with the statistics. … I think that it has definitely increased my awareness and my sensitivities to it. And now I understand the need for improved education in our country.

This, she believed, allowed her to reconsider her own educational background and to see the effort that her family made to promote her toward a successful life. She elaborated,

> I see that not everyone has that and that we should be very appreciative of the opportunities we are given. I feel like people who are privileged want to believe the myth [that they are more able] because otherwise they would have the responsibility for all this [under education of low SES students].

Other self changes that Anna perceived she made involved the gain of a sense of purpose in her life. One of the changes that she referred to was her belief that she needed to be involved as a lobbyist for educational change in the larger community. Moreover, she said that she realized she enjoyed interacting with people in a learning environment. This helped her to both choose a profession and to focus on her work at the university. In her post interview she explained,

> So now my game plan is organizational psychology, which is a combination of psychology and business. Which it really did have to do with ESEP! …ESEP has definitely helped my attitude as far as more dedication to school.

In addition to giving more effort to her academic studies, Anna noted that she came to think about science as an overarching and organizing discipline versus a set of independent fields. Moreover, she believed that she had gained time management, organizational, and communication skills that helped her academic performance.

Summary: Anna

Anna's beliefs about the ability of her elementary school students to learn science changed as evidenced by the expressions that she made during the course of her partnership. She modified her expectation of "unintelligent, misbehaved, and uninterested students." By the fourth week she still believed that most of her students were below the average child in abilities that she considered innate, although some were interested in learning science. At the end of the fall term, she stated that she believed most were interested in learning science. She perceived that some of her students were intelligent yet most were also uncreative. In the spring term, Anna viewed her students individually, each with different learning strengths and weaknesses. By the end of her SLST experience, she believed that although most of the students were intelligent, motivated, and able to learn science, they were not interested in learning in general and had little chance to succeed due to social, cultural, and economic barriers (Table 3).

Table 3

Nature of Beliefs Recorded about Student Learning and Factors as Expressed by Anna During each Time Period

Summary	Expectation *	Week 4	Week 11	Week 20	Week 23
Beliefs regarding student ability to learn science (RQ1)	In general students are unintelligent & disinterested	Most below average in “innate” skills, are uncreative; few have ability to learn ; Most low interest in science & other subjects	Some intelligent; Most uncreative ; Skill can be developed ; Most enjoyed science but unmotivated to learn	Some able but unmotivated; Students have various abilities/ learning styles	Most intelligent & able ; Students have various abilities; Most interested & motivated to learn sci, not other subjects; Most learned science
Beliefs regarding social, cultural, & economic factors that affect student ability to learn science (RQ2)	In general students misbehave	Poor home life causes learning difficulties, disinterest, & low motivation; Parents undervalue student education; SPS limits curriculum & resources; Science teachers are incompetent College student-, scientist-role model, & friend; Anna = caregiver substitute	Poor home life; Parents undervalue student education; Student inspired science inquiry; SPS provides adequate resources; Some science teachers are competent; College student-, scientist-role model, & friend; Anna care substitute	Poor home life; Society & politicians undervalue student education; SPS is under funded; Science teachers are incompetent; External factors deter most student academic & social success	Poor home life; Society & politics undervalue student education; SPS is under funded; Science teachers are incompetent External & motivation factors deter most student acad & soc. success; College student-, scientist-role model, & friend; Anna care substitute

* Expectation = belief(s) stated by participant during study about expectation held before SLST experience.

During the course of the partnership, Anna's beliefs changed concerning the social, cultural, and economic factors that affected her students' ability to learn science. She stated that before her experience, she expected her students would have behavior problems that would limit their learning. By week four, she perceived that the students were influenced by a pathological home-life characterized by drugs, violence, single guardians, and neglect. Her belief in s characteristically poor home life was by far the most constant of Anna's expressions about influential factors responsible for the learning difficulties, disinterest, and low motivation of her students. She retained it throughout her partnership. For the first 11 weeks of her experience, she held a related perception that the students' parents undervalued their children's education. By week 20, she additionally blamed society in general and politicians for devaluing low SES student education. This she related to what she perceived as an under funding of the SPS.

By the fourth week of her partnership, Anna identified inadequate curricula, insufficient resources, and incompetent science teachers as detrimental factors. Those factors were countered, she said, by the positive influences of her science teaching, her caring teaching relationship with the students, and her role modeling as a college science student. By week 11, Anna came to believe that another positive influence on the ability of students to learn was student inspired investigation stimulated by their recent experience with the inquiry-based science lessons that she presented. This, she believed, generated student interest, motivation, and the learning of science. At that time Anna also questioned her earlier belief that the SPS provided inadequate science resources and incompetent teachers for their students. By week 20, she had reverted to and proceeded to maintain her original perception. She concluded, however, that the SPS was under funded for science education and education in general. At the end of the partnership Anna believed that most of her students were able to learn science, however, she held the pessimistic view that external and motivation factors would deter most if not all of them from future academic and social success.

Case Two: Badra (Second Grade Class)

In comparison to Anna's experience in a first-grade classroom, the next case participant was a 20-year-old woman who taught in a second-grade classroom at a different elementary school during her junior year at the university. Badra taught science with Ms. Fran the entire academic year.

Motives

In response to questions regarding the reasons she elected to participate and stay with ESEP, Badra identified her meaningful relationship with the elementary school students, helping them learn science, and experience working with children in 41%, 16%, 11%, of the 129 references, respectively. Other notable motives were her pride in student learning, the opportunity to apply her science knowledge, and learning to teach (16%, 8%, and 7% of responses respectively).

Classroom Observations

Badra's lessons covered a range of topics suitable to the second-grade curriculum of the Southern Public Schools. The average lesson was 58 minutes long with a range of 45 to 81minutes. Badra led lessons an average of 82 % of the time. Ms. Fran did the majority of the behavior management with an average of five interventions per lesson compared to Badra's average of one.

Badra used teacher-centered and a combination of teacher- and student-centered teaching styles with equal frequency. Finite procedures and some inquiry process skills without reference to the nature of science were the most common lesson elements. On two occasions, however, she specifically included elements that taught the nature of science. Badra included the practice of science process skills (e.g., observation, measurement, or documentation) in four out of eight lessons. Three out of eight lessons integrated lesson components from other areas such as language arts. I observed the students apply their previous knowledge in four out of eight lessons and interact with each other in one. Badra's second-grade students were always engaged and enthusiastic about the science lessons. Badra's attitude toward science was consistently positive and the content of her lessons was accurate except on one occasion (Appendix R2).

Badra was prepared for all of the observed science lessons indicating that she had a sense of responsibility and care toward the students. She and her teacher partner moved the students through a progression of age-appropriate science activities and discussions. They consulted weekly and Badra designed the lessons to integrate language and some math skills with the science. Although Badra delivered the lessons, Ms. Fran effectively directed the timing of the lesson components.

Badra made a special effort to make the science lessons enjoyable for the students. For example, she dressed up as a clown and brought candy for a lesson they did on Halloween day. On occasion, she brought the students colorful papers and pencils to use as they practiced science. She frequently used question and answer discussions to involve all of the students in conversations about science (15 discussions in eight lessons). In the first several observations, her questions to the students were about facts that they had learned from their experiments. During the eighth week, she asked some probing questions to draw out the true meaning of the students’ answers and expedite student learning. In the spring, she asked the students to apply their knowledge across areas of science as well as to recall information. To elicit student knowledge and instruct prior to, during, and after inquiry-based activities, Badra used the students’ names in the whole class discussions with increasing frequency through the lessons that I observed.

Badra was consistently concerned with student learning. For example, one of the first things I observed her say to the whole class was, "Don't worry if you can't do it. We are here to help you." When she introduced or modeled a lesson activity, she generally stayed at the front of the classroom and used the blackboard. Occasionally, however, she sat with the students gathered around her on the floor. She made sure that all of the students could see and hear her. When she worked with individual students, she moved to their desks. She spoke softly and encouragingly to those who were struggling with tasks.

In every lesson observed, Badra reached out to the students. She used positive behavior, e.g., smiling and laughter, and positive language about science and student performance. Moreover, she made a point of framing her questions so they were relevant to the daily lives of the students. When a new student joined her class in the eighth week, she asked her to tell the class about herself. Badra was concerned that the students were treated equitably by their teachers and each other. During the sixth week of her partnership, Badra observed to Ms. Fran that several students who were left-handed were struggling in a lesson that required the use of scissors to cut paper. In the eighth week (third observation), she consulted the students' opinions about fairness and then modified the rules used in a review game. Badra was also concerned that the students felt that they were respected. She thanked the students for their good teamwork.

The students responded enthusiastically to Badra and science. They proudly showed her their work and discoveries during the lessons. When Ms. Fran allowed it, they loudly greeted, hugged, and thanked her for teaching them.

In the 22nd week, Badra clearly demonstrated her faith in the students' abilities to learn science. At the end of her last lesson, she told the students that they were good students and that she was sure they could become great scientists and succeed at whatever they did in the future. Then she thanked them for helping her to overcome her fears and to become a teacher.

Research Question 1: Badra's Perceptions of her Elementary School Students' Ability to Learn Science

Student ability to learn science (ability). During the course of the year, Badra commented positively on the ability of her students to learn science 34 more times than she did on the difficulties or barriers involved in student learning (46 and 12 times, respectively). She commented on student interest or willingness to learn 13 times throughout her partnership.

Initially, Badra expressed the belief that although they were generally able, the students were slow learners with poor memories and she had to assist her students to remember science information. She was concerned with the norm for recall for seven-year-olds. However, she optimistically stated, "I aid [the students]… in remembering as far as like applying our earlier concepts…I don't think I've seen a dramatic change, but I think that I will as far as [the] end of the semester is concerned." Although Badra integrated science, math, and language to help the students learn to apply their knowledge, the early questions that she asked of them involved direct recall of information and procedures.

At her mid interview, she retained her view of student ability, adding that the students sometimes needed a long time to recall concepts that were taught earlier. During the spring term of her partnership, however, Badra modified her belief about the students' ability to learn science. When asked what indication she had that her students were learning science, Badra's responses included the following type of evidence: (a) correct memory of and depth of thinking about facts, vocabulary and concepts, (b) questions asked, (c) degree of engagement in and enthusiasm for the lesson, e.g., "… when they make new discoveries or when they get excited about something that they see or when they ask me a question about something to further get knowledge from it. That makes me feel that, "Yeah. They're learning.", (d) ability to make conceptual connections, e.g., "I am happy that the students are connecting all kinds of concepts together, such as phase states, cycles of water and cycles of life, and coming up with ideas on how to relate projects together...", (e) ability to explain concepts correctly to each other, and (f) the application of knowledge and demonstration of science skills: e.g., ability to write about their science knowledge: "As far as concrete evidence, they write things for me … so when I can see that they're actually writing things down I know that they're learning."

Impressed by their "vivid memories," in her 14th week journal she expressed the conviction that her students were better able to learn science from inquiry-based experiential lessons that have real world applications. At week 20, she emphatically stated that they could learn any subject that they studied. In her post interview, Badra stated, "They learn the best when … what they're learning is something that is applicable with the real world and that they see it in real life and that it's maybe tangible and applies to them."

Student will, or interest and volition to learn science (willingness). Badra expressed an initial belief that her students were reluctant to learn science, but if they had "fun" in class they could become more interested and eager to learn. Late in the fall term, Badra cited their naturally inquisitive nature, the quality of the questions they asked, and their excitement to see and interact with her each visit as evidence that the students were interested and willing to learn science. In her spring summary, she wrote of the connection she saw between learning and student-generated questions about the science topic at hand,

> I know this through my interactions with them and my observations of them. They always ask great questions. When a person asks a question, it means that he is interested in the subject and is eager to learn more about it.

Badra expressed the belief that student motivation to learn science was related to their enjoyment with the process, to the teacher's interest and enjoyment in teaching science, and vice versa. In her post partnership interview she said,

> I think for a teacher, if your children aren't enjoying it, you're not going to enjoy it either. But if your children are enjoying it, then you feel better and you enjoy it more. So, yeah. It's kind of like a cycle. Kind of like a big circle. Like, okay if my kids are happy, I'm happy and if I'm happy, they're happy.

Student difficulties in learning science (difficulty). In her mid-, near end- and post-interviews, Badra expressed the belief that the difficulties her students had in learning science were related to circumstances that would affect any child. These circumstances ranged from previous underexposure in science to the need for practical and tangible applications of concepts to their everyday life. The teaching of concepts and vocabulary that were not applicable to the students' daily lives was the most common reason she gave for her students' learning difficulties. In her post interview, Badra stated,

> Well, they're great learners. They absorb materials like sponges and maybe they don't hold on to it for five years, or even like five weeks, but that's okay…Things that they don't retain, it's like anyone else. I think it's just a matter of if you don't use it, you're not going to retain it.

During course of the partnership, Badra changed her beliefs about student learning difficulties as she considered the developmental stage of the students. Initially, she expressed surprise that her students needed weeks to process ideas whereas she might learn a similar concept in one day. By the end of her partnership, she emphatically expressed the belief that the time her students needed to learn a concept was developmentally normal for seven-year-olds.

Research Question 2: Badra's Perceptions of Social, Cultural and Economic (SCE) Factors that Affect Student Learning

Of the 25 references Badra made to SCE factors, 32% involved home, community, politics and schools, 36% involved the culture of teaching and learning, and 32% involved SES and student opportunity.

Learning factors: Home, community, politics and schools. During the fourth week of teaching, Badra expressed her belief that the home environment could negatively affect a student's behavior in school and in turn interfere with the student's and his or her classmates' learning. At week 11, she said that witnessing violence at home and in the community could cause an otherwise passive student to misbehave in the classroom and interfere with their learning of science. Badra said that she learned about these things from talking to her teacher partner and observing the students herself. Similarly at week 20, she elaborated that inadequate home care physically influenced some students' abilities to learn in terms of their preparation and alertness. She noted that other ESEP undergraduate science-partners had also observed the effects of the home environment on their students' behavior. She stated,

> We talk about how some of the children in the class maybe come from homes where their parents really don't have much time to care for them or dress them in the mornings. Sometimes you will see some children come in and they are just so sleepy and maybe they haven't gotten much sleep and they fall asleep in class. Just the basic needs [are not met]. And I feel, as a teacher, it is very important to be aware of that and to help kids, especially the ones that are obviously at a disadvantage as far as their parents being able to take care of them. I think that they always need positive feedback and encouragement and you know, have some good words and all kinds of encouragements to make them feel that they are doing something right.

In her post interview Badra stated that to help disadvantaged elementary school students learn science, the politics for public schooling and the school system had to change. She expressed the belief that college science-partners, who represent student-, teacher-, and scientist-role models, could be a part of that change when they "reached into classrooms that haven't been touched by ESEP before" to work with teachers and students. With respect to the physical school environment, Badra was complimentary. She indicated that it was clean, safe, and adequate for student needs. Of greater concern for Badra was what the students experienced at the school relative to their need for stimulating science education.

Learning factors: Culture of teaching and learning. In her initial interview, Badra stated that she was intrigued that her second-grade students drew themselves when asked to draw a scientist because they did not have much previous experience with doing science. She believed that their families or other teachers before her had positively influenced the students' self concept and understanding of their potential. She said,

> …these are like African American children and it's really good to see, you know, African American people as being scientists. You know it's not just the White American European person that you might have learned about in elementary school that they've learned about.

Initially, Badra stated that she firmly believed that elementary school science education would be more effective for students if subjects such as math and English were integrated with it. She said, "I think it really important to like integrate all of them together. Use English in science. Use your science in math. You know. 'Cause you learn better that way." She maintained this belief throughout her partnership. After eleven weeks, Badra expressed the belief that teachers needed support to develop a culture of teaching with exciting and interesting presentations as well as the student practice of science in the classroom. This, she stated, was important to preserve and pass on. By the end of the fall term, Badra expressed her belief that the culture of teaching and learning impacted student performance in science. The pedagogy, she said, should include tangible real-world experiments that stimulated students to ask questions and stay involved, and the promotion of the students' ability to work together to help and teach each other. At the end of her partnership, she compared the science instruction that she provided her students to her own early science experience, "I think my science experience was more textbook based than the children in Ms. Fran's [and my] class science experience is." The relevant inquiry-based activities, she said, expedited her students' learning of science.

Late in her fall journal, Badra expressed her belief that the teaching relationship an undergraduate science partner has with the students is a factor that impacts their ability to learn science. She wrote,

> … not only are we teachers to the children, but we are their friends as well. I think having this type of relationship enhances the program. Also I think it is very important to continually get to know the students better and better. When we understand what is important to them and in their lives, we can customize teaching skills to optimize their learning.

By the 23rd week, Badra noted that the difference in the teaching relationships of regular classroom teachers and college science-partners with their students was due, in part, to the degree of student control that each exerted. By not involving herself in disciplinary interventions, she stated that she perceived herself as more of a friend who the students could trust. She had, however, come to believe that the flexible, responsive, and caring teaching methods of both regular teachers as well as college science-partners positively affect student ability to learn. She admiringly referred to the way Ms. Fran was concerned with the whole student when she said,

> I see how by just, you know, calling on someone or having an interaction with a student, I see what it does to the student. I see the change in them, you know… She's really caring about her students and that makes for a good teacher.

In her own teaching relationship, Badra admitted her unexpected and "great attachment to the children," which motivated her to care about them as whole persons. She explained,

> I try to keep aware of all aspects of their life, not just educational. Like if one of them is crying or one of them is sleepy I will just go up to them and try to find out what is wrong, because that is important to me….I am trying to care for them in all aspects.

This type of care, she said, was part of the “unique” teaching relationship she had with the students that involved friendship (amity and trust), role modeling, and fun.

Learning factors: SES and student opportunity. In her mid and post interviews, Badra stated that student experience with the practice of inquiry-based and experiential science was essential because “a foundation in science is something every child needs to succeed” in life. She considered science skills and understanding to be potential economic equalizers. In her post interview and spring summary she perceived the need for her students’ to have the opportunity for inquiry-based and experiential science instruction due to economic factors such as, “ maybe their school can’t afford this type of learning or hasn’t really had this [ESEP type of] experience before.” Badra expressed the belief that the ESEP teaching innovation brought materials, her science expertise, experiential and inquiry-based teaching methods, as well as more time dedicated to the purpose of learning science. All these things that the students did not have before, she stated, enhanced the students’ science learning experience and potential for success in life.

Comments by Badra’s Teacher Partner

Fran expressed the belief that Badra as well as the students benefited from the exchange of social and cultural information. With respect to student learning, Fran noted that until the partnership with Badra, most parental involvement was focused on reading and mathematics ability. She said that prior to Badra’s instruction, the parents never asked about their children’s performance in science or social studies. As the students became more enthusiastic about science, brought experiments home, and earned As and Bs instead of Cs and Ds, the parents became more interested in and supportive of their children's science schoolwork.

Fran connected the enhancement of student learning in science to the relationship that Badra had with the students. The students, she said, were interested in and needed a change from their daily experiences. As the students learned about Badra, Badra learned about them. Fran said that Badra was another student as well as a teacher who made them feel special and the effect was mutual. Fran called this Badra's own "social hands-on." In Fran's words, the relationship expedited student learning. She said,

> And you know, if you make them feel special, then they really will work to their, to the fullest because some of my students were drop bottom. And a lot of them began to progress, you know, with her interactions with them. I think it helps a lot.

Views on Self Change

At the end of the term, Badra stated that the SLST experience had influenced her development in several ways. She expressed the belief that at college she had limited opportunities to work as an integral part of the community. Through ESEP she felt connected and she believed that she was a better citizen because she had helped to make a difference in the education of disadvantaged students. From this she gained a social cause. Badra emphatically said, "I would really like to establish that I feel like this is something I want to fight for, you know."

Badra made it clear that she believed she did not fit the Emory stereotype of the wealthy student. Her family, she said, had to work exceptionally hard to support her educationally. In contrast to the stigmatized experience of her ancestors who's social status and low SES barred them from any chance for college admission, Badra was grateful “to be in a nation like the U.S. where a person’s background and economic position does not have to affect [limit] his future.” As noted, Badra believed that a solid science education could overcome social and economic factors that undermine learning. This she believed to be true for herself as well as for her students.

Badra expressed the belief that her career goal and resolve to work in a medical field and to help children was enhanced by her SLST experience. She explained that her goal was, “Just more written in stone. Yeah, I do want to work with children. It is not something I’m going to give up on.” To achieve that goal, she said that she was more motivated to learn science. Badra believed that she also changed the way she thought about science as a result of practicing science with the elementary school students. At the university her classes were specialized without much crossover. She said the experience helped her see that science and science learning was a layered process involving simple to complicated constructions of knowledge. In her post interview she reflected, “… I see how science can apply to everyone, really… So similar activities are just like the same thing only more in depth. I didn’t, you know, maybe realize that before. There’s just a whole range of what you can do with science.” She said that the dynamic nature of science interested her and motivated her to study, and the demands of science teaching helped her to better manage her time.

Badra also took a philosophical lesson from her work with her students. She came to believe that education is not a strict top-down process but more circular in nature with adults and children alike teaching each other. This she said influenced her to believe that education can be continual. She said,

> I was just thinking about that the other day. Just, you know, how important it is to want to always want to learn more, especially like if you’re trying to get

> ahead in life. You know, you need to keep learning, keep learning every day. Like just because you have your Ph.D. it doesn't mean you're done! I think from ESEP I've learned that.

Badra also perceived that she had gained important skills that she once struggled with. She said that she had become a better communicator and teacher who was more confident with others, "… in front of a classroom, even in college."

<u>Summary: Badra</u>

Badra's beliefs about the ability of her elementary school students to learn science changed during the course of her partnership as evidenced by her expressions. Badra initially believed that the students were able to learn, but were slow, somewhat disinterested, and unmotivated learners. Yet her early outlook was optimistic. She perceived that if the students enjoyed the practice of science, they would learn faster and remember more. After 11 weeks of SLST experience, Badra still believed that the students were slow learners, but they were interested and motivated to learn science. By the 14^{th} week, she again changed her perception. She expressed the belief that all of her students had vivid memories and could learn science as well as any other subject. Badra ended her partnership with this belief and that the students were normal seven-year-old learners (Table 4).

Table 4

Nature of Beliefs Recorded about Student Learning and Factors as Expressed by Badra During each Time Period

Summary	Week 4	Week 11	Week 20	Week 23
Beliefs regarding student ability to learn science (RQ1)	Most able but slow (poor memory) in learning science; Most have low interest & low motivation	Most able but slow (poor memory) in learning science; Most are interested & motivated	Students able to learn science & any other subjects; Students have vivid memories; Most are interested & motivated	Students able to learn science; Students are typical learners w/respect to their age ; Students have vivid memories; Most interested & motivated; Students learned science
Beliefs regarding social, cultural, & economic factors that affect student ability to learn science (RQ2)	Some home life can stimulate misbehavior, disinterest, & physical problems; Self concept & respect; Peer-to-peer interaction/ teaching promotes learning; Dull science lessons restrict ability	Home life can both detract from and support ability to learn science; A culture promoting & preserving relevant inquiry based science instruction Peer-to-peer interaction/ teaching promotes; Funding for science practice & knowledge promotes future economic success; College student-, scientist-role model & friend; Badra's caring interest	Home life can both detract from and support ability to learn science; A culture promoting & preserving relevant inquiry based science instruction; Peer-to-peer interaction/ teaching promotes learning; Caring science teachers; College student-, scientist-role model & friend; Badra's caring interest/attention promotes learning	A culture promoting/ preserving responsive,/relevant inquiry based science instruction & political & school value of science; Self concept & respect; Funding for science practice & knowledge promotes future economic success; Teacher interest in science; Caring science teachers; College student-, scientist-role model & friend; Badra's caring interest/attention

During the course of the partnership, Badra extended her beliefs concerning the social, cultural, and economic factors that positively affected her students' ability to learn science. From the fourth through the 20^{th} week of her partnership, she maintained that a few of her students experienced stresses from drugs, violence, or neglect in their homes or neighborhoods. These experiences, she said, sometimes stimulated their misbehavior, disinterest in learning, and physical problems. Unlike Anna and Chikara, she did not indicate that she believed this factor was pervasive. In contrast, she expressed the belief that the students' guardians could have been responsible, in part, for the students' belief that they could be scientists as well as other positive influences. By week four, Badra also perceived that peer-to-peer interaction where students learned from each other promoted their ability to learn science. Badra sustained her belief concerning the strength of peer-to-peer interaction throughout her partnership. By week 11, she revealed two more beliefs that she sustained throughout the remainder of her partnership. One concerned the need for a culture of inquiry-based science instruction that is relevant to student everyday life. The other was the need to further fund such science instruction in order to promote student economic success in the future.

By the 20^{th} week and through the end of her partnership, Badra expressed her perception that as a college student-, teacher-, scientist-role model, and friend, she had a positive influence on elementary school student ability to learn science. Badra believed that she and other ESEP undergraduates had a unique teaching relationship with the students that expedited their learning. At that time, she also stated her belief in the positive influence of caring science teachers, or those who promoted student learning while caring about the whole child. After her partnership, Badra expressed a new belief in an additional factor that influences student learning. That, she said, was teacher interest in science.

Case Three: Chikara (Third Grade Class)

In comparison to Anna’s and Badra’s situation, the third case participant was a 21-year-old man who taught science in a third-grade classroom at a different elementary school during his senior year at the university. Chikara taught science in his first semester with two teachers of the third grade at Peak Elementary School, Ms. Gail and Mr. Mike. In the second semester, he completed his SLST partnership exclusively with Ms. Gail, the teacher with whom he felt most comfortable. Because of this, Mr. Mike’s observations and comments are not further described.

Motives

In response to questions regarding the reasons he elected to participate and continue with ESEP, 51 % of Chikara’s 150 responses involved the theme having an enjoyable relationship with students while experiencing a more inclusive social setting. Chikara’s motives included the students’ excited and positive reactions to him and the ways that this made him feel, e.g., “The children are as enthusiastic as ever, they really pick me up.” A related theme, “a break from college” was expressed in 25% of his motivational responses. His need for a “break” was caused in part by his sense of isolation on campus, which he stated in every interview, was unnatural: “…freshman year I realized this half way through the year. We didn’t have cars, we never went off campus and it didn’t seem like real life. No, like, older people. Well, besides professors and like, kids.”

Chikara's motivations to help students and gain experience working with children were expressed in 5% and 6% of the responses. Similarly, he noted his pride in student learning, e.g., "…they had learned what I wanted them to. This made me feel good about myself, like seeing the fruits of my labor," and his interest in gaining teaching skills in 12% and 11% of his responses, respectively.

Classroom Observations

Chikara's lessons covered a range of topics suitable to the third-grade curriculum of the Southern Public Schools. The average lesson was 66 minutes long with a range of 50 to 84 minutes. Chikara led the lessons an average of 85 % of the time across the eight lessons that I observed. Ms. Gail did the majority of the behavior management for the lessons with an average of five interventions per lesson compared to an average of two made by Chikara.

Four of Chikara's lessons contained completely accurate science content. The balance of his lessons contained mostly accurate content. Chikara used a combination of teacher- and student-centered teaching styles. He used, with equal frequency, some inquiry process skills with and without reference to the nature of science. I observed the students apply their previous knowledge in three out of eight lessons and interact with each other in four lessons. Chikara's third-grade students were always engaged and enthusiastic about the science lessons observed. Chikara's attitude toward science was usually positive, although it was neutral during two lessons that were craft based (Appendix R3).

Chikara was not always fully prepared or organized for the science lessons that he facilitated. He always had a general plan or a lesson, however, in two of the eight lessons that I observed (weeks five and eight), he had not familiarized himself with the details or tried out the procedure for the day. It appeared as if he believed he could produce an adequate lesson at the last minute, e.g., reading about the facts and procedures as he directed the students. After class he usually planned for the next lesson with his teacher partner who insisted that the topic be relevant to what the students were already studying. Not until late in the partnership, and unlike Anna, Badra and Dawei, did it appear that Chikara realized how the quality of his presentation affected the students' learning of science. His modest effort supported his own role definition as a relaxed and fun person who was more friend than teacher yet a student role model who helped other students to learn science.

Up through the 11th week, Chikara used only a few of the students' names properly. His use of student names, however, increased in the spring term. In an informal conversation during the 17th week, Chikara expressed his excitement about the students' ability to learn science and his interest in integrating math into the next science lesson. He was enthusiastic about science and doing science and he appeared connected to the students as individual learners.

Typically at the start of the lesson, Chikara first asked the students if they had any pressing questions about a science topic or what they were going to study. If they did, he would answer them directly. In the first five observations, his review questions involved the recall of facts about previous lessons. From the front of the classroom, Chikara used short question-and-answer discussions (ten discussions in eight lessons) to engage and instruct the students before and during an activity. Sometimes he asked the class to brainstorm about words and concepts that were not of their experience. When

Chikara started his jeopardy style lessons in the spring term, however, he increased his use of questions that pushed the students to think more about science concepts and less about facts in isolation.

Ms. Gail regularly clarified and guided the discussions so that the students made progress with the terms and concepts. During the discussions, Chikara did not always correct student misconceptions, but he did help individuals and groups that were struggling with concepts, language skills, and procedures. Throughout the lessons that I observed, he and the students appeared impatient to do the science activities within the constraints of the available time. Chikara and Ms. Gail rarely engaged the class in a reflective discussion directly after an activity.

In all of the lessons that I observed, the students were excited about and interested in Chikara. He was politely casual and treated everyone equally. They acted pleased when he selected them to help him with a procedure or read their work to the class. They were concerned that he visited them every week and wanted to accompany him when he went on break. In the 11th week when he arrived after class began, one girl called out, “Mr. Chikara, you late!” The students then laughed and asked him details about the planets that they were studying. For motivation, Chikara gave them candy as prizes for their participation in a competitive review game and brought them folders to use as their science journals. The students often approached and asked Chikara questions about himself. They told him about their lives. In turn, he shared the nature of his life at college and asked the students about themselves. Both Chikara and the students seemed to enjoy themselves in their casual conversations with each other.

Research Question 1: Chikara's Perceptions of his Elementary School Students' Ability to Learn Science

Of 118 statements on student ability, Chikara commented positively on their ability to learn science just eight more times than on the difficulties or barriers involved in student learning (48 and 40 statements, respectively). Student interest or willingness to learn was discussed less often (30 times) throughout the academic year. In his mid interview, Chikara once mentioned that a few students were not able to learn science due to presumed learning disabilities.

Student ability to learn science (ability). In his initial interview, Chikara expressed the belief that only a few of his students thought about science as evidenced by the rarity of their questions. Moreover, in his fall journal he wrote that only some of his third grade students were able to grasp the material and he added "I think sometimes these children need to have the information slowed down so they can digest it and relate the information together." When asked what indication he had that her students were learning science, Chikara's responses included the following type of evidence: (a) correct memory of and depth of thinking about facts and experiments, e.g., "When I asked why they thought so they answered correctly", (b) questions asked about science, (c) degree of engagement in and enthusiasm for the lesson, and (d) skills gained by students, e.g., work cooperatively and explain concepts correctly to each other. Some students he said were "quicker" than others and only some were enough interested in learning to work at it.

By the 20th week of his partnership, Chikara had modified his belief about student abilities to learn science and noted his understanding of in-class factors that affect student learning. He retained his belief that some individual students were "smarter" or learned the material more quickly than the others, but he believed that all of his students were able to learn science. He looked at their learning of science more as a process that was affected by the methods used to teach it. As Chikara observed his students' responses to the science lessons, he was surprised, respectful, and proud of their ability to learn science. In his 20th week interview he stated,

> I have a great deal of respect for them. Like they are all, like each one has probably done something or explained something great once and surprised me.… At the beginning I thought there was a smarter group, which I do think that some kids do get it quicker and care more about learning in general. But I think everyone got it at some point. And I was surprised because I didn't know if it was lack of effort, but they all can do it. I was really proud.

Moreover, he elaborated that the change in his belief about the ability of his students to learn science factored in the efficacy of his teaching skills. Chikara asked himself, "In a way they all can do it but they are not always [learning]. So I [wonder], am I not getting through well all the time or what?"

Student will, or interest and volition to learn science (willingness). Initially, Chikara believed that only some of the students were interested in learning science. He stated that in general most of the students were not inquisitive at the start of the year and others acted as though they did the work just to get through the day. Based on the early drawings that students did of their concept of a scientist, he said that he believed few knew about science or scientists.

As the first semester progressed, Chikara reported an increase in student focus on the lesson experiments. He noticed that the students enjoyed any inquiry-based lessons, group work, and competition. These, he said, affected the students' willingness to learn. The students, he stated, were happy to see him, happy to work on the projects, and excited to see the outcomes. By the mid interview and fall summary, he believed that more students were interested in science and cared about learning it. He was speaking, however, of the students whom he said were "quicker" than the rest. In his fall summary he wrote, "I think the earlier feeling was not one of disinterest but one of [due to] a lack of exposure to science."

After the winter break and throughout the spring term, Chikara expressed the belief that enthusiasm for science continued to grow among several of the students. As noted in the previous quote, he considered that some students may not have given as much effort to learning due to a lack of experience with the practice of science. By the end of his partnership, Chikara believed that most of the students' willingness to learn science had increased. In his post interview he said,

> Well they started, did start asking a lot more questions and I was pretty happy towards the end. When they sat down I was like, "Any questions?" Sometimes, still sometimes, [there] would be nothing [no questions]. But they had a bunch of questions on plants, which made me happy. And [they] just keep thinking about it. Yeah, and they definitely, in the beginning, they didn't ask any questions.

<u>Student difficulties in learning science (difficulty).</u> Chikara started his SLST partnership believing that student learning difficulties involved individual behaviors such as "unreasonable" excitability or mental disconnection from classroom affairs. He stated that one half of the students "balked" at science lessons and, "… they always just sit there and in fact, they're hard to get to, hard to keep them involved… Even if most of the room is really eager, they sit back there and kind of do other stuff…" He compared those disinterested students to other students whom he said in his mid interview were, "… just normal, that work through it and if they need help they'll ask. And, like, most of them, I feel, understood the main points of what we were doing." In

his spring journal, Chikara stated that the students' expectations and the lesson design influenced their ability to learn. The students, he said, were enthusiastic for their next experiment after getting tangible results from a previous activity. If the experiments did not have clear methods, give clear results, or were not "fun", he believed that the students were more restless and less able to understand the concepts.

Research Question 2: Chikara's Perceptions of Social, Cultural and Economic (SCE) Factors that Affect Student Learning

Of the four categorical references to SCE factors affecting elementary school student learning, Chikara was primarily concerned with the classroom culture of teaching and learning (54%). Twenty-one percent of the comments he made were related to the effects of the students' home, community and school environments. Twenty-five percent of the comments he made were on the effects of SES and student opportunity. The "atmosphere" of the classroom was also a factor that he believed important to student learning. He characterized his classroom atmosphere as casual, friendly, and anchored by his approachable relationship with the students.

Learning factors: Home, community, politics and schools. During the first ten weeks of his teaching experience, Chikara did not reflect extensively on any social or economic factors that could have affected his students' learning. He stated simply that he could not relate to their lives outside of school. At the end of the fall term, he acknowledged his belief that when the students were not in school, they were home alone, watching television, "eating peanut butter and jelly sandwiches," and without supervised and formal learning experiences. This, he said, he based on his conversations with the students. In his 20-week interview he said,

> …they don't have much opportunity to get out and do stuff as I did when I was a kid. And, yeah. I wasn't allowed to watch TV like other kids [and these kids.] I think their parents spend less time with them than the teachers and stuff. They seemed to be home, at the home sometimes alone. All the parents are working or something and of course they're just going to watch TV.

Chikara stated that after school, the students' parents were elsewhere, i.e., at work, and noted that the students often acted detached and slept in class. Sometimes they were calm and sometimes "wild." By his 17th week of teaching, Chikara considered it likely that factors such as lack of parental supervision and sleep were responsible for the extreme swings he saw in student behavior and ability to focus on learning. He retained this belief through the end of the partnership.

Learning factors: Culture of teaching and learning. Initially in the fourth week, Chikara expressed the belief that student behavior forced teachers to group together inactive and uncooperative students in order to help them and for others in the class to be able to learn. Later, in the spring term, Ms. Gail placed a physical barricade within the classroom to separate and control students more effectively. Another teacher was brought in to augment the teacher-to-student ratio. After teaching in that context, however, Chikara stated in his spring journal and post interview that he believed that the technique marginalized and undermined student learning. In reaction he said, "I wasn't a fan of the teaching, the room splitting up at all. 'Cause I thought that they were not in the same classroom almost. Just 'cause they'd be across the wall and I couldn't see them." Chikara noted, and I observed, that he made a point of walking to each side of the barrier as he taught in an effort to include and engage all of the students. He grouped his students on both sides and encouraged them to work with each other. By the 11th week and through the end of his partnership, Chikara stated that he thought that letting the students work together positively affected their ability to learn. One of those factors involved the resultant type of teacher-to-student contact. He said he learned that dividing the students into small groups allowed him to more effectively question individuals in the groups. The other factor involved student-to-student interaction. With students in groups, he was more able to urge the students who understood the concepts to share and explain them to the others.

Chikara was concerned with the students' method of communication about science concepts. In the first four weeks, he noticed that students valued their one-on-one interaction with him over their interactions with other students. In his initial interview he said, "…they [would] always talk to me instead of try to tell the other students… I always say talk to your classmates instead of talking to me." By the end of the first term, he believed that his students could eventually share in the "fun" of the culture of science as co-learners. To do this, Chikara said that it was important for the students to learn to value and share student knowledge with each other like he did in team competitions in his college science course. Chikara introduced his students to a science "Jeopardy" game in the spring term. He also used it as a type of formative assessment. In the 20th week, Chikara stated that he had come to believe that the students learned to value peer-to-peer interaction within the context of competition. Moreover, Chikara believed that competition motivated his students to think about and learn science.

Learning factors: SES and student opportunity. In the 11th week, Chikara compared the students' lives to his own. At that time, he expressed the belief that the socio economic status of the students affected the educational opportunities they had outside as well as inside of the classroom. He stated that the students' education took place in school with him, Ms. Gail, and their classmates. Absent or itinerant parents, he perceived, did not or could not provide their children with any educational enrichment. In his spring summary, he wrote that he realized another positive in-class influence on student ability to learn was a series of lessons that were related to the same topic and allowed students to build knowledge over time (e.g., sequenced science-kit lessons versus disconnected inquiry-based lessons). In his post-experience interview, he stated that the lessons he presented to the students, using an inquiry-based approach, stimulated them to learn from methods that they had not yet experienced. He felt that he provided the students with an unprecedented educational opportunity similar to what he had when he was their age. Additionally, Chikara believed that Peak Elementary School restricted student learning in science because it did not adequately fund the "means" for inquiry-based science practice and possibly disallowed teachers to use some student-centered instructional methods.

Comments by Chikara's Teacher Partner

Without hesitation, Ms. Gail stated that the students' parents were not educationally supportive of their children because they rarely came in for conferences or returned calls regarding student performance. When a parent did come in to sign a form or in response to her "pleading" request, she or he made no comments in the interest of their child. In this context, Ms. Gail discussed the social impact of Chikara's teaching on student learning. She noted that the affinity that the students had for Chikara was related to his interest in them as individuals and the novelty of his work with them. Ms. Gail expressed the belief that the undergraduate-student relationship, combined with the enjoyment students felt by doing science, motivated them to learn more than when he was not present. With respect to the impact of the relationship on Chikara, Ms. Gail observed that he learned to be a more effective teacher as he learned about the students' backgrounds, needs, and behaviors.

Views on Self Change

At the end of the term, Chikara stated that the SLST experience had influenced his development in several ways. He expressed the belief that the experience helped him to see the educational advantages he had throughout his academic career. Unlike his students, he believed that he had parents and resources that supported his education. Additionally, Chikara believed that his preparations for the students helped him to change how he studied and thought about his own academic work in science. In his post interview he said,

> And definitely it, it just makes me think about it [science] differently. Like as if I'm explaining it to someone for class. And, and it just makes me learn it better and kind of understand all the aspects of it. I don't know why, maybe I think about science more thoroughly! … And that whole process of like when I do an experiment, I think about how I would present it. And you just learn it.

Chikara believed that he had learned to manage his time, teach better, and be more responsible to the students during the course of the partnership. He said that he "cared more" about preparing for them than he did for his own courses because, "I just think I was more so with ESEP versus leisurely doing it for some class or something. I thought I had to do it. 'Cause for just myself, I'm a little more lazy." Compared to his initial perception that they had little in common, Chikara believed that ultimately he could understand his students' situations and relate to them because their common ground in a shared interest in science. Although he felt that he had gained "a lot of respect for elementary school teachers," he did not feel that he had been influenced with regard to his purpose at college or his career plans. He was going to medical school. On the other hand he said that given the opportunity, he would enjoy teaching medicine once he became a doctor.

Summary: Chikara

Chikara's beliefs about the ability of his elementary school students to learn science changed during the course of his partnership. He modified his initial perception that only some students were able to learn science and they were uninterested and slow learners. He came to believe, by the 20th week, that all of his students were able to learn science, although some were still more able and more motivated (Table 5). Chikara sustained this belief through the 23rd week. The change is striking because he initially perceived most of his students as mentally disconnected or uninterested in learning, yet ended his partnership noting the respect that he had developed for the all of the students' intellectual abilities and interest levels. By the 20th week, Chikara believed that all of his students' interest in learning was stimulated by their science practice and he sustained this belief through the end of his partnership.

Table 5

Nature of Beliefs Recorded About Student Learning and Factors as Expressed by Chikara During each Time Period

Summary	Week 4	Week 11	Week 20	Week 23
Beliefs regarding student ability to learn science (RQ1)	Some able but slow (poor memory) in learning science; Some smarter/ more able; Most low interest; mental disconnect; excitable	Some able but slow (poor memory); Some respond to experience w/ science practice; science practice stimulated their interest in learning	"All" able to learn science; Some smarter/more able; Most interested in learning; Most motivated by experience w/science practice	"All" able to learn science; Some smarter/more able; Most interested in learning; "All" respond positively to experience w/science practice
Beliefs regarding social, cultural, & economic factors that affect student ability to learn science (RQ2)	Separation of misbehaving students allows them & others to learn; Limited student-to-teacher interaction restricts learning	Lack of parental supervision & opportunity for learning or enrichment at home negatively affects learning & health (interest, misbehavior, sleep); Inquiry-based science practice promotes learning; Peer-to-peer interaction/ teaching (group work & competition) promotes learning; College student-, scientist-role model; Chikara's friendship promotes learning	Separation of misbehaving students undermines all students' learning; Fun science practice promotes learning; College student-, scientist-role model; Chikara's friendship	Lack of parental supervision & opportunity for learning enrichment at home negatively affects learning & health; Separation of misbehaving students undermines all students' learning; Inquiry-based science practice promotes learning; Peer-to-peer interaction/teaching motivates & promotes learning; Inadequate funding & support for inquiry-based science practice by the school restricts learning; College student-, scientist-role model; Chikara's friendship

During the course of his partnership, Chikara was concerned with external factors that he believed affected the ability of his students to learn science. Of note is the change in his perception concerning the physical in-class arrangement of the students. Although he initially believed that the separation of misbehaving students from the main group allowed them and the other students a better opportunity to learn science, by week 20 he came to believe that this kind of arrangement interfered with all of the students' learning of science. This expression was noted after his statement, in week 11, that student groups and competitions which allowed students to interact and learn from each other, promoted their learning of science when it involved inquiry-based practice. He retained these beliefs about student-student interaction through the end of his partnership.

By week 11, Chikara expressed and retained through the partnership his belief that his students' ability to focus on learning was likely undermined by a lack of parental supervision and educational enrichment at home regardless of the underlying cause, i.e., systemic or individual. By week 11 he also expressed and retained his belief that his unique teaching relationship as a student-, teacher-, and scientist-role model positively affected his students' interest and ability to learn science. Unlike Anna, Badra, and Dawei, Chikara did not include the element of care in his belief about the influence of his teaching relationship with his students. Furthermore, Chikara did not reveal his beliefs about funding for science education during the course of the partnership as did the other case participants. Only in his final interview did he express his perception that Peak Elementary School restricted the students' ability to learn by providing inadequate funding and support for inquiry-based science instruction.

Case Four: Dawei (Fifth Grade Class)

The last case participant was a 20-year-old woman who taught in a fifth-grade classroom at yet another elementary school during her junior year at the university. Dawei taught science with Ms. Helen the entire academic year.

Motives

In response to questions regarding the reasons she elected to participate and stay with ESEP, Dawei spoke of her enjoyable relationship with the elementary school students in 34% of 138 responses. She made statements regarding her desire to help students learn science in 19% of her comments. Dawei expressed several other notable motives that she voiced in roughly equal frequency. She wished to gain teaching experience with elementary school students, become a better teacher, and apply her science knowledge in 12%, 10%, and 10% of her comments respectively. Additionally, 12% of her references to what kept her involved were to the pride she felt in the students' learning of science.

Classroom Observations

Dawei's lessons covered a range of topics suitable to the fifth-grade curriculum of Southern Public Schools. The average lesson was 43 minutes long with a range of 30 to 55 minutes. Although Dawei prepared most of the science lessons, she led the class an average of 32 % of the time. On one occasion Dawei led an entire lesson on mass. On another occasion, she prepared a lesson on mixtures but mostly assisted her teaching partner. Ms. Helen did the majority of the behavior management for the lessons with an average of six interventions per lesson whereas Dawei rarely intervened (Appendix R4).

Dawei used a teacher-centered pedagogic style, and a combination of teacher- and student-centered teaching styles, with equal frequency. The use of some inquiry process skills without reference to the nature of science was the most common element in Dawei's lessons. She taught the nature of science in one lesson. She included, however, the practice of science methods (e.g., observation, measurement, or documentation) skills in six out of eight lessons. In three out of eight lessons, she integrated lesson components from other areas such as language arts. I observed students apply previous knowledge in five out of eight lessons and interact with each other about science in five lessons. Dawei's fifth-grade students were always engaged and mostly enthusiastic about the science lessons that I observed. Dawei's attitude toward science was consistently positive and the content of her lessons was completely accurate except on one occasion.

Dawei was always well prepared and organized for the science lessons that I observed. Her teacher partner dominated the lesson facilitations. Dawei, however, designed and provided Ms. Helen with most of the lessons. Dawei used whole class discussions just four times in eight lessons. In one lesson, she gave an 18-minute lecture and the students took notes. When leading a class discussion, she listed all of the student responses on the board. Dawei also responded to and asked questions of the class based on individual student questions. In the fall term, I observed that she used only a few students' names in the first semester of the partnership, although she always treated everyone respectfully. By the 15th week of the partnership, Dawei was using all of the students' names in her conversations with them.

Dawei worked most often with groups or individual students on the inquiry portion of the science. She patiently showed them materials and observational techniques. In the eighth week of the partnership, she was helping all of the students with their questions and writing. She circulated from group to group, and from student to student. She helped those who approached her and sought out those who did not seem to be making progress. In the fourth observation (8^{th} partnership week) and those subsequent, she asked questions to help them think critically about the topics. Moreover, she made sure that Ms. Helen did not move the students from their research stations before they were finished with their observations and questions.

By the eighth week, the students and Dawei seemed comfortable with each other. Unlike younger students, Dawei's fifth-grade students did not generally become overtly excited when they saw her, but they were usually excited about her lessons. In the spring term, Dawei brought the students biology slides and fetal pigs from the university to enrich their learning experience. She was positive and encouraging to everyone. She often asked them questions about their work and I observed lively conversations about their observations and discoveries. Some conversations were more social in nature. In the 21^{st} week, a male student went to her with something in his eye and she kindly helped him. In that same week several students asked her about college, her studies, and how she was able to bring in specimens for them to observe.

Research Question 1: Dawei's Perceptions of her Elementary School Students' Ability to Learn Science

Dawei was concerned with her students' abilities and difficulties to learn science with almost equal frequency (68 and 66 references respectively out of 180 references in this category). She spoke less often about the students' willingness to learn (46 statements).

Student ability to learn science (ability). The beliefs that Dawei expressed about her students' abilities to learn science evolved during the course of her teaching experience. At the end of her partnership, Dawei revealed that before her SLST experience she expected to find unintelligent and below grade-level learners. This was reflected in her initial expression that there were only a few "bright" or intelligent students and in general the students were slow learners that needed repeated explanations to whole and small groups and again to individuals. At eleven weeks, she said: "And through teaching them I discovered that you have to go really slowly, can't expect them to pick up anything really fast." In her fall summary Dawei explained the inertia she saw in their ability,

> I remember the first experiment I did was the examination of soil. I had a hard time getting them to describe what they were seeing. Many of them needed prompting, like asking them what it looked like, what color was it, etc.

She had been, she said, surprised, whenever the students were able to make conceptual connections and felt that the reason lay in their slowly becoming accustomed to thinking about science and feeling comfortable expressing themselves. In her initial interview Dawei said, "Well, they've improved. But it's not like a huge jump. I think they just improved because they're getting used to it." Dawei worked to nurture student confidence with positive encouragement and individual attention. Concerned with the students' lack of writing skills, she expressed support for any measure of student development. In her fall journal she wrote, "One girl only managed to finish two sentences but she did them all by herself."

By the end of her partnership, Dawei had changed her overall belief about the ability of her students to learn science. In her post-experience interview she reflected,

> I think probably they've taught me not to judge people like on first impression, I guess, because they have all surprised me in some way. Like surprised me with some insight or some good questions or they've all surprised me in like their maturity ... When you first walk in and see them you think, these poor kids. They're all, they're so behind in school and probably not very bright. They're all so poor. But then after working with them you realize they're all very bright! They're as bright as any other kid, if not brighter. And they, they can all do the work.

When asked what indication she had that her students were learning science, Dawei's responses included the following type of evidence: (a) correct memory of and depth of thinking about facts and experiments, e.g., . "And they'll actually think and answer it themselves." (b) questions asked about science, (c) degree of engagement in and enthusiasm for the lesson, (d) ability to make conceptual connections, e.g., "They also make relationships about the activity to other parts of their life" and "…they listed a whole bunch that we don't really think about like salivation, hair growing, and sweating.", and (e) the application of knowledge and demonstration of science skills: e.g., ability to write about their science knowledge, or explain concepts to each other.

Dawei expressed the belief that student development in science was, in part, a result of her inquiry-based teaching methods. Initially, she noted that they were slow to develop "…the train of thought you need for science… [to] think about why things happen." In her fall summary, however, she related that the students had accelerated their learning from the practice of inquiry-based science. She wrote, "They are now much better at describing things and asking questions about them." In the spring and after her teaching experience, Dawei reflected on the students' improved ability to make connections from one science concept to another. She also wrote in both her fall and spring journals and spring summary that due to her teacher-partner's and her efforts, the students realized that the use of mathematical and language skills are integral to doing and learning science. Dawei wrote, "They've developed their scientific thinking and questioning … I think we've also taught them, through many exercises, that writing and math are also important parts of science."

Student will, or interest and volition to learn science (willingness). In every source, Dawei referred to the elementary school students' willingness to learn science for a total of 46 times. She consistently expressed the belief that most students wanted to learn science, but she was not sure why others were not interested in participating. In her initial interview, she believed that the reason could lie in the extremes, e.g., either they already knew the material, or it was too difficult for them to understand. Dawei noted that some students were indifferent to education in general when she said, "They just want to get through the school day. Some people, you know, there are some students that it doesn't matter what subject, it seems like they're just not interested."

Initially, Dawei expressed the belief that she needed to work with the students one-on-one similar to a tutor for them to make progress. Some students, she said, would not participate in the whole class but would respond to her alone. After 11 weeks she still believed that when she worked with students one-on-one they were more motivated to learn. At that time, however, she also expressed the belief that the students had different learning and communication styles. Some, she said, understood the concepts without help and some needed to talk first with other students.

During the first semester, Dawei noted in her journal that more students were willing to learn the science when the lessons were experiential or "hands-on." In her mid interview, she expressed the belief that text-based instruction and lectures bored the students and affected their will to learn. At that time, she also expressed the belief that the students were motivated to learn when they got to experiment or "just do" science and she sustained this belief throughout the rest of her partnership.

Student difficulties in learning science (difficulty). Much of Dawei's belief about the ability of her students to learn science grew from her expressed awareness of the difficulties they had due to underdeveloped skills. As her partnership progressed through the first term, Dawei's belief about the ability of her students to learn science was informed by her understanding that the students were "behind in the basics of education" (reading, writing, mathematics, and logic skills). In her fall journal, she wrote that she was surprised that the fifth-graders could not read or write proficiently. She discovered that her lessons were compromised if sections called for reading instructions or taking notes. Toward the end of her first semester, however, she wrote of her excitement when students made conceptual connections,

> To my amazement, they said (with a little prompting) that it [organic matter] would undergo decomposition! And when asked what kind of organisms helped decompose dirt, they answered worms and mushrooms. That made me really excited because I thought that they would not make the connection at all.

Dawei came to believe in the learning potential of her students. In the spring term when Crest Elementary School commandeered science time for standardized test preparation, Dawei stated that she believed the students would achieve more from doing a chemistry experiment because they needed to work on their reasoning skills. She noted in her journal, "The students probably don't have the logic skills necessary to do well on standardized tests. They are very bright but it takes training to answer multiple-choice questions. It is unfortunate because they didn't get to finish my chemistry lesson."

Research Question 2: Dawei's Perceptions of Social, Cultural and Economic (SCE) Factors that Affect Student Learning

Of her 88 responses involving social, cultural and economic factors that affect student learning, approximately 55% of Dawei's comments involved the culture of teaching and learning. Twenty-one percent of her comments involved home and school-system factors, and 22% of her statements referred to opportunities needed by students to learn science.

Learning factors: Home, community, politics and schools. At the end of the first semester, Dawei expressed her perception of the effects of home life, social status, and lesson content on student behavior and student achievement in science. She based her knowledge on what her students told her: "Some of them [students] though tell me things… I would say about maybe half;" She also used teacher partner supplied information: "Ms. Helen will tell me things like if a student's having problems." Dawei stated the belief that tensions at home, dress consciousness, and body image distracted the students from classroom work. She said that, although she understood that most all students at their age were influenced by these concerns, she had not expected the distractions to be so pervasive. Moreover, Dawei stated that because of their exposure to familial hardships (e.g., foster homes) the students were, "in some ways more socially conscious and open than their upper-class counterparts." She gave an example involving their openness to mixed-race family types. After several researcher visits, the students asked Dawei if I was her mother. This experience was novel for Dawei. In her fall journal she wrote,

> I have never been asked that when I am with a White woman, and I doubt that I would ever be asked that by the people I normally deal with. It made me happy that they didn't see my Asian background as making me different from them. Because the class is totally Black, they probably didn't have much experience with Asians. I found it a refreshing change from the world I come from.

In the spring, she wrote that she believed the students respected each other more than the young students she knew growing up who were economically better off.

In the fourth week, Dawei said she was shocked to find that her teacher partner replaced the planned science lesson with a health related activity in recipe preparation. The students, she noted, were interested in doing science experiments and upset to the point of misbehavior by the recipe lesson that had no exploratory component. Due to this type of lesson inconsistency and additional school sponsored interruptions, Dawei believed that her students were behind in their learning of science and she would have to work hard to improvise unique lessons to counter the disabling effects of those factors. By her 20th week of teaching, Dawei stated that she believed the amount of time the schools allotted to teach science was too little. She made a connection between the decreasing number of undergraduates going into science in our country and a need to enhance science time and science instruction in elementary schools like Crest. She believed that the students were discouraged and prevented from learning science by the politics of public education, school, and the school system. In addition to robbing time from science instruction, the innumerable interruptions and preemptions such as pretest practice, testing, entertainment assemblies, tornado drills, etc., also interfered with her utilization of the science kit curriculum available only on a prescribed rotation. In her near-end interview she explained,

> I think, like the way school works, you go in and they don't get science time and that sort of discourages them. Like Wednesday I was supposed to teach and I couldn't [because science time had been replaced by test preparation], so I had to clear my schedule to teach today. That's where it discourages [the students and her]. … And then we have to move everything over and so we don't accomplish what we need to get accomplished and things get cut off.

By that time, Dawei also considered the logistics of large class size to be a major barrier to student learning. In a large class, she said, fewer students could actually do the experiment and access her or Ms. Helen for discussion and guidance. Again, this reflects Dawei's concern with the issue of adequate time to practice science.

Learning factors: Culture of teaching and learning. Although after 11 weeks Dawei continued to express the belief that when she worked with students one-on-one, they were more motivated to learn, she also determined that peer-to-peer teaching through group work expedited student learning. In her mid interview she noted, "I think it helps when they teach each other, 'cause they can explain things so that they understand each other [in ways] that sometimes we [teachers] can't do." Although some students still preferred to interact with her one-on-one versus with the whole class, she no longer associated this with an impaired ability to learn science. In the late spring, Dawei stated that the students learned and remembered better when teaching methods allowed them to work in groups. She said,

> Maybe we underestimated the students in how they would get organized and work in groups. The teacher wasn't expecting everything to run so smoothly. Usually we run out of time and have to rush…More of them are participating. When they're in their groups doing the experiments almost all of them are part of the group, working together.

By December, she believed that her knowledge of the students helped her to change her methods of communication to accommodate student needs and promote the students' critical thinking skills. In her mid interview she said, "…it's a very cultural thing. I've had to sort of change myself to like match my duty to ESEP. So I changed myself so I can teach them." Dawei continued the practice of getting to know her students throughout her partnership experience. She wrote in her fall summary,

> I think I am a better teacher now than I was before. I have changed the way I think and teach because of the students. Now I ask questions to make students think more than recall. The experiments I design are simple but can relate to many things… I probably remember and know more things that the students are interested in than she [Ms. Helen] does.

As she taught in the spring semester, Dawei revisited her belief that limited science-lesson time restricted the opportunities for the students to think critically about what they were doing. Although the students learned to ask questions and perform experiments, she needed time to get them to think about their findings. In her post interview she said, "If it's [questioning] before [the experiment], sometimes they'll do it because they're excited to get to the experiments. But after, you have to really motivate them to finish [the thinking]." As noted, to motivate the students and counter the time limitations, Dawei perceived that she effectively changed her teaching methods. She felt that she had changed the way she approached them concerning science by modifying her questioning techniques and talking about things that interested them as well as those things that interested her.

Like Badra, Dawei stated that at the start of the partnership she had not anticipated that she would become attached to the students, but that she would "just go and teach…" By the end of her partnership she expressed the belief that her care to get to know them and what they were interested in had helped to expedite their learning. In her post interview she explained her unique teaching relationship,

> I think they see me as a friend, yet still a little separate from them; not just like one of the students. They treat me a little differently than they treat each other. But they treat me differently than they would the teacher. So I'm sort of in between, I guess. They tell me things that they wouldn't tell the teacher. They don't tell me everything. So they know I'm still an authority figure, but they know I'm more relaxed than the teacher is…If I give them the attention, they'll focus on what they're doing and they'll give me the answer if they know I'm looking for it.

Although she believed that they had the ability to learn the reading, mathematics, and science at their grade level, Dawei stated in her post interview that she also believed that the students were being undereducated by Crest Elementary School and would arrive in middle school under prepared. Additionally, Dawei perceived that they would be better served to succeed academically if teachers would use science as the base for instruction in language arts and mathematics in the elementary, middle, and secondary grades.

Learning factors: SES and student opportunity. As noted, once she got to know them, Dawei believed that her students had the ability and will to learn science. When asked in her initial interview about the barriers to learning science, she identified the lack opportunities to use simple materials for science lessons and experiments. She believed that schools with low SES students often did not have enough money for appropriate resources. Although she retained this belief, by the end of the partnership Dawei perceived that the students had gained from the ESEP science teaching innovation that valued inquiry-based science lessons and utilized undergraduate teaching partners as role models and learning expediters. She included this with her other belief in support of small class size. In her spring summary she wrote,

> I think the students gained the most from this partnership. Most of them have never had an ESEP partner or [science] kits. I know they enjoyed the hands on science very much. They may not like school or Ms Helen (so some have told me) but at least they can have fun learning for an hour. Science can be cool for them.

During the course of her partnership, Dawei modified her belief to include the following five opportunities that low SES students usually did not have: (1) college science-partners, (2) inquiry-based lessons with materials and informed teachers, (3) science lessons integrated with mathematics and language arts, (4) small classes for greater teacher-to-student interaction, and (5) the time to practice science. In her fall journal, for example, she noted that when she had an unavoidable conflict on a regularly scheduled teaching day, her students often did not actually practice science with their teacher. Instead, they listened to non sequenced science lectures or participated in disconnected activities such as recipe writing and worksheet assignments. However, once her teacher-partner started using the science kit-curriculum in the spring, Dawei believed that the students had more opportunities to learn science. When Dawei was not able to be present, her teacher partner had the materials and plans to follow. In her spring journal, Dawei wrote of her admiration for the students' demeanor and outlook: "They had such hope and enthusiasm for life that many adults in their [educational and social class] situation do not. That's why I enjoyed working with them; they did not really consider themselves to be disadvantaged."

<u>Comments by Dawei's Teacher Partner</u>

In reference to factors that affect the students' learning of science, Helen stated that she believed Dawei gained a greater understanding of the school system and the educational difficulties that students and teachers encounter as they try to meet educational goals.

Views on Self Change

At the end of the term, Dawei stated that the SLST experience had influenced her to re-evaluate her childhood and education. She said, "Working with these kids, I have gained a better appreciation for what I have. I know that I am very lucky and I would be wasting my resources if I didn't succeed in life." When Dawei considered other changes, she thought of how she managed her own academic work. She stated,

> I might be a little more motivated to finish work. Also, when I learned something in ESEP, it sort of makes me want to learn more about it in college… it sort of makes me more interested in how things work.

Some of the change in her thinking involved how she perceived science as connected to the world around her. She explained,

> I definitely see root-science relationships with everything now, because I have to make them relate to everything in the classroom. And so I see it [science] as more of a useful thing that applies to everything rather than just something you do in a lab. Before, science was sometimes just some theories to memorize.

This was a big change from her thinking about science in her fourth-week interview where she identified science as a type of language with vocabulary that needed to be learned and used appropriately.

Dawei said she believed that the students helped her to remember and understand the concerns of and influences on children. Moreover, because of her heightened social awareness, Dawei involved herself in university seminars on race relations. In her post interview, she stated that the teaching experience stimulated her interest in the students' culture and community with respect to the issues she encountered while teaching. Dawei compassionately said, "I am definitely more interested in like in their culture and the community and the problems in teaching because you experience it. And it made me wonder if maybe we can change it." Like Badra, she believed that she was a better person for the experience: "…to get to know the kids is really great and it made me sort of positive to know that I was doing something good." She also believed that she was more patient and better able to work with diverse people based on the unique teaching relationship that she had with the students. Dawei explained,

> I think the attachment with them has been really meaningful and helpful in a way because in college I don't get much contact with anyone besides college students. And so since they're from a different neighborhood, sort of, I think it's good to be in contact and good to make a relationship with people in that area.

This was useful, she believed, because her plan to become a medical doctor had not changed; however, she had become more purposeful about the type of medicine she would practice. Dawei said, "So pediatrics or family. Something with lots of contacts with people, I think. I really liked that after the year of working with them. I want to do more people things." Moreover, she said she believed that her enhanced communication and people skills would be an advantage for her future career in medicine.

Summary: Dawei

Dawei's beliefs about the ability of her elementary school students to learn science changed dramatically as evidenced by her expressions during the course of her partnership. Like Anna, Dawei's stated pre service-learning expectation was that her students would be below grade level in ability and not very intelligent. Like Badra and Chikara, Dawei also initially stated that the students were slow learners. Although at the outset she differed from the other case participants in that she perceived that most of her students were interested in learning science, she also believed that they all needed one-on-one work with her to learn. By the end of the first semester, Dawei believed that student ability was related to their different learning and communication styles. At the end of her SLST experience, Dawei admiringly expressed her belief that her students' intelligence and ability to learn science surpassed those of other students their age who were not affected by social, cultural, and economic hardships (Table 6).

Table 6

Nature of Beliefs Recorded about Student Learning and Factors as Expressed by Dawei During each Time Period

Summary	Expec-tation*	Week 4	Week 11	Week 20	Week 23
Beliefs regarding student ability to learn science (RQ1)	Most probably not intelligent and below grade level in ability	Some able but slow learners; Some only learn methods; Most interested in learning Students; need 1-on-1 w/teacher	Most able Students have different learning/ communication styles; Most interested in learning; Stu need 1-on-1	"All" able; "All" intelligent; "All" need logic training; Most interested in learning; Some students prefer 1-on-1 w/teacher	"All" able more so than most; "All" intelligent; Most interested in learning; "All" learned science yet are under prepared for middle school studies
Beliefs regarding social, cultural, & economic factors that affect student ability to learn science (RQ2)	Only as a teacher would she affect their ability to learn	Poor skills /boredom w/subject restricts ability; Low funding for resource materials & inquiry lesson consistency restricts; Experience w/science practice promotes learning	·Home life can both distract & support Text-based/ lectures= negative; Steady inquiry-based science practice promotes learning; Peer-to-peer interaction/ teaching (group work) promotes; Careful & responsive teaching promotes	Home life can both distract & support ability; Steady inquiry-based science practice promotes learning; Low school funding & time for science restricts present & future ability; Small class size promotes learning; Peer-to-peer interaction/ teaching (group work) promotes learning; Careful & responsive teaching promotes	Steady inquiry-based science practice promotes; Peer-to-peer interaction/ teach promotes Small class promotes; Responsive informed teaching promotes; Politics/SPS under funds science; Crest under prepares stu: math, lang, science; Integrated science, math, lang lessons promote; College stu-scientist-role model & friend; Dawei's caring interest/attention

* Expectation = belief(s) stated by participant during study about expectation held before SLST experience.

Initially, Dawei perceived that their poor academic skills and inexperience with science practice negatively affected her students' ability to learn. In contrast, by the end of 11 weeks Dawei identified influential factors external to the students that involved the methods used in the teaching of science. She stated and maintained the belief that adequate time to practice inquiry-based science integrated with math and language arts by a careful, responsive, and informed teacher positively influences the students' ability to learn. Moreover, from that time she also expressed and sustained the belief that the students gained from the opportunity to learn from each other while in organized groups. With respect to these things, Dawei believed that the students had been under prepared by their elementary school. Dawei's belief about the influence of the students' home life was unlike Anna's and Chikara's, and more like Badra's in her acknowledgement of a
potentially dichotomous affect. At the end of 11 weeks, she established and maintained into the spring term that she believed the students' home life could both distract and support a students' ability to learn science. In the combined role of college student, teacher, scientist, and friend, Dawei perceived herself by the end of her partnership as a positive influence on her students' ability to learn science.

Summary: Undergraduate Case Participants

The four undergraduate case participants expressed a total of 20 similar beliefs regarding their students (Table 7). With respect to research question one−In what way did the undergraduate's expressions of beliefs about the ability of their elementary school students to learn science change during the course of the SLST partnership experience?−all participants changed or modified their beliefs by the end of their service learning in science teaching experience. In the early stage of their partnerships, the undergraduate beliefs ranged widely from expressions that most students' were unintelligent and their ability to learn was compromised, to most were able, but slow. By the end of their partnerships, all case participants came to believe that their students were intelligent (Table S1, Appendix S). This was one in four of the beliefs expressed relevant to research question one (Figure 1). Also by that time, all participants believed that most students were able to learn science. Anna, however, was unlike the others in that she believed student learning would not persist beyond her science classroom.

Table 7

Similar Beliefs Concerning Students Expressed by Undergraduate Case Participants at End of Term (√ = belief expressed; --- = belief not expressed)

	Belief	Anna	Badra	Chikara	Dawei
	RQ 1: Ability to learn science				
1	Most students can learn science	---	√	√	√
2	Most students can learn science but learning is probably limited to the science classroom	√	---	---	---
3	Most students are intelligent	√	√	√	√
4	Students have different learning strengths and weaknesses	√	---	√	---
	RQ 2: Social, cultural and economic factors				
5	Students have different learning styles that affect learning	√	√	√	√
6	Student motivation is a factor affecting learning	√	√	√	√
7	Available resources/opportunity for science affect a student's ability to learn (need more)	√	√	√	√
8	The physical structure/environment of the school affects student learning	√	√	√	---
9	Science knowledge/skill can be an economic equalizer	√	√	---	---
10	Science knowledge/skill is important for everyone's development (value)	√	√	√	√
11	Teaching methods affect learning: methods should be flexible & responsive	√	√	√	√
12	Teaching methods affect learning: methods should be inquiry-based & relevant	√	√	√	√
13	Teachers need more science knowledge to teach science	√	√	√	√
14	A caring teacher positively affects student learning	√	√	---	√
15	Their unique teaching relationship with the students affects student learning (friend, role model, teacher)	√	√	√	√
16	Parental support of educ & home environ has positive & negative effects on student learning (uneven)	---	√	---	√
17	Parental support of educ & home environ has negative effect on student learning	√	---	√	---
18	Educational systems affect students' ability to learn (under education)	√	---	---	√
19	Political systems can affect students' ability to learn w/ respect to value of public science education	√	√	---	√
20	Class size affects students' ability to learn science	---	---	√	√

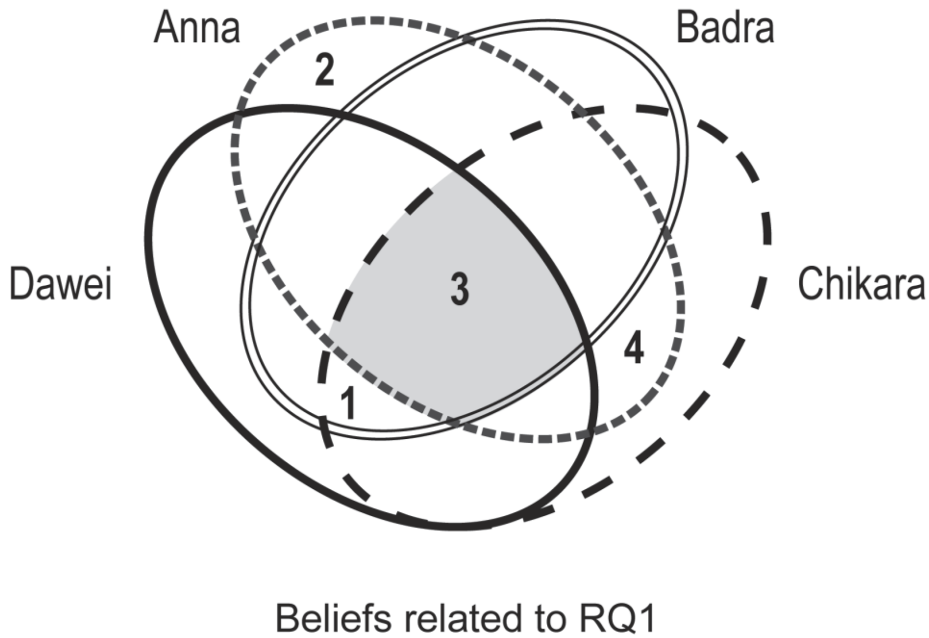

Figure 1. Similar beliefs shared by the case study participants that are related to research question one (RQ1) about the ability of elementary school students to learn science. Numbers correspond to expressed beliefs in Table 7.

The first time Anna stated that she believed some of her students were able to learn science was in the 20th week interview. Three weeks later, she stated that she believed that most of her students were intelligent and motivated as well as able. The other science undergraduates showed similarly marked shifts in the spring term. By the 20th week interview, Chikara and Dawei modified their belief that just some of their students could learn, to the belief that "all" of their students were able and interested in learning science. Similarly at that time, Badra changed from the belief that the students had poor memories to the view that they had "vivid" memories and could learn any subject including science.

With respect to research question two--In what way did the undergraduate's expressions of beliefs about social, cultural, and economic factors that affect their elementary school students' learning change during the course of the SLST partnership experience?--by the end of the partnerships, all case participants expressed in common eight of sixteen, or 50%, similar beliefs about factors (Figure 2). Those factors are: (1) the various student learning styles, (2) student motivation, (3) opportunity for science practice, (4) the valuing of science knowledge and skills by teachers and students, (5) flexible and responsive teaching methods, (6) inquiry-based and relevant teaching, (7) science-informed teachers, and (8) the undergraduates' unique teaching relationship with the students. Badra, Chikara, and Dawei attributed student learning issues, in part, to broad science curriculum and teaching factors as early as four weeks into their partnerships. By 11 weeks they identified specific factors in those areas.

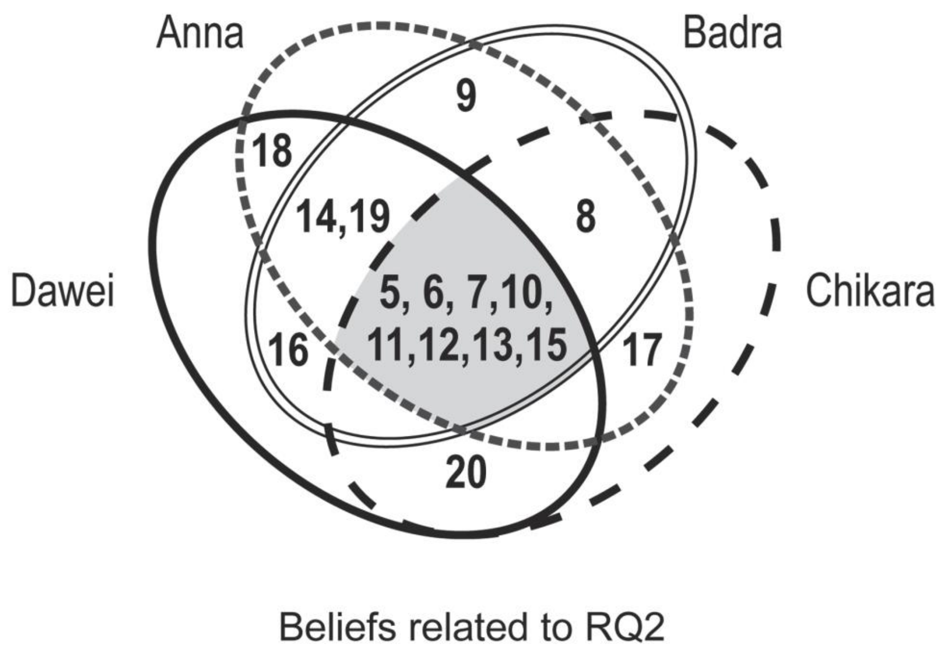

Figure 2. Similar beliefs shared by the case study participants that are related to research question two (RQ2) about the social, cultural, and economic factors that affect the ability of elementary school students to learn science. Numbers correspond to expressed beliefs in Table 7.

In comparison, Anna vacillated about teacher competency and school financing up until the 20th week after which she expressed the view that incompetent science teachers affected the students’ ability to learn science (Table U2, Appendix U).

In addition to the eight similar beliefs held in common, the undergraduates also uniformly expressed that the students’ lives outside of school and parental involvement were factors. Two undergraduates (Anna and Chikara) interpreted home life and parental involvement as negative influences and two undergraduates (Badra and Dawei) interpreted them as both positive and negative influence on students’ ability to learn science. Moreover, three undergraduates uniformly expressed similar beliefs in three additional factors that affect student ability to learn science. Those are: (1) the school environment, (2) a caring teacher, and (3) political systems with respect to adequate value placed on public science education.

The undergraduates identified ten similar ways that they believed they had personally changed. Five of these beliefs, or 50%, were uniformly expressed. Each case participant believed that they had: (1) gained an appreciation for the privileges of their own educational background, (2) were relieved of the sense of social and cultural isolation that they felt at the university, (3) gained new a understanding of others’ situations, (4) become more confident and effective teachers and communicators both in the elementary school classroom and at college, and (5) changed how they understood and thought about science (Table 8).

Table 8
Similar Beliefs Concerning Profound and Lasting Impact on Self and Self Knowledge Expressed by Undergraduate Case Participants at the End of the Partnership

	Belief	Anna	Badra	Chikara	Dawei
1	Gained new understanding of others' situations; empathy	√	√	√	√
2	Gained realization & appreciation for the privilege of their educational background (own education, the education system, and family care/support)	√	√	√	√
3	Was relieved of cultural/social isolation experienced at college; gained a sense of connectedness	√	√	√	√
4	Raised respect/admiration for elementary school teachers/profession	√	---	√	√
5	Gained realization of previous biases regarding students	√	---	---	√
6	Became more open minded, and patient or tolerant of others	---	---	---	√
7	Enhanced or gained time management ability	√	---	√	√
8	Became more confident communicator and teacher; able to work with others	√	√	√	√
9	Enhanced or gained reason for and commitment to study (sense of purpose)	√	√	---	√
10	Changed understanding of or thinking about science	√	√	√	√

√ = belief expressed; --- = belief not expressed

In the classroom, three of the undergraduates (Badra, Chikara, and Dawei) increased their encouragement of peer-to-peer interaction and teaching during the course of the partnerships. Moreover, all four case participants variously utilized questioning strategies that encouraged the students to extend and apply what they knew to other contexts and topics. I observed Badra include critical thinking types of questions in her lessons as early as the 8th week. Her concern that the students be able to apply what they learned to their world outside of the classroom became more dominant in her statements and classroom behavior in the spring term. By the 8th week, Dawei was asking the students questions about why things happened in order to, as she said, "make them think." I observed a transition to this type of questioning by Chikara during the 17th week of his partnership. From that point on, his review sessions and small group discussions included fewer recall type questions. Lastly in the 20th and 22nd weeks of her partnership, Anna asked her first-grade students to apply what they knew about weather and temperature to their understanding of earlier lessons on animals and their habitats.

In the next section, I present the beliefs about student learning that were stated by 20 additional Emory ESEP science-undergraduates who also partnered to teach science to local elementary school students. As noted, I sampled the focus groups at the end of the fall and spring terms and analyzed each set separately. The data are supportive and intended only to extend the standard for the ESEP undergraduate experience. Because of this, I combined the findings and provide a more succinct reduction for the focus group discussants than for the case participants.

ESEP Science Undergraduates (Focus Group Discussants)

In response to the moderator's protocol at the end of the fall and spring semesters, a total of 20 ESEP science partners (eleven and nine undergraduates, respectively) discussed their beliefs about how they had most profoundly changed intellectually, professionally, politically, and emotionally. The moderator also asked them to discuss their perspectives on society, humanity, and education, with respect to their SLST experience.

Together, the four undergraduate case participants and the focus group discussants expressed a total of 20 similar beliefs relevant to research questions one and two (Table T1, Appendix T). The science undergraduates in the fall and spring focus-group samples expressed all but two of the 20 similar perceptions expressed by the case participants concerning their beliefs about the ability of their elementary school students to learn science and factors that affect learning. Additionally, the undergraduate case participants and the undergraduate discussants in the fall and spring ESEP focus groups together expressed ten similar beliefs about changes that they perceived in themselves as a result of their SLST experience (Table T2, Appendix T).

The following description of the focus group discussions reveals the degree to which the beliefs expressed by other ESEP science undergraduates support those of the case participants.

Research Question 1: Focus Group Discussants' Perceptions of the Elementary School Students' Ability to Learn Science

Student ability to learn science (ability). A majority of the undergraduates said they believed that their students had the ability to and were learning science. The indicators of learning that they noted include: (a) student memory of science information and concepts, (b) conceptual connections or "insights" that students gained, (c) application of previous learning to new situations, (d) asking "intelligent" questions, e.g., "I hear people in my college classes that don't ask questions as smart as some of these kids do…", and (e) excitement for, interest in, and participation in inquiry-based science. The indications that the discussants gave for student learning are analogous to those given by the case participants which are analogous to each other.

The undergraduates who taught science in classrooms with students from a range of SES levels pointed out that all of the students were equally able to learn science. One of the males said, "Like, none of them are doing any better than others." Several said that they learned that students have a wide array of "intelligences" in addition to, "… being able to answer questions about science or having the ability to understand concepts." The women stated that the majority of their students were "bright," "perceptive," and "talented." One undergraduate, however, expressed his concern that the students' learning was probably short term due to their poor memory. Although no other focus group discussants expressed this most pessimistic belief about student ability, it is similar to Anna's perception that her low SES students were, in general, not interested in learning and had little chance for success.

Student will, or interest and volition to learn science (willingness). Most of the undergraduates expressed the perception that social, cultural, and economic factors can affect student learning of science, a change, they said, from their earlier perceptions that poor performance by low SES students involved the students' nature and effort to study. A male undergraduate explained what he used to believe: "You're always like, [your underachievement] it's because you're lazy. Or the reason he's working there [e.g., manual labor] is because he didn't work hard [in school]."

Several undergraduates talked about their early shock at the initially high numbers of students who appeared to be apathetic about learning. They based their expectations of the students' behavior on their own childhood interests in science. A female undergraduate said, "And it kind of took me aback [startled me] because I was like, you know, why is this?" All of the women voiced the belief that their students were willing to learn. In contrast, two men stated more reservedly that although most can learn, not all students were enthusiastic about learning and many seemed disinterested. Everyone agreed, however, that like anyone the students had certain strengths and weaknesses and the degree of student motivation is an important factor that affected their learning. Most discussants expressed their delight with the subsequent enthusiasm that they said most of the students developed for science during the course of the term.

Research Question 2: Focus Group Discussants' Perceptions of Social, Cultural and Economic Factors that Affect Student Learning

Most of the undergraduates expressed the perception that a variety of social, cultural, and economic factors can affect student learning of science. One woman set the tone in a discussion regarding student performance levels when she said that although she previously doubted "…all those people who said that people choose to be in a social strata or that certain races are inferior to others…", she believed that her SLST experience provided her with firsthand examples of how this was not true. When probed she said, "It made me more aware of the causes of their [students'] situation. … it's not their own inherent inability to do anything. It's the things around them that are holding them back."

Learning factors: Home, community, politics and schools. Many of the undergraduates expressed the belief that, in the interest of the students' future success, the home life of some of the students should be more supportive of their education. The returning undergraduates, who had partnered with both low- and middle-SES students, believed that there were two sets of parental expectations for teachers that drove much of what they saw in the classroom. At one extreme, the discussants perceived that the low-income parents left too much up to the teachers for reasons of job-related time restrictions or disinterest. At the other extreme, they perceived that the middle-income parents were too demanding of the teachers by assuming that their children would excel academically. The ESEP undergraduates expressed the belief that neither parental group held their children responsible for their performance.

A male opined, "I think it's difficult for the education system to overcome, you know, a background which doesn't kind of promote or bolster what's going on in the classroom…" Several women referred to their surprise at the varied degree of parental interest that they observed. A young woman said,

> In my class they'd [visiting parents] just sit in the back and sometimes they get involved with their kids and sometimes they don't, and sometimes they just

> wander in to see what their kids are doing, which really I thought was great because that's what happened in my elementary school. But then you have the other half of the class where the parents don't care… "I'm too busy, I don't have time," that's what their answer is. And it's their kid. So I had a lot of trouble dealing with that…

A male undergraduate talked about how he believed he changed his thinking about a low performing student with whom he felt frustrated all term. He said,

> That he doesn't exactly have the most stable life at home… I think I became so focused on him doing the work that I never really realized what else goes on in the kid's life. And this made me realize that there are other things that affect their behavior…It takes a kind of egocentrism out of it.

Another undergraduate described the complexity of the issue when he said,

> I think there is a strong relationship between the two environments and I wouldn't say that it's completely one or the other. I tend to think that a lot of people do say that it's family life that affects education, but education is also affected by [what goes on in] the school.

<u>Learning factors: Culture of teaching and learning.</u> Some of the focus group discussants made statements acknowledging that, compared to their own experience, they believed there were differences in the way science teaching and learning was valued in the elementary school classroom. A male said of his students,

> …when I walk in there, they're sitting there drudging through their [science] books, like reading and looking dull. They're not having a good time. And then you bring in this new experiment or whatever and they get excited about it and they want to learn.

Some undergraduates judged that good science teachers, in part, influenced performance by helping students to be motivated learners. For example, a male said, "I guess that I've learned that they [students] all have the ability and they want to learn but it's just they haven't been presented with the material in a way that makes them interested in it.". In way of explanation of why student performance had been low, several of the undergraduates believed that there were other problems, like degree of science knowledge, with the public school teachers' abilities to teach science well. Moreover, they doubted that their teacher partners would teach active inquiry-based science if they did not have a college science-partner to work with them.

Most of the undergraduates acknowledged that they came to believe that people learn in different ways and part of the learning process involves learning about the methods that teachers use. One woman said her SLST experience,

> …it allowed me to see that not everyone can learn in the same manner that we're used to learning in college or we were used to learn in our education system and that some students in different educational environments have to learn in different manners and different ways.

In response to this view, all of the discussants expressed the belief that the science partners and teachers must be responsive to those student learning-styles by using various teaching methods. One young man said, "It's important to be open to the different ideas and different ways to approach either problems from the standpoint of someone is not learning something or it's just not making sense to them…" They expressed the belief that the lessons had to be prepared so that the students would be more interested in and get more out of the experience and "exchange." A young woman said, "As opposed to lectures, I think it [teaching and learning] is kind of more interactive." Another young woman said, "… there are other [student] factors that I have to put into it [the lesson] … to alter it slightly so that it fits in more with the level that they're at and the area that they're coming from."

Notably, most of the undergraduates called for more time and resources dedicated to science instruction. Several said that the teachers were under pressure simply to prepare students to take standardized tests, which de-emphasized doing science. Most of the undergraduates believed that the teachers and schools were torn between responding to individual student needs and "…fighting against a system that makes them teach towards a test…" Moreover, they reasoned that the teachers and schools were not entirely at fault for poor science education opportunities because society required testing. Some discussants interpreted the use of the traditional teaching methods that they observed as a lack of systemic care to promote student learning of science.

Learning factors: SES and student opportunity. Both male and female undergraduates stated that they believed the range of educational factors, such as financial resources, was uneven for their public school students. This "great disparity" was perceived to be a major dynamic affecting the ability of low income students to learn science and in the broader social scheme, "…to just help them rise up a little." Several ESEP undergraduates, who came from low income families, believed that some elementary school students were unnecessarily "trapped" in their social stratum because they did not know the "ways to work hard and to get scholarships and to rise above your situation." Those undergraduates, whose parents did not have college degrees, had all attended public schools. All of the discussants agreed that there should be more of an effort made to inform the students of their potential, as was done for them. One female expressed the belief that the idea of economic immobility among poor people with access to education was peculiar to the United States, because in her country (Jamaica) education is "…the only way you can get out." The discussants said that they believed that the students needed help to gain knowledge with respect to social and economic mobility and this, they believed, was a result of a political devaluing of public education.

All of the women said that their personal teaching relationship with the students positively influenced the students' science learning. They additionally believed that their role in the relationship was that of a unique helper and friend who was also a student and scientist role model. All male and female undergraduates talked about how the elementary school students became their personal friends, no longer the nameless and faceless poor of the statistics with which they had some familiarity, but no identity. Responding to the moderator's probe (M) for the specifics that the SLST experience revealed to her, a young woman (F) said,

> F: Well, I guess just [that there are] kids that aren't as fortunate, or they haven't grown up how we have grown up.
> M: *But you've known that in our society there are rich people and there are poor people, you've known that.*
> F: I've known that and I've read it and I've heard it… I had the information, but I hadn't been exposed to it firsthand. So it was more of a personal experience as being real.

Most of the undergraduates expressed their concern about the students' future success. In terms of an opportunity for the students, they stated their belief that their responsibility as "role models," was to impart to the students their own interest and belief in education as a way to a stable and prosperous life by "opening the kids' eyes to college …[to] finish high school and [their] education and [that is] what it's all about." They recalled that they were surprised to find that their students did not know about college students, college as an institution, or Emory as a local university. Likewise, the undergraduates believed that they were themselves socially and culturally sequestered on the college campus where they were "…exposed to people from different backgrounds but they're mostly high status, good financial backgrounds…" and that they were able to realize this when they met and worked with the elementary school students. A male undergraduate insisted,

> I mean you need real-world experience. If you don't go out into the community, you don't get in it. You've just got this sheltered little __ [life]. And when you go out, you can see.

In these ways, the undergraduates perceived that both they and their students had been socially isolated. Just as the undergraduates believed that their partnership provided the elementary school students a previously missing opportunity to learn about science and ways to help themselves, they also believed that it extended their own education.

<u>Views on Self Change</u>

All of the undergraduates stated that they believed that their SLST experience had a profound and lasting impact on them. Each voiced a realization of some previous biases toward people of low SES and a limited understanding of others' situations. A young man said, "I guess that no matter how typical I think my experiences are, they probably aren't." Contrary to her early expectation, one undergraduate was surprised to find that her SPS elementary school was not "horrible". A senior contrasted his experience-based gains to other outcomes of his college education. He said, "I do not feel I'm particularly more well rounded after finishing four years of sitting in lecture…I don't think I've learned a lot from my undergraduate experience except for when it comes to ESEP." He credited his and his ESEP peers' enhanced understanding of community and social issues to the science teaching experience that took them out of a "four-wall kind of bubble of sorts…" while connecting them to academic learning. All of the undergraduates expressed the belief that they had become more open minded and patient with people of all ages and backgrounds.

The majority talked about having more confidence to work with people different from themselves. A young woman emphatically stated, “I can carry this experience on to my future endeavors. And that is what I plan to do. Well, even working in hospitals with different patients and just being able to interact with everyone.” Several undergraduates also thought that they had become better teachers.

All of the discussants passionately expressed that they had been privileged with the opportunity for a better education than their students and that they had previously taken their own academic successes for granted. Moreover, one young man believed that unlike his students’ situation, educational objectives and processes had been set up for him to achieve and progress toward a professional career. He said,

> …it’s a realization over the whole semester … I mean I’ve been lucky, I came from a background where, you know, it was like built to succeed. They want to strive to help you in every facet of life to succeed.”

Several of the undergraduates expressed the belief that the realization of their privileged position motivated them to put more effort into their own academic work at college. Some males specified the belief that they had gained from the experience a “sense of purpose” in life and a reason for studying. They considered the SLST experience to be a unique type of opportunity for self-change that should be valued more in higher education.

To summarize, there is a strong pattern of support among the fall and spring discussants for the beliefs similar to those expressed by the case participants about the ability of the elementary students to learn science, the factors affecting their learning, and the changes that the undergraduates perceived in themselves and credited to the service learning in science teaching experience. Of the 20 total beliefs, 18, or 90% were voiced by one or more case participants and also voiced by the ESEP science undergraduates of one or both focus groups (Table 9).

Table 9

Percent of Similar Beliefs Concerning Student Ability to Learn and Factors Affecting Learning Expressed by Case Participants and Focus Group Discussants

Research Question (RQ)	No. Total beliefs expressed at end of partnership	Agreement with one or more case participants and one or both focus groups
RQ 1 and 2 (ability and factors)	20	90% (18)*
RQ 1 (ability)	4	100% (4)
RQ 2 (factors)	16	88% (14)

* = (# of beliefs).

The two exceptions involve beliefs about factors relevant to research question two. These beliefs were stated by two case participants, but not stated in either focus group sample. The first exception concerns a perceived negative effect of parental involvement and home environment on the students' learning. Although case participants Badra and Dawei, as well as the fall and spring discussants, believed that parental involvement and home life both positively and negatively affect student learning, Anna and Chikara perceived those factors to be singularly detrimental to learning. The second exception concerns the belief that class size affects student learning. Only Chikara and Dawei stated that class size was a factor.

Of the four similar beliefs relevant to the ability of students to learn science, 100% were expressed in common by case participants and focus group discussants. Three of the participants and both focus groups believed that most students can learn science. Anna and a few spring discussants believed that although most students can learn, their ability and chance for future academic success is probably limited. In the total set of beliefs, this pessimistic view was expressed by a single participant and a single focus group discussant.

Of the 16 similar beliefs that were voiced by one or more case participants concerning factors that affect the students' learning, 14 or 88% were also expressed by the members of one or both focus groups. As noted, there are two beliefs that are not supported by the discussants in either focus group, however, eight or 50% were uniformly held beliefs by all four case participants and both fall and spring focus group discussants (Table 10). The eight uniformly held beliefs involve the influences of (1) student learning styles, (2) motivation to learn, (3) resources and opportunity to do science, (4) the valuing of science knowledge and skills, (5) responsive methods, (6) inquiry-based methods, (7) teacher's science knowledge, and (8) the unique undergraduate and student teaching relationship.

Table 10
Percent of Uniformly Held Similar Beliefs Concerning Student Ability to Learn and Factors Affecting Learning Expressed by All Four Case Participants and Both Focus Groups

Research Question (RQ)	Total beliefs expressed at end of partnership	Agreement with all four case participants and both focus groups
RQ 1 and 2 (ability and factors)	20	40% (8)*
RQ 1 (ability)	4	0
RQ 2 (factors)	16	50% (8)

* = (# of beliefs).

At least two case participants and the ESEP science undergraduates of one or both focus groups expressed eight or 80% of the ten similar beliefs about self change (Table 11). Moreover, three of those beliefs−gained appreciation for their own educational background, was relieved of the social and cultural isolation that they experienced at college, and gained new understanding of others' situations–were uniformly voiced by all participants and both focus groups (Table T2, Appendix T). Two beliefs, i.e., understanding science, and respect for elementary school teachers, were not expressed in either focus group. In point of clarification, only the case participants were asked directly about the influence of their experience on their understanding of science.

Table 11
Percent of Ten Similar Beliefs Concerning Lasting Impact On Self and Self Knowledge Expressed by Case Participants and Focus Group Discussants at End of Partnership

Agreement with neither focus group	Agreement with one focus group only	Agreement with both focus groups	Agreement with one or both focus groups
20%	20%	60%	80%

The data from this longitudinal study provide evidence that the four case study participants and other ESEP undergraduates shared similar beliefs about the ability of their students to learn science by the end of their SLST partnership. The percent of similar beliefs expressed by the case participants and other ESEP undergraduates is high. Moreover, there is evidence that the SLST science undergraduates perceived themselves as profoundly changed by the experience. In the next chapter, I discuss the study findings with respect to the service learning literature, the implications for theory and research, and ideas for future research.

CHAPTER 5. DISCUSSION

> In the end, the goal of the undergraduate experience is not *only* to prepare the undergraduates for careers, but to enable them to live lives of dignity and purpose; not *only* to give knowledge to the student, but to channel knowledge to humane ends. (Ernest Boyer, 1987, p. 219)

The issues of engagement and perceived social isolation continue to detract from U.S. colleges' abilities to retain and prepare a scientifically literate and skilled undergraduate for an increasingly diverse workforce. My research advances our understanding of the development of the undergraduate science student's perception of a science community, i.e., elementary science education, beyond the university classroom as a result of a science service-learning experience. In it I have chronicled the sequence of changes in the views voiced by four case participants of various cultural heritage, SES, and age during a non-health, yet science related course called Elementary Science Education Partners (ESEP).

The ESEP course involved the undergraduates in intensive reflection and long-term placements of responsibility while team-teaching science within the public schools. Change involved a reduction of initial beliefs that their elementary school students' scholastic performance was somehow impaired by personal weakness and family inadequacies. It involved a shift to more experientially-based beliefs in student ability and potential to learn when factors such as community resources, teaching methods, teacher knowledge, and opportunity to practice science were considered. My in-depth and longitudinal examination of the expressions of beliefs and field activities of individuals as they progressed through the service-learning program extended our knowledge of the impact of course-based experiential learning involving face-to-face interaction. The finding that science undergraduates, while participating in a service-learning in science teaching (SLST) course, reduced their deficit-type belief expressions, has implications for science undergraduate education and future service-learning research.

Change in Beliefs Expressed about the Ability and Factors that Affect the Ability of Students to Learn Science

Four weeks into their SLST experience, the novice undergraduate science partners' early perceptions of their elementary school students involved individual deficiency attributions such as: the students lacked necessary skills, lacked normal innate abilities, lacked creativity, had poor memories, and misbehaved. The case participants cited their SLST experience with the students, their teacher-partner's views, and their own expectations about low SES students, to support their beliefs. My documentation of these initial perceptions supports the arguments that the issue of deficit type thinking about low SES students is a concern especially because maintaining high teacher expectations is a critical component of student achievement (Ferguson, 2003; Irvine & York, 1993; Rist, 2000).

Based on interview, document, and observational data collected during the course of eight months, the case participants developed in three significant ways: (1) All four science undergraduates, who at the outset of SLST perceived their elementary school students as less intelligent and less capable than others to learn science, ended their experience voicing the belief that most students were intelligent and able to learn science; this was either a partial or a distinct reduction in the particular deficit type views of the participant, (2) the case participants modified what they perceived to be the factors that influence student learning; many of the new factors were similar and were structural- versus individual-based, and (3) the science undergraduates perceived that due to the SLST experience, they had personally and profoundly changed in various ways; again, many of the changes identified were similar.

My confidence in these results is reinforced by the consistency of the data among the study participants and similar expressions voiced by 20 other ESEP science undergraduates who were taking the course during the same time frame. These findings are likewise bolstered by a similarity with related findings of other studies on service-learning participants (Tables U1 and U2, Appendix U). Notably, when the service-learning literature is organized by relative positions of expertise, a decrease in the participants' belief expressions from a deficit thinking perspective appears associated with service-learning programs that utilize the expertise of the community members and university students (categories two and three, Table U1). In this literature analysis, however, an increase in awareness of social issues that impact the community does not seem to be associated with expertise (Table U2). The ESEP course utilized the knowledge and abilities of both undergraduates and community partners, but more information is needed to confirm any trends noted here relative to positions of expertise. The course had other characteristics, such as direct and prolonged interaction with community members within the community setting, a highly responsible service activity that was relevant to a community issue, and the integration of that activity with course content through intensive reflection. Therefore, the findings of this study should be considered in light of the ESEP SLST experience as a whole.

My research results are closely comparable to related findings from qualitative studies that involve service learning and preservice teachers in multicultural education courses. Although ESEP was not a multicultural education course, it supported the spirit of multiculturalism through the development of awareness, recognition, and respect for the cultural strengths and resources of the communities and individuals with whom the science undergraduates worked. The community of the SPS school system was largely composed of African American teachers and administrators who embraced the students, their education, and their cultures. The ESEP science undergraduates were highly trained in the science-kit curriculum, inquiry-based science instruction, and science. Like the preservice teachers in Barton's (1999) service-learning study on multicultural science teaching, the undergraduates came to question their beliefs about students that were from a different cultural and social background than their own. Moreover, they came to think more equitably about their community partners and similar to the findings in studies by Boyle-Baise and Sleeter (2000) and Boyle-Baise and Kilbane (2000), each case participant's initially expressed beliefs changed to different degrees. This acknowledgement of the strengths of the community is likely tied, in part, to the structure of the overall ESEP program and SLST course.

The timing of the first recorded changes in beliefs for factors affecting student ability to learn was generally earlier than changes found for the case participants' beliefs about student ability. Within the first semester, the science undergraduates began to attribute student learning issues to curriculum, teaching, and financial factors. They believed that the students' science education was given low priority due to the scarcity of classroom science materials, inadequate teacher knowledge about science and science practice, and limits on time dedicated to science instruction. I suggest that these beliefs arose directly from their experience as they supplemented available teaching materials, were respected by their teacher partners for their science knowledge, and frequently were interrupted or ran out of time for science lessons.

In comparison, the attribution of negative influences to student-family factors, such as the degree of parental involvement, changed little. Two participants, however, came to infer potential positive as well as negative family influences. The science undergraduates' interactions with their students' guardians was limited to those who occasionally visited the classroom while they were present. The question arises as to how the nature of the undergraduates' perceptions of their students' ability to learn and influential factors may change if, as part of their fieldwork, they are often involved with some of the students and their families in more social environments such as family science academies and science fairs, or other student performances.

The second term of SLST was the period when each undergraduate participant voiced the most striking reduction in deficit views related to the students' ability to learn science. It is possible that the timing of the changes could be an artifact of the interview schedule. There was, however, little prior evidence based on anything that they wrote in their weekly journals or in their discourse and behavior in the classroom that was as salient as the changes in perspective on student ability expressed in the fourteenth to twenty-third weeks. The view that most or "all" of their students were able and interested in learning science was repeatedly expressed as they described the things that their students did and the concepts that they remembered and connected. Previously stated comments about poor student memories were replaced with comments about "vivid" student memories that related to "any" subject.

Distinct from these findings, Hollis (2005) noted that blame attribution beliefs shifted from individual and cultural to structural factors as early as three weeks in her service-learning course on social problems. My findings did not support those of Hollis' with respect to the speed with which she noted these changes in her participants. In Hollis' study, the undergraduates were encouraged to examine and reframe their own belief systems as they related their community based experiences to sociological principles. The ESEP course, in comparison, encouraged undergraduates to reflect critically on their experiences with respect to student learning and engaging students in science practice. The focus of SLST was on science and culturally sensitive pedagogical practices. My study of science undergraduates found that four weeks, or 12 hours of face-to-face interaction in the classroom and four to five hours of critical reflective practice was not sufficient to effectively challenge the case participants' initial deficit type beliefs about student ability to learn science. The findings in this study suggest that for some undergraduates, a minimum of 20 weeks of SLST is needed to advance a shift in views.

There are developmental considerations with regard to the timing of the most striking change in the case participants' beliefs. The science undergraduates started their spring SLST after an eight-week holiday leave from their students. During the interim two months, the elementary school students naturally continued to mature and learn. It seems likely that when the undergraduates resumed their work in the spring, student growth provided them an outstanding point of contrast from which they could reassess their earlier beliefs about ability. In this way, the impact of future service-learning college curricula may be enhanced by incorporating considerably long breaks during which reflection may occur for undergraduates working with children.

For all participants, an interest in having an enjoyable relationship with the students was the most prominently expressed motive to participate and persist with service learning in science teaching. One participant explained this interest as a way to gain a "real world" social balance for his isolated college life involving peers and professors. The undergraduates claimed and emphasized that they developed a unique companionship type of teaching relationship with the students. Unlike the fulltime classroom teacher and student association, the science undergraduate and student connection was characterized by a highly anticipated biweekly interaction that stimulated the dynamic of the classroom. The relationship, as described by the undergraduates, was fun, friendly, nurturing, and motivational. In fact, they eschewed the role of behavior manager for fear that the students would disregard or dislike them. This is reminiscent of the findings for preservice teachers who believed that a good teacher, more than a skilled professional, is enthusiastic, motivating, caring, patient, engaging, fair, and nice (Fajet, Bello, Leftwich, Mesler, & Shaver, 2005). The engaging and personal nature of the undergraduate teaching relationship in this study suggests that it was a significant factor in the process of change in undergraduate views. Like the undergraduates in some other service-learning courses, these long-term acquaintances with persons out of their typical experience provided them the opportunity to see how they were like each other (Eyler & Giles, 1999; Giles and Eyler, 1994; Rockquemore & Schaffer, 2000). As members of an intergroup that shared the important work of science practice with their student “friends,” I suggest that the ESEP undergraduates also saw and appreciated many of the real versus presumed differences between their groups. The data show that they saw the “real” inequities in access to science-appropriate materials, engaging lessons, and time to practice science, which contrasted to their “presumed” idea that elementary school science education was just as they experienced it as youths except for differences in student ability.

I noted that all four participants came to believe there were systemic inequalities involving adequate funding for their students’ science education. For example, one female expressed the belief that society and politicians undervalued and underfunded the education and potential of low SES students, thereby suppressing their upward social mobility. This situation, she believed, was exacerbated by negative home and community factors. The issue of restrictions that social problems place on what public schools can actually achieve has been argued by Berliner (2006) based on the strong and persistent association of social class with public school student achievement: the lower the students’ SES, the lower their achievement on both national and international tests in mathematics, science and literacy. The SPS, however, expended more per student in the year of this study than most other school systems across the state and nation. Although nationwide many urban school districts have an unequal distribution of school finances (Kozol, 1992), research shows that student achievement is not clearly related to increases in spending (Chubb & Loveless, 2002; National Research Council, 1999b). In fact, SPS spent a total of $10,790.91 per elementary and secondary school student (Georgia Department of Education) compared to the state median of $7,351 total expenditure per student by school systems, and the national median of $8,007 total expenditure by school districts (Johnson, 2004) in the 2001 fiscal year. The female participant linked what she saw as student underachievement with a larger social-political scheme. In contrast, the other participants more simply maintained that allocated funding for the science education of low SES students was either locally misappropriated or was not enough to be effective for student learning in science. The complicated and urgent issue of ample financial resources for low SES public school students is beyond the scope of this study. Nonetheless, an assertion I am able to make is that the science undergraduates became more mindful of structural influences, however conceived (e.g., systemic inequalities in access to adequately prepared science teachers). They transcended beliefs in individual culpability as the basis of low performance to those involving a complex of external factors.

With respect to the tenacity of prior beliefs, the conditions that expedite belief change−the triggering of doubt by a challenging discrepancy between belief and experience, the resolution of doubt through educational experience and reflection, and the development of different beliefs that fit with other beliefs−appear to have occurred for key perceptions during the case participants' SLST partnership. The case participants, however, variously modified their initially expressed beliefs. This suggests that for some, initial views were deeply rooted in their belief structure and for others, they were more recently made and less central to their sense of self. One undergraduate's expressed belief (that the students had unstable home lives with unsupportive guardians and single parents, who were violent drug-users) persisted throughout the study. This implies that her's was a previously held and ingrained belief that was insufficiently challenged by new understandings or direct experience. As a self-reported surrogate caregiver, she believed that she supplemented the attention and education that the students needed. These findings recall those of Garcia and Guerra's (2004) for teachers who felt sorry for their culturally and linguistically diverse students, assumed a type of "parental" responsibility for them at school, and held low expectations for their learning potential. In contrast, another undergraduate's belief (that her students' were disinterested and poorly motivated to learn science) reversed to a positive perception within six weeks after it was first recorded. The relatively early change suggests that her belief was more tenuously held. This study notes the progression of change in expressed beliefs but does not determine the degree of assimilation or accommodation, nor suggest persistence of these undergraduates' beliefs.

<u>The Field Connection: Classroom Observations</u>

Although the classroom contexts in this study varied by school, grade level, and teacher-partner age, ethnicity, and experience, much of the undergraduate science partners' teaching behavior and discourse was similar overall. The undergraduate participants, more often if not always, arrived prepared to teach interactive, inquiry-based, and accurate science lessons throughout the lessons that I observed. They all maintained a positive attitude toward science and their students through actions and body language. The students were engaged with them as they were with the students.

These similar fieldwork characteristics invite the question as to what behavior, if any, the participants displayed, or what critical incident took place that may have some connection to their change in perspective. An answer may be found in the development of two teaching skills that I observed in each of the undergraduates during the course of two semesters. The first skill is their increase in the use of questions that required more critical thinking by the students as compared to those that required simple information recall. The development of this skill was different for each. Two of the participants asked these types of questions, as early as the eighth week, to encourage students to apply what they learned to their world outside of the classroom and to "make them think." I observed the others utilize these types of questions in the spring term. These changes in behavior may indicate that the undergraduate partners were becoming more invested in their students as individual learners. Another potential connection to their change in perspective may lie in the use of a second skill; the three undergraduates with the older students in second-, third-, and fifth-grade classes increased their encouragement of peer-to-peer interaction and teaching during the course of the partnership. Their exercise of this method suggests that they came to respect student knowledge and student ability to teach each other. Of course, these teaching skills should be considered in the context of the students' age-related development and other classroom influences. For instance, the changes in questioning style and focus on peer-to-peer interaction can be seen merely as improvements in their teaching skill which naturally occurred as a reaction to what worked and what did not work in student instruction. Likewise, teaching skills could have developed from teacher-partner example.

Germane to this is the consideration of the potential influence of the teacher partner on the undergraduate's beliefs about student abilities, parental care, and the students' home lives. As novices to elementary school science-teaching, as well as to their particular students, it is likely that the undergraduates deferred, to some extent, to the teacher as an authority on issues pertaining to the students. As noted, I observed one classroom conversation concerning student abilities and backgrounds and found data to support teacher influence in three out of four teacher and two undergraduate interviews. This is similar to the documentation of derogatory commentary about families made by community-organization directors to service-learning preservice teachers (Boyle-Baise, 1998). Teacher views could have effectively strengthened the undergraduates' preexisting deficit beliefs. Furthermore, teacher views could dampen the process of deficit-thinking reduction. This is a concern relative to the success of future SLSTs. A counter component of student-family views on issues, such as time constraints due to job demands, may help to mitigate potential negative teacher opinions and facilitate science undergraduates' positive beliefs about elementary school students.

Views on Self Change

Some of the profound self changes reported by the undergraduates reflect abilities that one would expect to arise from intensive practice through social interaction. Undergraduate participant stated gains in communication and time-management skills, and ability to work with others different from themselves reflect the findings in various areas of service learning such as nursing, pharmacology, sociology, and engineering (Astin & Sax, 1998; Juhn et al., 1999; Kearney, 2004; Kendrick, 1996; Narsavage et al., 2002; Osborne, Hammerich, & Hensley, 1998; Rice and Brown, 1998; Ropers-Huilman et al., 2005; Wade, 1995). These developments desired by labor force interests, however, may not necessarily accompany a change in perception of those with whom they worked.

In comparison, the following acknowledgements can easily be seen as accompanists and contributors to the positive changes in the participant undergraduates' expressed beliefs about the ability of their elementary school students to learn science. Three of the self-change beliefs–(1) the gain of a new understanding of others' situations different from their own; (2) the realization of and appreciation for their relative positions of privilege due to their educational background and family support; and (3) the perception that they became more socially and culturally connected to their community outside the university and their college classrooms–were expressed commonly by all case participants. They were able to make a connection between themselves and their elementary school students' education to gain new awareness and to empathize with the students. Reflection on their own advantages assisted the undergraduates in the process of transforming old beliefs about their students' ability to learn science. This is similar to the undergraduates with initial deficit views who came to believe that they were like those with whom they worked except that their clients were experiencing stressful situations like AIDS and poverty in the family (Jones & Abes, 2003; Rockquemore & Schaffer, 2000). Moreover, these beliefs reflect findings for undergraduates for whom the service-learning experience mitigated their sense of isolation developed at institutions where they had little connection to community-oriented goals or to individuals (Eyler & Giles, 1999). As seen by Eyler (1993), Eyler & Giles (1999), and Myers-Lipton (1996a), the positive change in the undergraduates' expressed beliefs in this study is a testimony to the crucial role of intensive reflective practices in the promotion of undergraduate development. In a rapidly diversifying world, this type of undergraduate growth is integral to an adaptive type of challenge for our society. That challenge, counteractive to the influences of negative societal norms, is to prepare young people so that they can be flexible and balanced learners, teachers, and workers in science as they move into adulthood. In a larger context, that process is part of working toward a world where adults understand inequities in education so that they can better manage their fear and anxiety about poverty and people they perceive as different from them.

Notably, all undergraduate case participants expressed the belief that due to SLST, they had changed the way they understood science by seeing it through children's eyes. They reported that they perceived it as a process of connecting and organizing experiences to generate knowledge that applies to everyone. Of the participants, the three females believed that they gained a reason for studying science and a justification for the pursuit of a career in science or a science-related field that involved working with people. They stated that they had a more cohesive view of their world and this validated and stimulated their interest in science. Specifically, the application of their science knowledge through teaching children helped them to erase any doubts about preparing themselves in science. From their new perspective on science and learning science, the undergraduates focused on the present and near future. This is somewhat different from the perspective change reported for master's level preservice multicultural-science teachers (Barton, 1999). The teachers in that study noted that they had come to include the students' interests, ideas, and cultural contexts in what they understood as multicultural science and best science teaching practices. Their focus appears to have been further in the future when they would be teaching professionally. Nonetheless, the findings of both studies are similar in that the SLST participants appeared to think of science less as an external and objective body of knowledge to remember and more as a way of generating knowledge. In doing so, they identified science knowledge with the science practitioner.

Conclusion

The main result of this study is that the science undergraduate experience in a service learning in science teaching (SLST) course can contribute to the development of a positive perspective on a community of learners who are relatively less educationally privileged. I found that the changes in expressed college student beliefs were typical of other science undergraduates. Deficit type thinking is not exclusive to persons of upper and middle classes or a particular race or ethnicity. Three of the undergraduate case participants were Asian Americans, one each of Chinese, Indian, and Japanese heritage, and one self-reportedly from a low income family. Just one was European American. Although the case participants may have identified to some extent with mainstream culture (Delpit, 1988) or the dominant ideology (Kluegel & Smith, 1986) about the poor, the suggestion is that deficit thinking with respect to group identity, however construed, is a social tendency (Allport, 1954; Watson, 1982) that can be modified through reflective course-based experiential learning. Clearly, the application of science knowledge and face-to-face interactions with young people different from themselves engages science undergraduates and encourages positive social perceptions. This finding is important to future science curricula. It is significant in light of the natural tenacity and dangerous nature of preexisting deficit beliefs.

Implications and Future Research

The case participants all believed that the teaching of science prompted them to think more holistically about science as processes within constructed and fluid bodies of knowledge. They worked to facilitate science in practical ways that were meaningful to their students. This implies that the experience may stimulate undergraduate engagement in science because it helps them to see that science applies to everyone. In time, the undergraduates may come to see themselves as part of a larger web of science learners. This suggestion is supported by the evidence that the experience helped them to shed their sense of isolation. Moreover, this study found that through presenting science undergraduates with a context in which to meaningfully apply their knowledge, SLST validated their academic and career pursuits in science. SLST may strengthen science-related career goals for those who hold reservations and, as in these cases, clarify career goals for those who are committed.

Ideally, future undergraduates will see more comprehensive college science curricula that will encourage them to participate in SLST partnerships where they will be prompted to learn about pedagogy, teachers, student ability, and science. Teacher partners will have the opportunity to learn about undergraduates, facilitating science curricula, and science; elementary school students will learn about college students, science practice, and their own ability to generate knowledge. When institutionalized, this type of science course has the potential to influence the focus and methodology of courses in other disciplines such as engineering and mathematics.

The implications of comprehensive college science curricula are important with respect to the development and preservation of a well-trained and strong science workforce and national economy. The type of empirical information in this study may help colleges engage and prepare science practitioners who can work better with people unfamiliar to themselves. Within the workforce and their social and family circles, these science undergraduates have the potential to act as social ambassadors. Such undergraduates can extend the reach of the positive social perspectives they have gained though their SLST experience, and influence others' belief systems through testimonials, argumentation, and action. Without the opportunity for the type of experience that SLST provides, low SES students may remain nameless and faceless to science undergraduates, who, as budding members of society, may not perceive them as able learners and potential colleagues in science. Direct interaction with science undergraduates may also help to stimulate the frequency of science practice and pursuit of science knowledge for those children who otherwise may not consider a career in science as they mature. Indeed, when science undergraduates and elementary school students practice science together, their common ground may promote social cohesion and stimulate interests that will benefit all.

There are a number of possibilities for future research based on the findings of this study. The method of detailing change used in this qualitative work could be enhanced by the use of mixed qualitative and quantitative methods. In this approach, the use of a larger sample and a control group would help to discount the possible impact of other causes, such as physical-mental maturation, which might have influenced the perspective transformation that I observed.

To understand the social impact of the changes determined by this research, future research could investigate the persistence of positive social perspectives up to a decade later when the service learning in science teaching participants have established themselves in the community. Pointedly, we need to know if SLST undergraduates stay in science related fields and, as scientists, they continue to invest in the community by teaching or assisting students in science. Additional questions could be asked about the nature of their research with respect to the element of social consciousness. Specifically, what research questions do they ask, how do they word their grant proposals, and how do they regard their own students?

Future studies could also examine the effect of SLST on various participants from specific fields. How do research oriented science undergraduates, e.g., in engineering, chemistry, or physics fields, compare to those who are socially oriented, e.g., in nursing, premedical, or science teaching professions? In addition to their social perspective, how did their understanding of the nature of science change? For preservice teachers in programs with a one-year pre practicum requirement, the findings of this study are useful in light of research suggesting that student achievement is affected by teacher beliefs. What role does the level of expertise of the community partner and undergraduate have in perspective change? Moreover, it is important that the impact of SLST partnerships on the community partners be comprehensively investigated. Peripheral data from this study indicate that the elementary school students and teacher partners responded positively to the practice of science with the science undergraduate-teacher team. In future partnerships with SLST undergraduates, longitudinal research on elementary school student and teacher attitudes toward science in tandem with student achievement in science may contribute to our holistic understanding of the effect of service learning in science teaching practices.

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APPENDICES

Appendix A: ESEP Program Note

In 1995 the ESEP teacher enhancement program was funded by National Science Foundation through a Local Systemic Change grant for five years (Kozaitis, 1997; RISE, 1998; Weinberg, DeHaan, & Goebel, 1996). This four-part program provided (1) a manipulatives-based curriculum, (2) creation of a cadre of mentor teachers, (3) a teacher empowerment and professional development component, and (4) an assigned undergraduate science-partner for each participating teacher. An eight-member consortium of urban institutions of higher education and a large Southern urban-school system in the vicinity of Emory collaborated to promote and support active inquiry-based science-instruction in all of its 69 elementary schools as advocated by the National Science Education Standards (National Research Council, 1996). The last-named component of this teacher-enhancement program was semester-long science-teaching partnerships between science undergraduates and the local elementary school teachers. The influence of the ESEP undergraduate science-partner on the introduction of inquiry pedagogy and hands-on science into the classroom is described by Jester (2000).

With support from the National Science Foundation and university funds, the science-oriented undergraduate partners came from seven local colleges in the ESEP consortium. Each college sent undergraduates to the nearest of the 69 elementary schools during the five year duration of the program. Over the five years, ESEP established a total of 1,499 semester-long undergraduate partnerships with teachers of Southern Public Schools or SPS (pseudonym). Although similar, the SL programs for undergraduates from the different campuses varied in detail.

Thirty-nine percent of the undergraduate science-partners during the tenure of the program were provided by Emory. The Emory ESEP undergraduate partnership component functioned for an extra year for a total of six years (December 1995 through August 2001) with teachers in 25 of the original 69 elementary schools. To become a partner in science teaching, college students enrolled in the Emory ESEP community service-learning course for two science credits. After two semesters of service, undergraduate science partners qualified to run for election to the ESEP Student Council. The Student Council was an undergraduate-selected body composed of eight to twelve members who advertised the program on campus, helped with orientation and focus-group sessions, and made suggestions for program change.

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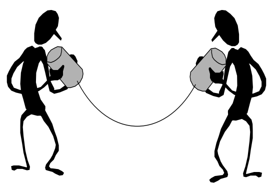
Appendix B: Course Atlas Description

BIOLOGY 239R: Elementary Science Education Partnership (ESEP)
DeHaan, TBA, MAX: 999, WRT: YES
Content: Science majors (sophomores, juniors, and seniors) will attend introductory sessions on the use of inquiry, active-learning strategies and modular kit use with children. They will be paired with an elementary teacher in a nearby school as a science-partner to facilitate the teaching of hands-on science to grade 1-5 classes.

Text: Assigned readings
Particulars: Students commit six hours per week for preparation and in-school teaching (between 10:00 a.m. and 2:30 p.m.) of inquiry-based science exercises. Attendance at weekly reflection sessions and submission of weekly journal entries are mandatory. Students wishing to fulfill a writing requirement are welcome. Access to a car is highly desirable. The course is 2 hours credit and may be repeated, although only 2 hours may be counted toward the major. Course can be taken SU or letter grade with a term paper. Permission of instructor is required.

Appendix C: ESEP Course Syllabus

Elementary Science Education



Partners

Course Syllabus

FALL 2000

Emory University

Anth397R, Bio239R, Chem497R, Phys397R, Psyc497

ESEP

www.emory.edu/COLLEGE/ESEP

FALL 2000, EMORY ESEP COURSE SYLLABUS

Dear ESEP college science-partner,

Research shows that traditional lecture-style teaching tends to allow students to memorize without understanding concepts. Thus science becomes a body of obscure, unimportant facts that are easily forgotten. Worst of all, science becomes boring. However, if hands-on activities and guided discussions are used to show how science works in our daily lives, young students see science as a way of learning and, most importantly, they see science as fun. Studies have shown that children learn more and retain what they learn longer in such an atmosphere. However, the latter way of teaching science is difficult. It requires energy and confidence on the part of the teacher/partner to integrate these activities into state required objectives. Hands-on science can be noisy and messy and require more than one pair of hands to lead. Above all, discovery-based science brings up lots of questions that the teacher may not be able to answer.

The Elementary Science Education Partnerships (ESEP) program is designed to help teachers with these difficulties. Inspired by a national movement to improve pre-college science education, the program provides support to elementary school science programs in the form of one-on-one partnerships between elementary school teachers and Emory undergraduate science majors. The science-partners bring scientific knowledge, resources and enthusiasm for science, while the teacher-partners bring pedagogical expertise to form a team well-equipped to bring science to life in the classroom. Teachers and science-partners work with modular science kits and an experiment manual as resources. Together they can link science to other subjects such as mathematics and language arts. Together they can show students the value of asking questions about their world.

Though this partnership is temporary, it is the goal of the ESEP program that the effects are permanent. This program aims to bring new knowledge and materials to the teacher and to give her or him a link to the science community at Emory. Above all, the goal of the ESEP program is to instill confidence in the teacher concerning science instruction. You, the college science-partner are an agent of change. Welcome to the program! Sincerely, Camille Goebel, Assistant Director, ESEP

EMORY COURSE EXPECTATIONS AND REQUIREMENTS

First day in schools: Monday, September 18th; Last day in schools: Tuesday, December 12th

Prompt Contact

Partners are expected to start their visits to their school the week of Monday, September 18th !

Partners must go into the schools and introduce themselves to their teacher during the week of Orientation. The 3 hour per week requirement begins on September 18th. You can try to call your teacher and introduce yourself first, but you must go into your elementary school and introduce yourself to the instructional liaison specialist (ILS) or principal. Ask her or him to help you find your teacher. Meet the teacher and children, and get to know them. Exchange phone numbers with your teacher and plan together what hands-on experiment you will do when you come in next. Notify Camille in the ESEP office of the days and times you will be teaching.

Weekly Class Work:
Students must devote a minimum of six hours each week to ESEP activities. This may include planning, preparing, commuting, and facilitating in the classroom. A minimum of <u>three</u> of those six hours must be in the classroom team-teaching science. Teachers assess students based on their effort, reliability, professionalism, and ability to communicate ideas.

Reflection Groups
Students meet weekly with a group of fellow students led by a student council member who is part of a facilitating team. The team consists of the student council member, a cultural specialist, a science faculty mentor, an ESEP staff and sometimes a liaison teacher. During these meetings, students receive visits from scientists and teachers, provide science lesson ideas and experiments, discuss experiences and support each other. Students are responsible to call the group leader regarding their participation and attendance.

Journal Entries
Students submit a weekly journal entry on LearnLink. It is expected to be thoughtful and reflective. The last entry is a summary of the student's entire semester experience in the classroom. There are two conferences, one for the journals and one for the summary.

First Day Of Class:
Wear your name tag (each time you visit the school); dress neatly (follow the school dress code.)
Go to the main office and sign into the ESEP binder (put your name on a sign-in sheet)
Introduce yourself to the principal and instructional specialist (ILS) and tell them a little about yourself (i.e., you're a student at Emory, your academic interests, etc.) Ask about the school (i.e., number of students, grades and teachers; safety procedures, etc.) The administrators will help you get to your classroom.
Meet your teacher and students. Tell them a little about yourself. Let them ask you questions and then ask them some. The children will be eager to find out about you!
Learn every child's name. Play name games (i.e., say your name and something you like beginning with the same letter as the first letter of your name; have the children do the same; have the teacher describe a student and you guess who it is.). Make science name-tags.
Ask the teacher about the children; what do they know/what do they need to know in science, reading/writing levels, disabilities and skills.
Plan with your teacher what science lessons and experiments you will do next week and throughout the term. Exchange phone numbers.
Schedule your visits and find out about scheduled school vacations, assemblies and field trips.

Teaching Tips:

Plan with your teacher-partner each exercise and experiment in advance. Collect materials so that all of the children can be involved. Go through the activity yourself and be sure it works! Be sure to set a good example of science safety. All scientists should wear safety goggles when working with liquids and compounds.

Arrive early at the school to allow time for set-up and the unexpected. Always sign in at the office.

Know the emergency procedures of your school.

Discuss the ground rules for class management with your teacher. Establish the science rules with the children. Let them suggest the important ones and decide what the outcome is if they are not kept.

Ask as many questions as possible and make as few statements as possible. Teaching is not telling!

Call on as many children as equally as possible. Everyone needs to be involved.

Allow plenty of wait-time to questions. Seven to twelve seconds seems like eternity, but many students are carefully considering how to respond.

Use words of praise for effort and attentive and helpful behavior.

Be specific and simple with your directions to avoid confusion.

Give directions then pass out materials.

Always link experiments and activities to the children's' lives. Make their science relevant. Bring in and draw pictures.

Find out about the children. What do they know? What do they want to know?

Always bring the children together to summarize the lesson. What did they learn?

Make eye contact with the children.

Science is fun! Smile and relax! Let excitement be contagious and constructive.

Classroom Management: A Partnership

1. Assess:
    a. students' learning style
    b. teacher's style
2. Plan rules: I'll do, You'll do
3. Build on teacher's environment: integrate science subject material with the other subjects the teacher is involved with at that time
4. Communicate, demonstrate and model: try to focus on what the children hear you say and see you do
5. Reflect: on what worked and what did not work in the lesson; were the children engaged with the experiment?
6. Establish clear signals: e.g., when I clap my hands, everyone touch their nose
7. Pre-prepare visuals
    a. you will have less down-time (wasted time) while you are writing
    b. you will not have your back to the class

Set time-frames: give warnings, e.g. you have 5 more minutes to finish before you clean up.

Eliminate distractions, e.g. no materials on the desks or in hands when you are giving instructions

Link: put things into context with other lessons and with real life
Praise: always praise positive, attentive and helpful behavior!

Grading

Everyone in this course starts with the grade of 'A'. To sustain that grade, you need to complete the following:
Attend orientations I and II (returning students must attend the morning of I and all of II)
Facilitate science lessons in your elementary classroom a minimum of 3 hours per week for ten weeks
Attend and participate in seven reflection sessions
Submit a minimum of nine thoughtful and reflective journals on time
Submit one thoughtful and reflective summary of experience on time
Receive an excellent evaluation from your teacher-partner

For students taking the course for satisfactory/unsatisfactory (SU), a grade equivalent of C or better based on the course requirements must be received. For students who wish a letter grade (LG) in biology, satisfying the above requirements will ensure a minimal grade of C. A grade of B or A will depend on the quality of the above items plus the grade on the term paper.

Grade Apportionment:

Requirement	SU (all depts) & LG Students (Anth, Chem, Phys)	LG Biology Students
Teacher evaluation	50%	30%
Summary	10%	10%
Reflective Journals	20%	10%
Reflection Sessions	20%	10%
Term Paper	-----	40%

FALL 2000 ESEP Teachers' Science Partner Evaluation Sheet

Science Partner's Name_________________________
Teacher's Name_______________________________ School _______________________________ Grade_____
Teacher's Signature ____ Date ___
Rating Scale:

*Please note, the partner is a college student with a science background, but is not a trained teacher.

4=Excellent Your partner did an outstanding job overall
3=Good Your partner performed well in the classroom
2=Average The performance of your partner was acceptable but could improve
1=Poor Your partner showed minimal effort

IMPORTANT!
Evaluations are due Friday, Dec. 8th at the Emory ESEP office.
FAX to Camille at 404-727-3051

Week Of :	Activity Names/topic Name of experiment or subject of week's science lessons	CollaborativeEffort Arrived on time Dressed appropriately Returned calls Collaborated w/ you	Preparation Displayed knowledge of science content Organized and was familiar with materials	Enhanced Learning Promoted learning of science skills through hands-on and inquiry Asked students open-ended questions and encouraged them to ask questions as well	Interaction with children Communicated well w/ students, verbally /body language Moved around the room/worked w/ student groups Responsive to questions
9/18					
9/25					

10/2		SAMPLE		SAMPLE	SAMPLE
10/9					
10/23					
10/30					
11/6		SAMPLE		SAMPLE	SAMPLE
11/13					
11/27					
12/24		SAMPLE		SAMPLE	SAMPLE
12/11					

Fall 2000 Emory Esep Student Evaluation Calendar:

Name: ________________________________ ID# : _________ Dept./(LG, SU):
Grade Taught: ____________ Reflection Leader: ____________Teacher name:
____

Journal Entries and Summary: (See point rubric, start with 4 points)

Week # Due by midnight on or before:
Week 2 9/24 1
Week 3 10/1 2
Week 4 10/8 3
Week 5 10/15 4
Week - 10/16-17 Emory holiday. No teaching, reflection sessions or journal entries this week!
10/23 First draft ESEP term paper due for Bio 239R LG!
Week 6 10/29 5
Week 7 11/5 6
Week 8 11/12 7
Week 9 11/19 8
Week - 11/20-24 Emory/ SPS holiday. No teaching, reflection sessions or journal entries this week!
11/30 Final draft ESEP term paper due!!!
Week 10 12/3 9
Week 11 12/10 Two-page Summary (no journal)
Total points: Journals _____ Summary _____
Comments:

Reflection Session Participation: (0 = absent; 1 = silent; 2 = occasional; 3 = shared every time; 4 = contributed greatly)
9/11 Introductions /child development and information processing
9/25 Social/cultural factors affecting development
10/2 Questioning and language
10/9 Classroom culture
10/16 Emory break
10/23 Classroom management and expectations

10/30	Curricula and testing
11/6	Innovation in the classroom
11/13	Science lesson presentations
11/20	SPS break
11/27	Constructing science knowledge
12/4	Special topics
12/11	Change

WRITTEN ASSIGNMENTS

Partners are responsible for submitting a reflective journal entry each week to the ESEP conference on LearnLink. These entries must be submitted by or before midnight on the Sunday of each week. Additionally, partners will submit one Summary of Experience at the end of the semester. See the Emory ESEP calendar. Please submit using the following method:

Write your journal using word processing software with your name, teacher, grade, school and date in a header, e.g., Journal #2, John Smith, teacher Ron White, 5^{th}, Perkins, 3/10/00. Select all and copy.

- Go to LearnLink, open the ESEP conference. Open your reflection leader's conference
- Click on the appropriate Journal or Summary conferences
- Click on Message and then New Message
- Under subject write your login name and ‘J- # (1-8)’, or ‘Summary S00’, e.g., jsmith2J-1
- Paste your journal into the message.

SEND !! Click on the red Send icon in the menu and be sure you see the red stamp with a slash through it meaning "sent" .

Go back a save your original journal on a disk or your hard drive. Note, sometimes LearnLink fails and students lose their work. Don’t let this happen to you. Keep a copy!

Weekly Reflective Journal Format:

Students should discuss their experiences in the classroom through their reflective journals. Use the following questions as a guideline. Write at least ½ a page, single space, 12-font.

- What significant learning events happened in your science classroom this week?
- What caused them to happen?
- What do you think about these occurrences? How do they affect you?
- What was your role and what was your teacher’s role in the science lesson?
- You may focus on:
    - How the children responded to your hands-on activity
    - How the children interacted with you, the teacher and each other
    - The children’s attitudes toward the experiment
    - How the teacher felt about and reacted to the experiment
    - Anything you have gained from the experience
    - Any changes you have experienced

You are expected to be thoughtful at all times. If for some reason you can not or do not teach during the week, you still must submit a journal explaining the situation.

Weekly Reflective Journal Scoring Format:

Task	Point Value
Entry was submitted on Learn Link by Sunday at midnight, ½ page, single space, 12 font (If entry is one day late, take off .5 points. If it is more than one day late, take off an entire point)	.5-1
Entry was well-thought out and clear	1
Entry included a detailed description of significant classroom events	.5
Entry included a reaction to the classroom events, i.e. How did the children respond? What were the children's' attitudes toward the experiment? How did the teacher react? What were the partner's feelings/ reactions/thoughts?	1.5

Summary of Experience Format: (submit in place of journal)

After nine to ten weeks of experience teaching, take a look back at your journal entries and think about the changes you have catalyzed and witnessed in your children, teacher and yourself. In a two page, single spaced, 12-font report, discuss:

The events and behaviors in your classroom with respect to the science lessons you were involved with; use anecdotes to describe any changes in the children's attitudes toward science and skills they have gained. Include changes you see in pupil understanding of science and give multiple examples of work, scores, and comments.

The most important outcomes of this experience for you, relative to things learned about your elementary science education, your local culture, your other course work at the university and your career interests. You are encouraged to reference any relevant reading or information gathered from scientists, teachers or ESEP facilitators during the course of your experience. Give examples.

Summary of Experience Scoring Format:

Task	Point Value
Entry was submitted on Learn Link by Sunday at midnight, two pages, single space, 12 font (If entry is one day late, take off .5 points. If it is more than one day late, take off an entire point)	.5-1
Entry was well thought out and clearly communicated	.5
Entry included anecdotes of the classroom events, commented on how the children changed, what skills the children gained while the partner was there, whether the pupils and the teacher seemed to learn science and how the partner determined this, the partner's feelings/ reactions	1
Entry included a lengthy discussion of the impact of the ESEP experience on the partner, i.e. things learned about science education, local culture; feelings about college education and career interests and explanation of why	1.5

BIO 239R Letter Grade: TERM PAPER

Students taking the Bio 239R course for a letter grade must write a two-section term paper on a science concept of their choice from one of their science classes or seminars. In section one of the paper a current literature search must be made. The topic will be discussed in detail, in relation to current methodologies or a review of history and its' relevance to the lives of elementary school children. Section two will contain a discussion of how the topic would be communicated in terms appropriate for elementary children. For example, a lesson in the inquiry-science format might be described to present the concept as a hands-on activity. The literature for both sections must be researched using peer reviewed references (scientific and pedagogical), like research journals, and must be cited in the text of the document (see sample below). Textbooks can be used only as a references for general information and cannot be used as primary resources. A ten page double-spaced paper is required for the term paper. A fifteen page double-spaced paper is required for the term paper when it is to be used for the writing requirement. You must notify Camille Goebel in advance if the paper is to be used to satisfy the writing requirement and indicate writing requirement on the paper submitted. A complete reference list must be included in all cases. A first draft of the paper is required. Writing requirements will not be satisfied without a first draft submission. Remember, this paper is 40% of your grade.

ESEP BIO 239R LETTER GRADE: TERM PAPER RUBRIC

First draft due: Monday October 23rd; Final draft due: Thursday Nov. 30th, 2000

<u>Points</u>/<u>Requirements</u>	
4	Has gotten topic approved and discussed writing and referencing
4	Has turned in a complete first draft
<u>Section one</u>	
9	a) a science concept is thoroughly developed from a perspective, e.g. historical or current research methodologies and applications
9.5	b) is well researched with at least five (10 page paper) or seven (15 page paper) appropriate, recent and peer-reviewed primary research references cited
9	c) is justified as to the relevant value to human education and the lives of young pupils
4.5	d) is at least 5 (8) pages double-spaced
<u>Section two</u>	
10.5	a) clearly describes an age-appropriate lesson or lessons or a method in which the above concept is feasibly communicated to elementary level pupils, e.g. in an inquiry fashion using a hands-on activity(s)
10.5	b) is well researched with about least five (10 page paper) or seven (15 page paper) appropriate and peer reviewed references cited
10.5	c) describes assumptions about the pupils' background and learning level, e.g. age, grade, culture, socio-economic level
4.5	d) is 5 (8) pages double-spaced
20	Complete and standard reference list attached
4	Submitted <u>on or before</u> 5 pm on Thursday November 30th, 2000
100	Total points possible

Sample Writing/Citing Excerpt For Term Paper

… Prader-Willi syndrome is the product of a paternal deletion. The recipient has one or two copies of chromosome number 15 from the mother, but lacks this chromosome from the father. Prader-Willi syndrome is characterized by generalized muscular hypertonia and severe feeding problems in early infancy followed by hyperphagia which ultimately leads to obesity in childhood (Kennerknecht, 1992.) The weight of newborn infants is usually below normal and weight gain is minimal due to poor sucking responses; the persistent appetite and weight gain becomes apparent after two years of age. The hyperphagia ultimately leads to food stealing and foraging and it is often stated that children with this syndrome search through trash containers, eat out of garbage pails and consume unpalatable items (Luiselli, Taylor & Caldwell, 1988.)… (Please note et al. is used for references with 3 or more authors after the first citing where all authors are listed.)

Sample Reference Style

Kennerknecht, I. (1992). A genetic model for the Prader-Willi syndrome and its implication for
Angelman syndrome. Human Genetics. 90, 91-98.

Luiselli, J., Taylor, R., & Caldwell, M. (1988). Issues in Prader-Willi syndrome: Diagnosis,
characteristics and management. In Mary Lou Caldwell and Ronald Taylor (Eds.), Prader-Willi syndrome: Selected research and management. Colon: Springer-Verlag, 44, 1-12.

For suggested pedagogical references see the ESEP reference binder in the ESEP office library.

RESOURCES

2000-2001 ESEP Student Council:

Y-Y. C.
N. F.
M. G.
A. H.
A. H.
M. J. Co-President ESEP Student Council
P. H. P.
S. P.a
J. R.
P. S. Co-President ESEP Student Council
J. S.
S. S.
J. W.

Emory ESEP Office: Camille Goebel, 575 Rollins Way, Emory University; Phone: 727-3052; e-mail: cgoebel@cellbio.emory.edu; front office phone: 727-3000; Fax: 727-3051
ESEP Office Library: A variety of resource books, magazines and reference papers are available to browse;Woodruff Library: Downstairs, 1st floor, books and magazines like Science and Children;Supplies: Some supplies are available at the ESEP Program office. Call AJ <u>at least 48 business hours in advance</u> to reserve items: 727-3062

Materials Manager:
Hi Everyone!
I'll be your materials manager this term. My job is to help you out in the classroom by supplying as many materials for your experiments as I possibly can. We have a variety of materials here at the ESEP trailer. However, due to budget constraints, we don't have everything, so we need to be creative at times. You will need to get all fresh items (e.g. milk, ice, and water for the ice cream experiment). In order for me to do my job, and make all of our lives a little easier, I have a few basic rules:

I require 48 business hours notice for materials request. What do I mean by business hours? I have office hours Monday through Friday from 9a.m. - 5p.m. If you need something for your class on Thursday, you have to let me know by Monday afternoon. If you need something on Monday, you have to let me know by the previous Wednesday. Otherwise, you are out of luck. This requires a little planning on your part! You have to bring stuff back! I'll let you know which items are disposable, and which items are I need you to return. I need those items back no later than 2 days after you use them, and please be sure to clean them-I don't like doing dirty dishes. If you need an item for more than two days, please be sure to let me know and I'll see what I can do. Another reason you need to return materials, is the simple fact that there are about 60 other partners, all whom need materials. Chances are there is another class in the APS system studying the same topic your class is studying, and they will need the same materials that you have! Some of the more expensive items: videos, board games, and the chick incubator will require a refundable $15.00 deposit.

I take materials request through Learnlink and phone. To get a hold of me, send me a message through Learnlink (to A J) or call me at 404-727-3062 (leave a message if I am not at my desk)! When you leave a voice message, please tell me your name, phone number, the date you need the supplies, what supplies you need, how many you need, the experiment you are doing, and the total number of students and groups you will have. This helps me out if I don't have exactly what you need. I will be creative and come up with an acceptable substitute.
NO UNAUTHORIZED BORROWING!!!! I keep a detailed inventory of the materials that we have available for you. You're are more than welcome to look over the inventory, or come to the lab and browse, but do not take any materials without speaking to me first. Don't leave me a note telling me that you borrowed a bunch of graduated cylinders. They could be materials for a person that gave the proper 48 hours request. Please do not ask any of the other office staff to check materials out for you-that is not their job! So please be courteous to your fellow partners and me.

You can pick up your materials in the blue bin, outside of the back door of the ESEP trailer. You can also return your materials there (make sure your name is on them) or inside the lab. Have a fantastic semester! I look forward to helping you in any way I can. Sincerely, AJ (404-727-3062)

Elementary Science Education Partners (ESEP)/ “X” Public Schools (APS)
MATRIX OF SCIENCE TEACHING KITS

Grade level	Life Science	Physical Science	Earth Science
1	Organisms (STC)	(Trade books related to Weather & Organisms kits)	Weather (STC)
2	Insects (FOSS)	Balance and Motion (FOSS)	Water Cycle (Delta)
3	Plant Growth and Development (STC)	Chemical Tests (STC)	Soils (STC)
4	Food Chemistry (STC)	Magnetism and Electricity (FOSS)	Rocks and Minerals (STC)
5	Human Body Systems (EDC/Insights)	Mixtures and Solutions (FOSS)	Landforms (FOSS)

See the Quality Core Curriculum in the ESEP office and learn to teach these subjects for your grade so that you can prepare your students.
You may use the lesson guides for the kits when you are at the ESEP trailer. They must remain in the trailer. There will be a lesson guide for each kit in the library (media center) at your school.
See the ESEP Experiment Manual for additional inquiry-based lessons.

Some Science and Science Teaching Websites

PhysLINK: The Ultimate Physics Resource http://www.physlink.com
Chlorine Chemistry Council http://c3.org/classroom/bbc.html
Project Primary: http://www.owu.edu/~mggrote/pp/
The Food Zone: http://kauai.cudenver.edu:3010
Museum of Dirt:
http://www.planet.com/dirt/dirt.html
Digital Anatomist Interactive Atlas:
http://www9.biostr.washington.edu/da.html
4000 Years of Women in Science
http://www.astr.ua.edu/4000WS/4000WS.html
Human Anatomy Online
http://www.cs.brown.edu/people/oa/Bin/skeleton.html
http://www.innerbody.com/indexbody.html
Human Anatomy Online
http://www.cs.brown.edu/people/oa/Bin/skeleton.html
http://www.innerbody.com/indexbody.html
Educast http://www.educast.com
Earth Foundation http://www.earthfound.com

PlanetK-12 http://www.planetk-12.com

Earth science and geology sites

Earth Science and Global Change:
http://gcmd.gsfc.nasa.gov/pointers/edu.html
Geological data:
http://www.esri.sc.edu/data/lib-main.htm
USGS-The Learning Web http://www.usgs.gov/education
Internet Geophysics URL Archives http://cancer.mss.co.jp/Geophysics
American Geological Institute
http://agi.umd.edu/agi/agi.html
GeoByte http://www.geobyte.com
Petroleum related Organizations
http://www.pidwights.com/links/indes.html#org/socs
GeoMine http://www.info-mine.com/technomine/ege/exploration.html
http://pubs.usgs.gov/publications/text/dynamic.html
http://quake.usgs.gov/
http://fremi.jhuapl.edu/states/states.html
http://volcano.und.nodak.edu/vw.html
http://www.dc.peachnet.edu/ ~pgore/geology/geo101.html
http://www.uh.edu/~jbutler/anon/anonfield.html
K-12 RESOURCES http://www.cuug.ab.ca:8001/~johnstos/geosci.html
General Government
http://www.ed.gov/free
http://www.ed.gov/pubs/parents/internet
General Science http://www.sciencenetlinks.com/science/approved_science_sites.shtml
Chemistry http://ice.chem.wisc.edu/seraphim

Astronomy:
Welcome to StarChild: http://starchild.gsfc.nasa.gov
The Nine Planets: http://seds.lpl.arizona.edu/nineplanets/ninplanets/
Lunar Prospector: http://www.moonlink.com/lunarabout
Sun & Moon Data, U.S. Naval Observatory http://aa.usno.navy.mil/AA/data
Sky Online, Sky & Telescope maganize http://www.skypub.com
Astronomy Magazine Online
http://www.kalmbach.com/astro/astronomy.html
The Space Calendar
http://newproducts.jpl.nasa.gov/calendar/calendar.html
AstroEd, Astronomy Education Resources
http://www-hpcc.astro.washington.edu/scied/astro/astroindex.html
USGS - Astronomy and Space Science
http://www.usgs.gov/network/science/astronomy/index.html
NASA Space Educators Handbook
http://tommy.jsc.nasa.gov/~woodfil/SPACEED/SEHHTML/she.html
Ask the Astronomer
http://www2.ari.net/home/odenwald/qadir/qanda.html
A Practical Guide to Astronomy: http://www.aardvark.on.ca/space
Other Astronomy Sites:
http://cse.ssl.berkeley.edu/spanish/family/activist.html
http://www.hq.nasa.gov/education/
http://www.fourmilab.ch/earthview/vplanet.html
Life Science: http://fastplants.cals.wisc.edu/
Weather:
http://ww2010.atmos.uiuc.edu/(Gh)/guides/mtr/home.rxml
Constructivist learning :
http://www.prainbow.com/cld/index.htm
http://www.cudenver.edu/~mryder/itc_data/constructivism.htm
Cross refeerence to modular science kits:
http://www.disney.com
http://www.soilmoist.com
http://net.indra.com
http://www.znet.com
http://www.dare.america.com
http://www.realtime.net.doe.k12.ga.us/
The Explore Science homepage - http://www.explorescience.com
The Sierra Club - http://www.sierraclub.org/education
The Why Files - http://whyfiles.news.wisc.edu/index.html
Animal Diversity Web - http://www.oit.itd.umich.edu/projects/ADW
Pitsco's Ask an Expert - http://www.askanexpert.com/askanexpert/
Ethnic and Gender Equity – http://equity.enc.org/.
Art – http://www.microsoft.com/clipgallerylive./default.asp
Teacher Tools- http://www.puzzlemaker.com/
http://ericir.syr.edu/
http://www.si.edu/resource/start.htm

Appendix D: Literature Search Terms and Database Samples

Terms Sample:
Academic
Achievement
Belief
Beliefs
Teacher beliefs
Care/ Teacher care
Career
Change
City
College
Community
Course-based
Development
Deficit thinking
Epistemology
Experience
Experiential
Higher education
Inquiry-science
Learning
Reflection
Reflective practice
Science major
Science
Service learning
Service-learning theory
Teaching
Persistence
Undergraduate
Urban

Database Sample:
ERIC
Education Index
GALILEO
GPO Access (U.S. government index)
ISI Web of Science
JSTOR
PsychInfo
Social Science Abstracts
Sociological Abstracts
Wiley Interscience Journals

Appendix E: Research Literature Summary for Service Learning

Table E1. *Category One: Studies Where University Students Provide Certain Expertise to the Service-Learning Relationship*

Note: This category contains contexts where SL university students volunteered certain abilities or expertise and community members provided them access to a situation or experience, e.g., tutoring students after school. University students volunteered to help mitigate a certain community need. For all undergraduates in SL courses, general college level knowledgeability is assumed. In certain SL courses more course-specific academic knowledge is also assumed, and when that was the case, this specific knowledge will be noted under the pertinent detail column in the table below. In category one, any expertise provided by the community was either underplayed to that of the undergraduates or was not revealed.

Researcher(s)		Sample
Method	Pertinent details	Findings for participants
Ames & Diepstra (2006)		63 undergraduates (85% EuroAm; mean age 22; 93% fem)
Mixed methods: Quant/qual; pre/post attitude questionnaire; post open-ended writing questionnaire	Ugrads w/academic knowledge in social work, values & skills from a Human Behav & Social Environ course; service: accompanied & took oral histories at older adult daycare & apartments in diverse ethnicities/low SES comm.	73% reported ability to initiate/maintain relationships w/diverse others; increased appreciation for impact of social environ on human development; Some identified/confronted stereotypes about elders. Some gained admiration of their elder community partners
Astin & Sax (1998)		3,450 undergraduates from 42 institutions
Quantitative: 1990-1995 longitudinal; pre/post; quasi-experimental; institutional records, survey self-report	Ugrads at various institutions involved in a range of service and SL courses; services include tutoring, improving neighbrhds (envir & health), prevent crime; 1-12 mos service experience	Both SL and generic service associated w/ pos aca, civic responsibility, & life skills; SL increased knowledge of & ability to work cooperatively with people of other races and cultures; SL increased understanding of social problems; the more time in service, the more positive the effects

Astin, Sax, & Avalos (1999)		12, 376 undergraduates from 209 institutions
Quantitative: 1985-1995 longitudinal; pre/post survey self-report	Ugrads at various institutions involved in a range of SL courses and services	SL positively influenced behavioral & value outcomes 9 years after college graduation that include amount of activistic community service performed, frequency socializing with other races, and promoting racial understanding (p<.05)
Batchelder & Root (1994) (Some science topics)		96 undergraduates (48 SL, 48 control)
Quantitative: pre/post; quasi-experimental; survey self-report, journals, early/end problem analysis essays; responses to social problems were scored on 8 dimensions for higher-order & complex thinking & analyzed w/ hierarchical multiple regres; compared SL to traditional	Ugrads w/academic knowledge in one of 8 course areas (Educ, Enviro Sci, Engl, Health Sci, Gerontology, Poly Sci, Psyc, Relig) service: assist Head Start; student lit tutoring; poetry workshop for seniors/prisoners; implement alch abuse prog; investig enviro issues; one term	SL undergraduates showed significant increase in prosocial reasoning (reasoning concerning another's needs) & decision-making; significantly greater awareness of multiple dimensions and variability involved in dealing with social problems; on-site autonomy predicts prosocial reasoning; the quality of classroom instruction (involving reflection integrated with service experience) was positively related to the level of prosocial reasoning
Bixby, Carpenter, Jerman, & Coull, (2003) (Science topic)		120 undergraduates
Qualitative: written reports & end summary description	Ugrads w/science knowledge in Environmental Science course; service: on-campus measurement of energy use	Ugrads learned about energy conservation & waste management as relates to campus and selves
Driscoll, Holland, Gelmon, & Kerrigan (1996) (Some science topics)		4 classes undergraduate (actual number not provided)
Mixed methods: Quant/qual; pre/post survey self-report; comp case study: interview, focus groups, doc analyses; 4 diff courses/groups: ugrads, faclty, com agencies/ institns	Ugrads w/academic knowledge in one of 4 course areas (Graphics; Public Health; Writing; Intro Education); service venues not revealed	SL positively influenced undergraduates' awareness of the community & sensitivity to diversity (attitude, understanding, comfort, & confidence), & involvement in community

Esson, Stevens-Truss, & Thomas (2005) (Science topic)		51 undergraduates
Mixed methods: Descriptive quant/qual; one-shot post survey self-report; sum essay	Ugrads w/science knowledge in intro Chemistry course; service: presented science experiments to elem schl students	Ugrads reported SL positively influenced their problem solving, crit thinking, & communic skls; But no help to better understand chem.; Females signif. ($p = .05$) more positive than males
Eyler, Giles, Jr., & Braxton (1997)		1535 undergraduates from 20 US colleges/ universities
Quantitative: quasi-experimental; pre/post survey self-report, pre/post problem-solving interviews; comparison of SL and non SL undergraduates;	Ugrads at various institutions involved in a range of SL courses and services; disciplines included Education, Social Work, Service-Learning seminars and other traditional arts and sciences disciplines	SL is predictive of tolerance of others, ability to understand and empathize with others' situations, and ability to remain open to new ideas; positive efficacy for the SL objective
Eyler, Root, & Giles, Jr. (1998)		24 undergraduates from 4 colleges (7 novice service, 7 exper service, 7 exper SL, 3 control)
Qualitative: quasi-experimental; one-shot problem-solving interviews & capacity tests; control group; comparison of novices vs. experts in service	Ugrads at various institutions involved in a range of SL courses and services	The greater participation in SL and service, the higher capacity to identify and solve community based problems

Giles & Eyler (1994)		72 undergraduates (56 pre/post surveys; 54% fr, 18% so, 12% jr, 16% sr; 83% EuroAm, 15% AfrAm, 2% AsianAm; 66% female)
Quantitative: pre/post survey, self-report, attitude scales	Ugrads w/academic knowledge from interdisciplinary major Human and Organizational Development; 13 week SL course; 24 hours service at various social service agencies	SL positively influenced perceptions of their community partners (from racial & ethnic stereotypical views); gained empathy & understanding of partners' situations; undergraduates showed significant increases in outcomes measured for beliefs that people can make a difference in community issues and in commitment to service
Gray, Ondaatje, Fricker, & Greschwind (2000)		1300 undergraduates (725 SL; 597 no service; 78% female) from 28 institutions
Quantitative: one-shot longitudinal survey (1995-1997) of experiences, attitudes, & outcomes; comparison grp = no service	Ugrads at various institutions involved in a range of SL courses and services related to education, human needs, public safety, & environment	SL ugrads perceived SL increased their involvement in civic affairs & improved life skills; did not improve academic skill or career prep
Hollis, S. A. (2004)		100 undergraduates (93%unstr & 92% struc EuroAm; 50% fem)
Qualitative: course case comparison: structured v. unstructured SL; journals & essays; researcher = course instructor	Ugrads w/sociology knowledge in (2 formats, 1 term), intro Sociology course "Social Problems" (examined political socialization re blame attribution); service: various roles work w/ youth e.g., tutoring, coaching/supervising recreation, computer training; assigned 20 hrs in one of 13 service agencies	Structured SL ugrads where service linked in concert w/course classroom activities showed posititve change in attitude toward comm members; attributed social probs to social structure factors, e.g., living conditions and probs of clients; in unstructured SL, ugrad changed from optimism to blame the victim and their culture

Juhn, Tang, Piessens, Grant, Johnson, & Murray (1999) (Science topic)		152 undergraduates (57 SL, 95 control)
Mixed methods: Quant/qualitative; pre/post; quasi-experimental; survey self-report, focus groups & interviews; posttest for discipline expertise	Ugrads w/science knowledge in Nursing course; service: taught Health Science topics to middle school students and teachers	SL students had significantly higher skills, & knowledge in health work; self-reported increased confidence working with adolescents, parents, teachers, others.
Kearney (2004) (Science topic)		84 graduate professional (mean age 26-27; 64% female)
Quantitative: pre/post survey self report for attitudes	Grads w/science knowledge in Pharmacy course; service: various: tutor/mentor assistant in daycare (50%), senior home, shelters, rec center, free clinics; not nec healthcare related; one academic quarter, 16 hrs service	No change in sense of efficacy to affect change/help; only those who worked with seniors gained ability to listen to/understanding others; gains in critical thinking, comm./leader skills and social awareness for all; those w/previous SL exper had greater gains in these areas
Kendrick (1996)		122 undergraduates (59 SL, 63 control; 75% fr; 86% EuroAm; 63% female)
Quantitative: quasi-experimental; grades, pre/post attitude measurement scale, survey self-report, course evaluations; researcher = course instructor	Ugrads w/sociology knowledge in 2 optional sections of same intro Sociology course, one w/SL, one w/out SL; service various: assisted as teacher's aids, daycare, prepared/served meals; 20 hours	SL positively influenced outcomes measured for social competency (work with others); ability to apply SL course knowledge to new situations; No diff in course grades

Mabry (1998)		144 undergraduates (84% EuroAm; 68% female)
Quantitative: quasi experimental; pre/post survey self-report for civic attitude/values; SL pedagogical practices compared	Ugrads at one state institution involved in a range of SL courses and services; 23 different SL courses (Arts/Sciences, Human Resources, Education); compared hours of service, type of interaction & reflective practices	Males & non EuroAm & those with the least service experience scored signif higher for change in civic attitude (responsible to solve soc probs/help others); More service (15-20 hrs), weekly in-class & ongoing & summative written reflection, ongoing interaction w/sups & instructors had positive effect on SL undergraduates
Markus, Howard, & King (1993)		89 undergraduates (so & jr; 60% male, 40% female)
Quantitative: experimental; pre/post survey self-report grades, attitude scales; course evals	Ugrads w/political science knowledge in 2 sections of an 8 section Political Science course; (2 SL, 6 control); service: assist in homeless shelter, wom crisis cent, ecology cent, & after-schl tutor at-risk youth; 20 hrs	SL students had significantly higher course grades and belief in importance of equal opportunity, volunteering, & work in “helping” careers
Miller (1994)		125 undergraduates (36 SL, 89 control; age 19-20)
Quantitative: quasi-experimental; pre/post survey self-report	Ugrads w/psychology knowledge in optional SL section, 2 courses Developmental Psychology & Social Psychology; 1 term, service: 50 possible venues include work in day-care, pre & elem schls, comm. centrs, shelters, advo agencies; 40 hrs	No difference re final grades & mastery of course concepts; SL ugrads reported enhanced ability apply concepts outside class

Miller (1997)		327 undergraduates (70% EuroAm)
Quantitative: pre/post survey self-report	Ugrads w/psychology knowledge in Psychology SL course w/ 8 sections; service: 50 pos service venues w/economically disadvantaged persons; 40 hrs	Significantly lower sense of social self-efficacy for all undergraduates, but mainly sourced in sophomore males of color, non frat- non religiously-active, in social sciences working w/young children (*p* <.004)
Narsavage, Lindell, Chen, Savrin, & Duffy (2002) (Science t.)		79 graduate/professional
Mixed methods: Quantitative/qualitative; pre/post tests for course objectives, journals, focus groups, web-based discussions, survey self-report	Grads w/science knowledge in summer & fall master's in science Nursing courses, 5 SL projects; service: worked w/homeless, seniors, teaching public school children, hospice staff, health education; 8-24 hrs	SL has significant positive affect on outcomes measured for social issues and subject knowledge (8 items, p < .0001) in areas of perceptions of comm partners & of social, cultural, & econ factors; knowledge of needs & barriers for comm; self-reported gain in understanding, admiration, & empathy for comm prtnrs; enhanced knowledge & how to work with comm. partners
Osborne, Hammerich & Hensley (1998) (Science topic)		95 undergraduates (48 SL, 45 laboratory; 60% female)
Quantitative: experimental (random assn); pre/post survey self- report; six scales/tests (i.e., soc behavior, cognitive complexity)	Ugrads w/science knowledge in 4 sections Pharmacy course; SL vs non SL lab-based experience; service: worked in non-retail hospital- and clinic-based pharmacies; No length of field praxes given	SL positively influenced outcomes measured for social competency and cognitive complexity; SL positively influenced outcomes measured for perceived knowledge of & ability to work with diverse others (or efficacy in pharmacy objective), and self worth in social situations

Potthoff, Dinsmore, Eifler, Stirtz, Walsh, & Ziebarth (2000)		136 undergraduates (93% EuroAm; age 19-23; 66% female)
Quantitative: one shot survey, self-report	Ugrads w/teaching knowledge in one of 7 venues for preservice teachers (PTs) in Developmental Behavior course; service: working w/disabled, preschl, adlesc ed, rec, skill build; 50 hrs	91% PTs reported the SL course enhanced their warm/caring feelings, willingness to serve others, and empathy for persons different from self; enhanced their understanding of environmental risk factors & connections betwn behavior & learning; (Direct interaction vs. no interaction w/clients promotes change)
Rice & Brown (1998)		230 undergraduates (169 total quant [64 fall #1, 44 spring, 61 fall #2] 207 qual; 43% EuroAm, 28% Latino/aAm,7% AsianAm,3% AfrAm; mean age 20.6; 68% female)
Mixed methods: quantitative/qualitative; pre/post attitude scale ; one-shot post course evaluations for perception of what gained	Ugrads w/academic knowledge in required intro to SL Multiculture Community course; study over 3 semesters & multiple sections (Women's Studies, ESL); service: various venues including assisted single mothers & writing tutors; 30 hrs	SL undergraduates reported increased advocacy for community service, understanding of their positions of privilege in the communities they served; became personally and emotionally engaged; recognized their assumptions re the community partners; SL students scored significantly higher on civic participation. Self reported gains in communication and job related skills, and ability to work with others different from self
Rockquemore & Schaffer (2000)		120 undergraduates (50 qual sub sample; 80% EuroAm, 14% Latino/aAm, 4% AfAm, 2% AsianAm; age 18-22; 69% female)
Mixed methods: Quant/qual; pre/post attitude measurement scale; 50 journals ; No significance tests performed on data; grounded theory	"Affluent" ugrads w/academic knowledge in one of Sociology or Religion SL courses; one semester; Service: various, e.g., food delivery, geriatric, youth mentor, free-clinc, homeless, publ schl. No length field praxes	Substantial positive change in attitude about equality of opportunity in the US and ability to impact social problems; 3 stages of engagement: shock, normalization, & engagement; gained recognition of their relative positions of privilege

Steinke, Fitch, Johnson, & Waldstein (2002)		153 undergraduates from 12 private Iowa colleges
Mixed methods: Quant/qual; regression anal; pre/post test survey self-rep for 5 predictors (reflection, plcmnt qual, comm. engage, diversity, stu voice), 5 outcome vars (cogn, intell, spirit/ethical, civic engage, com. impct); narrativs	Ugrads w/academic knowledge in one of 12 diff SL courses in Soc, Educ, Busi, Psych, Relig; service: various comm venues w & w/without direct interaction, e.g., tutoring, public relations, fundraising; range 1-14 wks & 1-14 hrs/wk	In narratives ugrads reported respected more self & others they worked with, awareness of own position of privilege & opps, felt connected w/ community, affirmed importance of diversity. The quality of placement (level of challenge & responsibility) did not predict more positive outcomes (vs. findings of Eyler & Giles, 1999). Integrated reflection methods help ugrads to appropriate/process information/concepts & spiritual/ethical development, but not intellectual dev or civic engagement.
Tsang, Van Haneghan, Johnson, Newman, & Van Eck (2001) (Science topic)		96 undergraduates (freshmen)
Mixed methods: Qualitative/ quantitative; pre/post attitude survey self-report, retrospective survey, essays	Ugrads w/engineering knowledge in 1st-year Mech Engineering; service: partnered w/middle school students& teachers in sci/math to design/implement projects; data collected over 3 aca years; courses ea 1 quarter; No length of field praxes given	SL ugrads gained knowledge & teamwork skills; self-reported positive attitude toward mech engineering; pre/post surveys gained awareness of civic responsibility
Vogelgesang & Astin (2000)		22,236 undergraduates
Quantitative: 1991-1997 longitudinal; pre/post survey self-report; comparison of SL, generic service, and no service groups	Ugrads at various institutions involved in a range of SL courses and services and service agencies	SL is a strong predictor of commitment to promoting goal of racial understanding (p <.001, N=19439); SL has pos effect on commitment to activism (p <.001, N=19789). Leadership skills & self efficacy to effect soc no diff from generic comm service (w/out course base); SL enhanced critical thinking/writing skills; self report signif higher GPAs

Table E2. *Category Two: Studies Where Community Members and University Students Each Provide Certain Expertise to the Service-Learning Relationship*

Note: In this category, community members and SL university students each had certain strengths and expertise, and they learned from each other as they worked together. Examples of such programs would be ESEP, or multicultural education courses that tried to effect holistic social change. University students volunteered to promote a social cause. For all undergraduates in SL courses, general college level knowledgeability is assumed. In certain SL courses more course-specific academic knowledge is also assumed, and when that was the case, this specific knowledge will be noted under the pertinent detail column in the table below. In category two, community members provided their expertise in the form of planning, training, or working with university students and faculty, or giving evaluative feedback.

Researcher(s)		Sample
Method	Pertinent Details	Findings for participants
Barton (1999) (Science related topic)		8 masters graduate/professional (4 EuroAm, 2 AsianAm, 1 AfAm, 1 Latino/aAm; 88% female)
Qualitative case-study: Pre /post indiv interviews, researcher field notes, PTs' journals, interviews, & focus group conversations; author participant-observer/teacher, did early interviews; research assistant did post interviews	Grads w/science and teaching knowledge in summer Multicultural Science Ed seminar for preservice teachers (PTs); service: taught science in homeless shelter w/middle-school children 4 hrs/ wk for 7 weeks; comm. agents planned/ collaborated w/faculty	SL positively influenced PTs' views and definitions of science education in theory & practice; showed an integrated vision of science, school and society (political issues regarding the hierarchy of valued knowledge taught); attitude toward science changed to be more challenging, open-minded and responsive to the context; began to view teaching as more student-centered; learned to question their stereotypes of the low SES children and their communities

Boyle-Baise (1998)		65 undergraduates (most European Am; middle working-class; no specific ages provided; most female)
Qualitative case-study: group interviews, essays, survey self-report	Ugrads w/teaching & culture knowledge in Multicultural Ed crs for PTs; service: observed & assisted in low SES & minority churches, theater & comm cntrs; 20 hrs; comm. agents planned w/faculty, oriented PTs, provided feedback	Felt more aware of issues/comfortable teaching in culturally diverse classrooms, but did not express critical concern for inequities
Boyle-Baise & Kilbane (2000)		24 undergraduates (20 EuroAm [83%], 2 Lation/aAm, 2 AfAm); no specific ages provided; 17 females [68%])
Qualitative case-study: group interviews, essays, pre/post survey self-report, focus groups, observations	Ugrads w/teaching & multiculture knowledge in Multicultural Ed crs for preservice teachers; service: tutoring, teaching, assisting in low SES & minority churches & comm. cntrs, girl scouts, Head Start; No length of field praxes given; comm. agents planned w/faculty, oriented & guided PTs, provided feedback, taught PTs about themselves	SL PTs learned to think more equitably about community partners (change in deficit thinking and disruption of stereotypical views of those partners based on race, ethnicity & SES); some gain cultural awareness/behavior

Boyle-Baise & Sleeter (2000)		117 undergraduates (89% EuroAm, 6% AfrAm, 3% Latino/aAm, 2% AsianAm; 74% female; Midwest & West coast)
Qualitative: Data from 1994-1998; reflective essays, & grp interviews; data from 4 yrs	Ugrads w/teaching & multiculture knowledge in Multicultural Ed crs for preservice teachers; service: tutoring or assisting in low SES & minority churches & comm. cntrs; 20-50 hrs/sem; one term	Most partially changed deficit views; some maintained views (blamed parents); prev exper w/in comm. expedited change of views; gained knowledge about SCE factors affecting low SES clients; concern for equality/opps, but did not recognize systemic inequalities; gained some understanding culturally relevant pedagogy; some saw selves as role models /caring substitutes when not exposed to families; familial placements helped reduction of stereotypical views
Dorfman, Murty, Ingram, & Evans (2002) (Science topic)		49 undergraduates (13 SL, 36 non SL)
Mixed methods: Quant/qual; pre/post attitudinal scales; pre/post open-ended questions, journal, summary essay; compared ugrads with SL experience to ugrads w/out SL	Ugrads w/academic knowledge of aging, the elderly, science & sociology in intro to Gerontology course (cross-list w/Sociology, Health, Nursing, Sports); service: visited/took oral history w/elders at nursing hm, asst living, meal/activity sites; one term, 16 hrs; comm. agents planned w/faculty, oriented ugrads, provided feedback, taught ugrads about themselves	SL ugrads showed more positive change at post-test in overall attitudes toward the elderly than non SL; ugrads reported gained knowledge about rural elders and communities

Dorfman, Murty, Ingram, Evans, & Power (2004) (Science topic)		59 undergraduates
Mixed methods: Quant/qual; two pre/post attitudinal scales for elderly & working w/elder; pre/post open-ended questionnaire; data from 5 semesters (5 cohorts)	Ugrads w/academic knowledge of aging, the elderly, science & sociology in intro to Gerontology course (cross-list w/Sociology, Health, Nursing, Sports); service: visited/took oral history w/elders at nursing hm, asst living site, apartment site, meal/activity site; 16 hrs; comm. agents planned w/faculty, oriented ugrads, taught ugrads about themselves	Aggregate scale data indic overall change for attitude toward elderly, but only cohorts 1 & 2 showed signif positive change & cohort 2 was marginal; Other cohorts had more positive baseline attitude and elders w/poorer function/cognitiv abilities
Eyler & Giles, Jr. (1999)		57 to 1,535 undergraduates from 20 US colleges/ universities; 84% EuroAm; each sample 2 females for every one male [67%]
Mixed methods: Quant/qual; quasi-experimental; summary of 3 studies of various SL w/controls; pre/post survey self-report, pre-post problem-solving interviews, attitude measurement scales & interviews; used HMR controlling for SES, gender, service, minority stat.	Ugrads at various institutions involved in a range of SL courses and services and service agencies; service only and SL experience/ institutions; one semester; mode for 48% ugrads spent 1-3 hrs per wk; 14% spent > 6 hrs per wk.; 36% did service with children; some portion of comm. agents planned and worked w/ugrads	SL undergraduates reported SL positively influenced their tolerance and stereotypical views of partners; positively influenced their understanding of the causal complexity of social issues, learning & ability to apply knowledge (*N*=57). Developed sense of connection with individuals and community. The quality of placement (level of challenge & responsibility) predicted more positive outcomes. Character of reflection activities (discussion & writing) & application of service & subject matter have impact on stereotyping, tolerance

Myers-Lipton (1996a); (1996b)		225 SL jr & sr level undergraduates (control 1 *N*=25-30, control 2 *N*=150) from a Western state university
Quantitative: Pre/post quasi-experimental nonequivalent control; scales for racism, civic responsibility, civic behavior, locus of control & understanding; control 1, random= service not linked to courses; control 2= no service; multivariate analysis	Ugrads w/ sociology knowledge in one of 3 sections of 2-year, 4-course Sociology program in civics problem solving; service: various; intensive reflection; 6 hrs service/week plus one mos international agriculture aid project abroad (Jamaica) = >200 hrs; comm. agents planned, trained and worked w/ugrads = comprehensive SL program for local, national & international concerns	Only after 2-year period, SL undergraduates showed significantly higher reduction in modern racism (stereotypical views), gain in understanding social issues, civic behavior, concern for civic responsibility, and belief in cooperation compared to other groups
Nnakwe (1999) (Science topic)		34 undergraduates
Quantitative: pre/post attitude scale	Ugrads w/science knowledge in a required SL senior level Nutrition & Dietetic majors course; 5 wks; comm. health & food assist agencies collaboration & admin survey; comm. agencies provided training, supervision, & feedback	SL undergraduates showed significant increase in concern, social commitment and attitudes toward activism related to homelessness & victims of hunger; felt the need to become more involved in community issues

Romack (2004) (Science topic)		22 undergraduates
Qualitative descriptive: weekly journals; reports; post essay, client interviews	Ugrads w/science knowledge in an upper division Kinesiology Motor Development course; service: provided activity plan, phys therapy & companionship to elders in nursing home; one term; 15-20 hrs; comm. directors designed/planned/ implemented/monitored ugrads	Ugrads w/high responsibility showed positive change in stereotypical views of elders & aging
Ropers-Huilman, Carwile, & Lima (2005) (Science topic)		40 undergraduates (fr & so; age 17-22; 68% EuroAm; 55% female)
Mixed methods: Quant/qual; post survey self-report social attitudes & engineering objectives; post focus-group interviews	Ugrads w/physics, maths & engineering knowledge in first year Biological Engineering course; service: designed a playground, worked w/community clients to plan; one semester; comm. agents/partners planned and gave expert evaluative feedback	Ugrads gained knowledge & skills in bio engineering, teamwork, communication, understanding the needs of the community

Wade (1995)		41 undergraduates (jr & sr; 100% Euro Am; 1 male [98% female])
Mixed methods: Quant/qual; pre/post survey self-report, interviews, journals, essays, & “feedback” documents; interrater reliability; 41 interviews; 39 pre/post survey	Ugrads w/teaching & sociology knowledge in Sociology Ed Methods elementary schl; service: combo teaching practicum w/service project; 21% PTs venues w/o people, e.g., pick up trash; 79% w/client contact: e.g., visit elders, teaching, tutoring low SES children, babysitting; one semester; comm. agents worked w/PTs on teaching, gave evaluative feedback; one term	67% PTs believed they had a greater knowledge of and 72% strong personal connections to others; 74% felt increased self-knowledge; Feelings: 74% enjoyment; 62 % sadness, anger, or frustration; 82% increased self-efficacy to effect change; 28% dev concern for social issues; 19% dispelled assumptions; 13% dev respect; 28% incr soc struc knowledge; (Direct interaction vs. no interaction w/clients promotes change)

Table E3. *Category Three: Studies Where Community Members Provide Certain Expertise to the Service-Learning Relationship*

Note: In this category, community members had a certain target expertise and SL undergraduates learned from them, e.g., internships. For all undergraduates in SL courses, general college level knowledgeability is assumed. In certain SL courses more course-specific academic knowledge is also assumed, and when that was the case, this specific knowledge will be noted under the pertinent detail column in the table below. In category three, community members provided their expertise in the form of planning, training, or working with undergraduates, or giving evaluative feedback.

Researcher(s)		Sample
Method	Pertinent details	Findings for participants
Bringle & Kremer (1993)		44 undergraduates (14 SL; 10 experiential seminar crs; 20 lecture/control); most EuroAm undergrad; mean age 31; 86% female)
Quantitative: quasi-experimental; semantic differential scales + quiz; qualitative: interviews; 1 focus groups; weekly reports; lecture/control grp	Ugrads w/psychology knowledge in one of 2 Psychology courses re ageing & the elderly; service: visitation w/AfrAm seniors; one term; 8 hrs service SL grp; 6 hrs service seminar grp; comm. agents trained (communic skls, comm. resources, aging), read ugrad reports, evaluated the program	Both visitation groups significantly gained positive attitude toward elderly & own aging. Gained knowledge comm. resources/service systems. Self reported: gained understanding of elderly, & diverse race/culture, $p < .05$

Greene & Diehm (1995) (Science topic)		40 undergraduates (24 optional SL, 16 control)
Mixed methods: Quant/qual; quasi-experimental; early/post survey self-report, interviews; only journal group randomizd; between grp design for effects of SL on ugrad perceptions; non SL comparison grp	Jr. level ugrads w/science, health & social knowledge in Occup Therapy on Human Diseases crse; service: visitation w/nursing home elderly; 4 hrs w/reflection limited to journals; comm. agents paired ugrads & supervised; Elders taught ugrads about themselves, provided evaluative feedback	Reduction of stereotypical views not statistically significant, p = .237, but decreasing trend (survey); elders contributed to their knowledge, p = .04; 70.8% wrote that SL broadened their knowledge on aging; 50% wrote they had less "stereotypical" images of the elderly, Quality of reflection issue: Type of journal feedback significantly affects views re elders' contribution
Jones & Abes (2003) (Some science topics)		8 undergraduates (1 fr, 6 so, 1 jr; 7 or 88% EuroAm; 6 or 75% female)
Qualitative: case study; early/post interviews, observations, reflective essay documents	Ugrads w/sociology knowledge in Ed Policy & Leadership SL course on HIV/AIDS & prevention; service: prepared/ packagd, or interacted with & delivered meals to HIV/AIDS clients; 3 hrs/wk for 1 quarter; comm. agents trained, worked with/assisted ugrads w/their presentations, gave evaluative & formative feedback on program & ugrad learning	Ugrads gained knwldg about the syndrome & understanding /empathy for social factors/victims; ugrads who had direct interaction w/clients recognized own attitudes/stereotypes; they gained respect for their partners and a sense of connectedness; some w/out interaction blamed the client; (direct interaction vs. no interaction w/clients promotes change)

Reed, Jernstedt, Hawley, Reber, & DuBois (2005)		33 undergraduates (14 SL, 19 control)
Quantitative: quasi experimental; pre/post survey self-report	Ugrads w/ psychology knowledge in Psychology crs on the learning process; Lab with elders at end-of-life in hospice, medical & geriatric care centers; 2-4 hrs service; comm. agents trained ugrads, determined length of visits, supervised, & debriefed ugrads; elders taught ugrads about themselves	SL learners reported no change or maintenance in sense of social responsibility ($df = 13$, $t = -0.63$, $p = .27$), but an increase in sense of meaningfulness of college, comfort speak w/dying elders ($df = 13$, $t = 2.19$, $p = .024$), anxiety about death, & likely to choose service-related occupation
Strage (2000)		477 inexperienced undergraduates (166 SL; 94% female)
Mixed methods: Quant/qual; journals & one shot grades; data from 5 semesters; observation only experience vs. SL experience	Ugrads w/ psychology & education knowledge in of Intro to Child Dev in Psychology for Ed majors; service: observed & assisted teachers w/students in pre-, elementary, middle, & high classrooms; 20 hrs; comm. agents worked w/ugrads to expedite learning of physical, cogn., soc & emot developemnt	SL students had significantly higher course grades and linking course concepts with service experience

Appendix F: Elementary School Settings and Demographics

School Name	Community Features w/in Approx. 1 Mile (1.6 kilometers) of School	Student Body Demographics	Building
Summit (grade 1)	Middle-income neighborhood, small businesses, an interstate freeway, National Guard/Police Academy, 2 recreational centers, 1 city park, historical center, zoo and garden, fire station, post office, library, 6 churches, 1 bible college, and 4 public schools	195 enrolled 70% African American 24% European American 2% Latino 1% Asian 1% Native American 2% other 47% male 53% female 78% eligible for free/reduced lunch	Peeling paint and flooring, old fixtures and plumbing, poor ventilation. Scheduled for closure
Ridge (grade 2)	Low-income apartment developments and low- and middle- income neighborhoods, small businesses (shopping center), 4 cemeteries, 1 library, 2 parks, 1 rec. center, federal prison & prison farm/landfill, 3 churches, 3 public schools	615 enrolled 100% African American 46% male 54% female 96% eligible for free/reduced lunch	New paint and flooring, recent fixtures and plumbing, good ventilation, new library
Peak (grade 3)	Low-income apartment developments, and low- and middle- income neighborhoods, small businesses, large businesses, an freeway, metro railway stations, central bus station, 4 hospitals, 2 libraries, 4 fire stations, 2 post offices, 1 police station, Civic Center, 3 parks, 2 rec. centers, 5 major tourist attractions, 3 museums, 2 major theaters, 21 churches, 1 private technical university, 3 public schools	502 enrolled 100% African American 49% male 51% female 82% eligible for free/reduced lunch	New paint and flooring, recent fixtures and plumbing, good ventilation

Crest (grade 5)	Low-income apartment developments, and low- and middle- income neighborhoods, small businesses, large businesses, 2 interstate freeways, metro railway station, 1 cemetery, 3 libraries, 5 parks, 5 rec. centers, City Courthouse, City Hall, State Capitol, state offices, Federal Reserve Bank, 4 major tourist sites, 3 stadiums, 1 hospital, 5 fire stations, 4 post offices, 3 libraries, 1 police station, 33 churches, 1 state university, 5 public schools	549 enrolled 100% African American 48% male 52% female 99% eligible for free/reduced lunch	Recently reno-vated, new library and gym, new paint and flooring, recent fixtures and plumbing, good ventilation

(Data is from SPS annual reports for each elementary school)

Appendix G: University Setting and Demographics

Undergraduate Enrollment	U.S. Region of Origin*	Race Composition	Building
Total: 5,044 Male: 2310 (45.8%) Female: 2734 (54.2%)	Study state: 26.1% SE states: 18.3% NE states: 23.8% Other states: 29.6% Foreign: 2.2%	Native American or AK Native: 0.2% Asian or Pacific Islander: 15.4% African American: 8.7% Latino: 3.2% European American: 67.3% Other (citizens): 3.4% Foreign or non-resident alien: 1.8%	Continuous renovations and construction of new facilities, state-of-art fixtures and facilities

(Information supplied by Emory University)
*SE region = AL, FL, NC, SC, TN; NE = CT, DE, ME, RI, MA, NY, NJ, NH, PA, VT;
Other states = Puerto Rico, U.S. Virgin Islands and all other states; Foreign = non U.S.A.

Appendix H: Orientation Agenda Samples

EMORY ESEP UNDERGRADUATE SCIENCE-PARTNER ORIENTATION:
PART I
Saturday September 16th, 2000, 10:00 a.m. – 3:30 p.m. School of Public Health Bldg.,
AGENDA

Entry Hall (by elevators):
10:00 - 10:10 Sign-in and pick up syllabus, name tag, hand-outs and rotation group card.
Pick up breakfast, be seated and fill out tax forms in the center room (room A).
RAR room:
10:10 - 1045 Welcome and introductions- Camille Goebel: ESEP Student Council.
Course expectations; Review course reading and syllabus.
Real-Life Scenarios: Conversational Vignettes

10:45 - 11:25 1. Select and Register Teacher (your name, their name, school, grade, days and times)
Select Reflection Session (sign up)
Sign up for day(s) for Orientation Part II – science kit training
Purchase Experiment Manual ($15.00)
Turn in completed tax forms
11:25 – 11:30 Greetings: Robert DeHaan, Director ESEP
11:30 - 1200 Break / Food!

Rooms A (center), B, and C: Break into 3 groups (see your card) & rotate hourly to Mini-Classrooms, Inquiry Skills and Questioning Skills

12:00 - 1:00
Group A => Room A: Mini-Classroom - Ms. A. J. and pupils from “A” Elementary School
Group B => Room B: Inquiry Skills - Ms. K. H.
Group C => Room C: Perfecting the Question – Ms. D. B. & Ms. Camille Goebel

1:10 - 2:10
Group C => Room A: Mini-Classroom – Ms. L. J. and pupils from “B” Elementary School
Group A => Room B: Inquiry Skills - Ms. K. H.
Group B => Room C: Perfecting the Question – Ms. D. B. & Ms. Camille Goebel

2:20 - 3:20
Group B => Room A: Mini-Classroom – Ms. J. G. and pupils from “C” Elementary School
Group C => Room B: Inquiry Skills - Ms. K. H.
Group A => Room C: Perfecting the Question – Ms. D. B. & Ms. Camille Goebel
3:20 – 3:30 Question and Answer

EMORY ESEP UNDERGRADUATE SCIENCE-PARTNER ORIENTATION: PART II
Monday, September 18th and Thursday September 21st, 5:00 - 8:30 p.m.
School of Public Health Bldg., 8th floor

AGENDA

5:00 - 5:30 Plenary Session, RAR Room (A) - Introductions, and overview of activities, Camille Goebel

5:30 - 7:30 Kit Lessons: Go to your grade level and school

Teachers:
Monday – Mess's J. G., L. J., A. M., S. M., J. O., B. P., C. P., A. U., D. W., P. W., & H. W.

Thursday – Mess's J. G., L. J., A. M., S. M., J. O., B. P., C. P., A. U., D. W., P. W., & H. W.

7:30 – 8:00 Break / Food!

8:00 – 8:30 Kit Lessons Continue

8:30 Clean up and Adjourn

You need to go to your school and meet your teacher, ILS, principal and kids this week! Plan with your teacher your first inquiry-based science experiments. Have them draw a scientist. Your first journal is due this Sunday: describe your kids, their drawings of a scientist, your teacher and classroom and your feelings.

ESEP TEACHER-PARTNER ORIENTATION

Thursday, September 7th , 2000
4:00 - 5:00 p.m.
SPS Instructional Services Center, Room 3-4

AGENDA

Expectations and Responsibilities of a Teacher-Partner

4:00 Individual review of teacher packets; Refreshments. (CNN ESEP Video: "College Science-partners in the Classroom")

4:05 Welcome and Introductions: Ms. Camille Goebel (404-727-3052), Emory University; Ms. S. L.-S. "A" University Center, Ms. A. M., "B" State University

4:15 ESEP Real-Life Scenarios: Ad-lib Conversational Skits

4:30 Responsibilities and Expectations Discussion and Summary

4:45 Questions and Answers

5:00 Adjourn

Visit us at: www.Emory.edu/COLLEGE/ESEP and www.gsu.edu/~geoabm/

AGENDA NOTES :
Expectations and Responsibilities of a Teacher-Partner

ESEP Real-Life Scenarios : Ad-lib Conversational Skits – Teachers perform 2-3 problem-based scenarios ad-libbed by teachers. Audience invited to contribute solutions

Your expectations of the partnership: Teachers discuss in groups and share with everyone.
Questions:
What qualities does a team need to teach science well?
What can I, the teacher, provide for my science-partner?
What I would like to know about the ESEP partnership?
What kind of risks does a teacher-partner take?
What kind of risks does a college-partner take?

Appendix I: Focus-Group Topic Samples

ESEP reflection group assignments for the week of September 18
Read, share and discuss (see #3 below) excerpts on child development from the following books: (a) Science for Elementary School. 1993. E.V. & R.D. Kellough pg. 38-43 and (b) Teaching Elementary Science. 1993. W.K. Esler & M.K. Esler, pp. 33-39
Consider the student's conceptual development compared to the curriculum. Is the information the student receives related or integrated? Think about how the child might process information, e.g., on the habitats of living forms like birds or plants. What are you seeing in your classroom?

Discuss ESEP reflection group assignments for the week of September 25;
From Dr. Mel Konner's book Childhood, read pages 239-242, the age of transition; the 5-7 shift, and 251-257, IQ and tests; multiple intelligences. Prepare to discuss social and cultural factors affecting child development with Dr. Konner himself in the Thursday evening session.

Discuss ESEP reflection group assignments for the week of October 1;
Prepare to reflect on the teaching and learning culture of your classroom with Dr. Kathryn Kozaitis. Think about your early expectations for the teaching experience.

Discuss ESEP reflection group assignments for the week of October 9;
Prepare to discuss whole class and individual student responses to science lessons with ESEP SKIL teacher Ms. Jane Nettles.

Discuss ESEP reflection group assignments for the week of October 16;
Prepare to share and discuss with chemistry professor McCormick, the pros and cons of inquiry-based lessons you have expedited. Bring examples of student work.

Discuss ESEP reflection group assignments for the week of November 6;
Prepare to reflect on innovations and changes you bring to the classroom and your students, e.g., what was your classroom like at first; what is it like now?

Discuss ESEP reflection group assignments for the week of December 11
Prepare to reflect with Dr. Kathryn Kozaitis on the changes you see in yourself as a result of your ESEP experience, e.g., what are your views on science teaching; what are your views on how your students learn science?

Appendix J: Participant Summary

Table J1

Undergraduate Participants and Source Information

Undergraduate	Grade	Gender	Age	Coll Year	Race & Ethnicity	No. of Interview*	No. of Observations	No. of Summaries	No. of Journals
Anna	1	F	21	Sr.	European American	4	9	2	22
Badra	2	F	20	Jr.	AsianAm (Indian)	4	9	2	19
Chikara	3	M	20	Jr.	AsianAm (Japanese/German)	4	9	2	19
Dawei	5	F	21	Sr.	AsianAm (Chinese)	4	14	2	18

*Four semi-structured interviews: initial (4 weeks), mid (11 weeks), near-end (20 weeks), and post (23 weeks)

Table J2

Teacher Participants and Source Information

Teacher	Grade Taught	Gender	Age Range	Race & Ethnicity	No. of Interviews *	School	No. of Years Teaching Elementary School as of S'01
Ellen	1	F	50-55	European American	1	Summit	6
Fran	2	F	30-35	African American	1	Ridge	4
Gail	3	F	30-35	European American	1	Peak	9
Helen	5	F	28-30	European American	1	Crest	1

*One semi-structured interview post partnership

Table J3

Classroom Demographics

School	Grade	Number of Students in the Class	Race and Gender of Students
Summit	1	13	3 African American females; 5 African American males; 2 European American females; 3 European American males
Ridge	2	14	9 African American females; 5 African American males
Peak	3	12	8 African American females; 4 African American males
Crest	5	22	13 African American females; 9 African American males

Appendix K: Informed Consent Letter

Emory University, Division of Educational Studies: Informed Consent Form
Title: Adult Science Partnerships in Elementary Classrooms
Principal Investigator: Camille A. Goebel
Sponsors: Emory University and National Science Foundation
Background and Purpose: This study involves research on long-term teacher and college student science-partnerships in elementary classrooms supported by the Elementary Science Education Partners (ESEP) program. Such science partnerships are rare and to date the elements and characteristics of the program that support and promote inquiry-based science instruction in the urban classroom have not been systematically studied. It is important to observe, interview and survey teachers and college students who are new to partnering to gain an understanding of the benefits that volunteer partnering contributes to elementary science instruction as well as to teacher and undergraduate development. You are being asked to volunteer as a partner in this research along with 4 other teachers and undergraduate science partners each from different schools. This study will proceed throughout the academic year 2000-2001.
Procedures: You will be given a pseudonym and your identity will remain anonymous. You will fill out a 10-minute survey on your attitude toward science before and after partnering. You will be interviewed twice about partnering, once at the start and once at the end of the partnership. Five to seven classroom observations will be made of you and your partner during science time. Some observations may be made when your science partner is not present. Over the course of the year, participation in the study will involve approximately 2 hours of your time outside of regular instructional time.
Risks and Benefits: There will be no special or unusual circumstances related to this research which might give rise to special concern for your welfare. The benefit of your participation is the contribution of valuable information that can be used to enhance science instruction in elementary classrooms.
Voluntary participation and withdrawal: Your participation in this study is voluntary and you have the right to withdraw at any time without any loss of benefits.
Confidentiality: You will be given a pseudonym to maintain your anonymity. Facts about you will be kept private.
Contact Persons: Call Ms. Camille Goebel (404-727-3052) if you have any questions about this study. If you have any question about your rights as a person who is a part of this research, call Dr. Robert Jensen, Chair, Division of Educational Studies Human Subject Committee (404-727-0606).
Copy of consent form to participant: You will get a copy of this consent form to keep. If you are willing to volunteer for this research, please sign below.

______________________________	__________
Participant	Date
______________________________	__________
Witness	Date
______________________________	__________
Principal Investigator	Date

Appendix L: Interview Protocols for Undergraduate and Teacher Partners

Undergraduate Partners:
Week 4, Initial

1. Why did you decide to become a partner? (What are your expectations?)
2. What is the greatest help to learning science?
3. What is the greatest barrier to learning science?
4. Describe your classroom. What do you notice about your students? (how they learn)
5. What are the students' overall attitudes toward science?
6. What evidence do you have that your students are learning science?
7. In your elementary classroom, what typically happens during science time?
8. What do you feel about your ESEP experience so far?

Week 11, Mid
Describe your students.

1. What did you learn about them and how they learn?
2. What do you think that they learned this semester?
3. What changes do you see in your student's concept of a scientist?
4. How have you changed as a science teacher?
5. What did you learn about your student's lives outside of school?
6. How has that knowledge affected your understanding of them as learners?
7. What stands out the most from your experience with ESEP this semester?
8. How have you changed over the semester (from this experience) as a person?

Week 20, Near end

1. Why did you get involved in a science partnership with an elementary teacher and students?
2. Briefly describe the needs of the elementary students in your class. What have you learned about your feelings and actions toward the students in your classroom and your school?
3. In what ways has being a science partner helped you?

Undergraduate interview protocols (continued)

Week 23, Post

1. Why did you decide to become a partner?
2. What were your expectations?
3. What typically happens during science time?
4. How would you describe the relationship you have with your students?
5. What skills and sensibilities does your role as a science partner require?
6. What evidence do you have that your students are learning science?
7. How has that knowledge affected your understanding of them as learners?
8. How have the students' attitudes toward science and learning changed as a result of the partnership?
9. How did ESEP influence their actions/behavior related to learning science?
10. How have you most profoundly changed after being involved in ESEP (as a result of the experience)?
11. How has your experience in the ESEP program affected your understanding of science?

Teacher: Post

1. How many years and grades have you taught?
2. Why did you decide to become a partner?
3. What were your expectations of the partner?
4. Would you please describe your relationship with your partner?
5. What skills and sensibilities does your role as a science partner require?
6. Compare your partnership now versus at the start of the term. How do you two teach together now versus then?
7. What typically happens during science time?
8. Describe your primary role (and others).
9. How did you teach science before getting a partner? How often?
10. How often do you teach science now?
11. How do you feel about teaching science compared to the other topics?
12. What do you notice to be the greatest help to teaching science?
13. What are the greatest barriers to teaching science?
14. What evidence do you have that your students are learning science?
15. How have the students' attitudes toward science and learning changed as a result of the partnership?
16. How would you describe the relationship you have with your students during science time compared to other topics?
17. What are some of the things you learned from your partner?
18. What are some of the things that you have taught your partner?
19. Why should a college student be a science partner?
20. What type of changes or learning have you seen in your partner over the term?
21. How do you feel about science in general?
22. What areas in science do you feel knowledgeable and comfortable?
23. Why should a teacher be a partner?
24. How have you changed from being involved in an ESEP partnership with a college student?
25. How has the ESEP partnership affected your understanding of science?

Appendix M: Transcription Criteria

Each one-on-one interview transcription starts with a header of identifying information, e.g. the name of the respondent, and a key. Transcriptions are word for word for all conversation, comments, and sounds, e.g. laughs or coughs, made by the respondent and interviewer, as well as, identification of background noises, e.g., [loudspeaker announcement] and clarifications, e.g. [interviewer knowledge] in brackets. A line ___ means speech is not clear enough to capture. A … means a pause in speech and is sometimes followed by a change in thoughts. The interviewer's voice is transcribed in italics.

The end-of-term focus group transcriptions are again verbatim records of all conversation, comments, and sounds made by the ESEP undergraduate group members and the moderator. I transcribed the moderator's voice in italics. I assigned a gender and numerical pseudo name to each undergraduate, e.g., M for male, F for female, as in M1, M2, M3… and F1, F2, F3… for the full number of group members who spoke.

Appendix N: Undergraduate Document Guidelines

Weekly Reflective Journal

Students should discuss their experiences in the classroom through their reflective journals. Use the following questions as a guideline, but not a limit. Write at least one page, single space, 12-font.
What significant learning events happened in your science classroom this week?
What caused them to happen?
What do you think about these occurrences? How do they affect you?
What was your role and what was your teacher's role in the science lesson?
You may focus on:

- How the children responded to your hands-on activity
- How the children interacted with you, the teacher and each other
- The children's attitudes toward the experiment and how they changed
- How the teacher reacted to the experiment or changed
- Anything you have gained from the experience.
- Any changes you have experienced.

Summary of Experience

After ten to eleven weeks of experience teaching, take a look back at your journal entries and think about the changes you have catalyzed and witnessed in your children, teacher and yourself. In a two page, single spaced, 12-font document, discuss:

a) The events and behaviors in your classroom with respect to the science lessons you were involved with; use anecdotes to describe any changes in the children's attitudes toward science and skills they have gained. Include changes you see in pupil understanding of science and give multiple examples of work, scores and comments.
b) The most important outcomes of this experience for you, relative to things learned about your elementary science education, your other class-work at the university, your career interests, and how you think, study and view science. You are encouraged to reference any relevant reading or information gathered from scientists, teachers or ESEP facilitators during the course of your experience. Give examples.

Appendix O: Classroom Observation Protocol

Partnership: _________Grade: ____ School: __________Date: ______ StartTime: _______End:____
Lesson Subject: _______________________
Class Composition:

Attribute	Undergraduate Partner Times	Teacher Partner Times	Notes
Roles			
• Lead teacher (L)			
• Co-lead/ co-assistant (CL)			
• Class Behavior Manager (M)			
Attitude Toward Science (ATS)			
• Negative (N)			
• Neutral (U)			
• Positive (P)			
Teaching Styles (TS)			
1) Teacher-centered			
2) Combo teacher- student-centered			
3) Student-centered			
Accuracy of Lesson Content (AC)			
1) Completely inaccurate			
2) Mostly accurate			
3) Completely accurate			
Elements of the Science Lesson (EL)			
1) Finite procedures			
2) Some inquiry process skills but nature of science absent			
3) Some inquiry process skills & nature of science present			
Student Engagement Level (SEL)			
1) Not engaged/Disruptive			
2) Not engaged/Not disruptive			
3) Engaged/Cooperative			

1. Role(s) of the undergraduate and time spent in each role when teacher partner is present
2. Role(s) of the undergraduate and time spent in each role when the teacher partner is absent
3. Role(s) of the teacher partner and time spent in each role when undergraduate partner present
4. Time and nature of hands-on inquiry-based science by undergraduate partner
5. Time teaching methods other than hands-on inquiry used by undergraduate partner
6. Teacher-centered vs. student-centered lesson
7. Accuracy of science-lesson content
8. Elements of inquiry lesson
9. Evidence of undergraduate’s attitude toward science
10. Reaction of the students to the science lesson(s) (e.g., engaged or off task)

Appendix P: Code Book Sample

NVivo 2.0 Node Listing
Project: Science Undergraduate Beliefs
User: Camille Goebel

Codes in Set:	All Nodes
Created:	4/8/2004 - 9:07:27 AM
Modified:	6/8/2005 - 12:50:56 PM
Number of Nodes:	142

2	(1 1) /Teaching_Inquiry/Student T Meth
3	(1 1 1) /Teaching_Inquiry/Student T Meth/Adapt to Stu Needs
4	(1 1 2) /Teaching_Inquiry/Student T Meth/Experiential
5	(1 1 3) /Teaching_Inquiry/Student T Meth/Traditional
6	(1 1 4) /Teaching_Inquiry/Student T Meth/INQUIRY
7	(1 1 5) /Teaching_Inquiry/Student T Meth/Sci Methods Process
8	(1 1 6) /Teaching_Inquiry/Student T Meth/Teaching Efficacy
9	(1 1 7) /Teaching_Inquiry/Student T Meth/Integrated
10	(1 1 8) /Teaching_Inquiry/Student T Meth/Applications
11	(1 1 9) /Teaching_Inquiry/Student T Meth/Interactive
12	(1 4) /Teaching_Inquiry/TeaPrtnr Activ
13	(1 4 2) /Teaching_Inquiry/TeaPrtnr Activ/Partner Cooperation
28	(4) /SCE Factors
29	(4 1) /SCE Factors/Ugrad
30	(4 1 1) /SCE Factors/Ugrad/Privilege
31	(4 1 3) /SCE Factors/Ugrad/Opportunity Exposure
32	(4 6) /SCE Factors/Students
33	(4 6 1) /SCE Factors/Students/SES Low
34	(4 6 2) /SCE Factors/Students/Stu Opportunity
35	(4 6 5) /SCE Factors/Students/Home_Community
36	(4 6 5 3) /SCE Factors/Students/Home_Community/Politics and School
37	(4 6 7) /SCE Factors/Students/Learning culture
38	(4 6 8) /SCE Factors/Students/Teaching culture
65	(6 1) /Change/Change
66	(6 2) /Change/No Change
68	(7 1) /ABS/Willingness
69	(7 3) /ABS/Disability
70	(7 4) /ABS/Developmental
71	(7 5) /ABS/Difficulty
72	(7 6) /ABS/Ability
73	(7 7) /ABS/Sci Skills

Appendix Q: Motivations to Participate

Motivation/Undergraduate	Anna	Badra	Chikara	Dawei
Have an enjoyable relationship with students	59%*	41%	51%	34%
Help students learn science	12%	16%	5%	19%
Gain experience teaching children	9%	11%	6%	12%
Become a better teacher	0	7%	11%	10%
Pride in student learning	7%	16%	12%	11%
Break from college	6%	0	8%	2%
Apply science knowledge	5%	8%	3%	10%

* Percentages are rounded up

Appendix R: Lesson Observations

Table R1

General Observations for Anna

Date 2000-01	Subject	Total time lesson (min)	Total time lead (min)	% time lead	Total time assist (min)	Behavior manager undergrad*	Behavior manager teacher*	ATS	TS	AC	EL	SEL	SIL
10.27	Plants	66	15	22.73	51	1	5	P	2	2	2	2	2
11.06	Life	56	16	28.57	40	5	5	P	1	3	1	2	2
11.27	Habitat	66	37	56.06	29	8	10	P	2	3	3	2	2
12.01	Mamls	68	62	91.18	6	3	5	P	1	3	1	2	2
3.19	Magnet	50	50	100	0	4	2	P	2	3	2	2	2
3.26	Magnet	55	55	100	0	3	3	P	2	2	3	2	2
4.11	Weathr	52	45	86.54	7	0	5	P	2	3	2	2	2
4.23	Temptr	32	31	96.88	0	0	5	P	1	3	2	2	2
Stats:													
Mean		55.6	38.9	72.75	16.63	3	5						
Min		32	15	29	0	0	2						
Max		68	62	100	51	8	10						
Median		55.5	41	88.86	6.5	3	5						
Mode									2	3	2	2	2

*	= occurrence
ATS	= attitude toward science: "P" positive, "N" negative, and "U" neutral
TS	= teaching styles: (1) teacher centered, (2) combination teacher and student centered, and (3) student centered
AC	= accuracy of lesson: (1) completely inaccurate, (2) mostly accurate, and (3) completely accurate
EL	= elements of lesson: (1) finite procedures, (2) some inquiry process skills but NOS absent, and (3) some inquiry process skills and NOS present
SEL	= student engagement level: (1) not engaged/disruptive, and (2) engaged/cooperative
SIL	= student interest level: (1) indifferent, and (2) enthusiastic

Table R2

General Observations for Badra

Date 2000-01	Subject	Total time lesson (min)	Total time lead (min)	% time lead	Total time assist (min)	Behavior manager undergrad*	Behavior manager teacher*	ATS	TS	AC	EL	SEL	SIL
10.31	Bal Mo	60	58	96.67	0	1	4	P	2	3	2	2	2
11.02	Gravity	52	19	36.54	33	4	6	P	1	2	1	2	2
11.14	Bal Mo	52	52	100	0	2	6	P	1	3	1	2	2
11.30	Float	65	44	67.69	21	2	6	P	2	3	2	2	2
3.06	Life cyc	45	45	100	0	0	7	P	2	3	3	2	2
3.22	Sol Liq	57	50	87.72	7	0	2	P	1	3	3	2	2
4.19	Magnt	81	54	66.67	27	1	7	P	2	3	2	2	2
4.26	RvSci	55	55	100	0	0	3	P	1	3	1	2	2
Stats:													
Mean		58.38	47.13	81.91	11	1.25	5.13						
Min		45	19	36.54	0	0	3						
Max		81	58	100	33	4	7						
Median		56	51	92.19	3.5	1	6						
Mode									1 & 2	3	1 & 2	2	2

* = occurrence
ATS = attitude toward science: "P" positive, "N" negative, and "U" neutral
TS = teaching styles: (1) teacher centered, (2) combination teacher and student centered, and (3) student centered
AC = accuracy of lesson: (1) completely inaccurate, (2) mostly accurate, and (3) completely accurate
EL = elements of lesson: (1) finite procedures, (2) some inquiry process skills but NOS absent, and (3) some inquiry process skills and NOS present
SEL = student engagement level: (1) not engaged/disruptive, and (2) engaged/cooperative
SIL = student interest level: (1) indifferent, and (2) enthusiastic

Table R3

General Observations for Chikara

Date 2000-01	Subject	Total time lesson (min)	Total time lead (min)	% time lead	Total time assist (min)	Behavior manager undergrad*	Behavior manager teacher*	ATS	TS	AC	EL	SEL	SIL
10.25	Temp	63	45	71.43	18	0	2	P	1	2	2	2	2
11.15	Moon	81	41	50.62	40	4	7	P	2	2	2	2	2
11.29	Sol Syst	82	60	73.17	22	4	3	U	1	3	1	2	2
12.06	Planets	84	68	80.95	16	4	7	U	1	2	1	2	2
3.12	Evap	50	50	100	0	0	1	P	2	3	2	2	2
3.27	Plants	57	57	100	0	4	6	P	2	3	3	2	2
4.10	Plants	56	56	100	0	1	7	P	2	2	3	2	2
4.24	Observ	53	53	100	0	1	3	P	2	3	3	2	2
Stats:													
Mean		65.75	53.75	84.52	12	2.25	4.5						
Min		50	41	50.62	0	0	1						
Max		84	68	100	40	4	7						
Median		60	54.5	90.475	8	2.5	4.5						
Mode									2	2 & 3	2 & 3	2	2

*	= occurrence
ATS	= attitude toward science: "P" positive, "N" negative, and "U" neutral
TS	= teaching styles: (1) teacher centered, (2) combination teacher and student centered, and (3) student centered
AC	= accuracy of lesson: (1) completely inaccurate, (2) mostly accurate, and (3) completely accurate
EL	= elements of lesson: (1) finite procedures, (2) some inquiry process skills but NOS absent, and (3) some inquiry process skills and NOS present
SEL	= student engagement level: (1) not engaged/disruptive, and (2) engaged/cooperative
SIL	= student interest level: (1) indifferent, and (2) enthusiastic

Table R4

General Observations for Dawei

Date 2000-01	Subject	Total time lesson (min)	Total time lead (min)	% time lead	Total time assist (min)	Behavior manager undergrad*	Behavior manager teacher*	ATS	TS	AC	EL	SEL	SIL
10.11	Orgs	55	10	18.18	45	0	3	P	1	2	2	2	1
10.30	RvPrCn	45	3	6.67	42	1	16	P	2	3	2	2	2
11.13	Sol Sys	47	0	0	47	1	6	P	1	3	1	2	2
11.15	Mass	43	38	88.37	5	0	9	P	2	3	2	2	2
12.06	Nutrit	39	18	46.15	21	0	3	P	1	3	1	2	2
2.26	Mixtrs	45	0	0	45	0	2	P	2	3	3	2	2
4.16	Mamls	40	22	50	18	0	1	P	1	3	2	2	2
4.16	Mamls	30	15	50	15	0	6	P	2	3	2	2	2
Stats:													
Mean		43	13.25	32.42	29.75	0.25	5.75						
Min		30	0	0	5	0	1						
Max		55	38	88.37	47	1	16						
Median		44	12.5	32.17	31.5	0	4.5						
Mode									1 & 2	3	2	2	2

* = occurrence
ATS = attitude toward science: “P” positive, “N” negative, and “U” neutral
TS = teaching styles: (1) teacher centered, (2) combination teacher and student centered, and (3) student centered
AC = accuracy of lesson: (1) completely inaccurate, (2) mostly accurate, and (3) completely accurate
EL = elements of lesson: (1) finite procedures, (2) some inquiry process skills but NOS absent, and (3) some inquiry process skills and NOS present
SEL = student engagement level: (1) not engaged/disruptive, and (2) engaged/cooperative
SIL = student interest level: (1) indifferent, and (2) enthusiastic

Appendix S: Thematic Findings Specific to this Study

Table S1

Thematic Findings for Research Question One Involving Expressed Beliefs on Ability of Students to Learn Science

Finding/Undergraduate case participant	Anna	Badra	Chikara	Dawei
(a) Changed or partially modified deficit views of low SES students' ability to learn science	x (22)*	X (20)	X (20)	X (23)
(b) Expressed admiration of students' intellectual abilities	X (23)	X (20)	X (20)	X (23)

*X denotes distinctly modified belief expressed; x denotes partially modified belief;
(#) indicates the week a change in a belief expressed about this subject was first recorded

Table S2

Thematic Findings for Research Question Two Involving Expressed Beliefs on Social, Cultural, and Economic Factors

Finding/Undergraduate case participant	Anna	Badra	Chikara	Dawei
(a) Expressed awareness of social issues (e.g., work schedules, illness, education, loss of guardian) that may impact the education of students	x (20)*	X (23)	X (23)	X (23)
(b) Expressed conviction that their unique teaching relationship & knowledge of the students expedited student learning in science	X (11)	X (20)	X (11)	X (11)
(c) Expressed awareness of the impact of the culture of teaching and learning (e.g., language, value placed on science, behavior management, inclusive science pedagogy), and lesson context on student performance	x (20)	X (11)	X (11)	X (11)
(d) Expressed conviction that adequate financial support combined with student-centered inquiry-based science practice, materials, and time allocated to science instruction positively impacts student ability to learn science	X (22)	X (23)	X (23)	X (23)

*X denotes distinctly modified belief expressed; x denotes partially modified belief;
(#) indicates the week a change in a belief expressed about this subject was first recorded

Appendix T: Comparison of Similar Beliefs for All Groups

Table T1

Similar Beliefs Concerning Students Expressed by Case Participant and Fall (F) and Spring (S) Focus Group Undergraduates at the End of the Partnership

Belief/Undergraduates	Anna	Badra	Chikara	Dawei	F(11)*	S (9)
Research Question One:						
(1) Most students can learn science	---	√	√	√	√	√
(2) Most students can learn science but learning is probably limited	√	---	---	---	---	√
(3) Most students are intelligent	√	√	√	√	---	√
(4) Students have different learning strengths and weaknesses	√	---	√	---	---	√
Research Question Two:						
(5) Students have different learning styles that affect their learning	√	√	√	√	√	√
(6) Student motivation is a factor affecting learning	√	√	√	√	√	√
(7) Available resources & opportunity for science affect a student's ability to learn (need more)	√	√	√	√	√	√
(8) The physical structure/environment of the school affects student learning	√	√	√	---	√	---
(9) Science knowledge/skill can be an economic equalizer	√	√	---	---	---	√
(10) Science knowledge/skill is important for everyone's development (value)	√	√	√	√	√	√
(11) Teaching methods affect learning: methods should be flexible & responsive	√	√	√	√	√	√

Table T1 (continued)

Belief	Anna	Badra	Chikara	Dawei	F(11)*	S (9)
(12) Teaching methods affect learning: methods should be inquiry-based & relevant	√	√	√	√	√	√
(13) Teachers need more science knowledge to teach science	√	√	√	√	√	√
(14) A caring teacher positively affects student learning	√	√	---	√	---	√
(15) Their unique teaching relationship with the students affects student learning (friend, role model, teacher)	√	√	√	√	√	√
(16) Parental support of educ & home environ has positive & negative effects on student learning (uneven)	---	√	---	√	√	√
(17) Parental support of educ & home environ has negative effect on student learning	√	---	√	---	---	---
(18) Educational systems affect students' ability to learn (under education)	√	---	---	√	---	√
(19) Political systems can affect students' ability to learn w/ respect to value of public science education	√	√	---	√	√	√
(20) Class size affects students' ability to learn science	---	---	√	√	---	---

* = total number of focus group discussants; √ = belief expressed; --- = belief not expressed

Table T2
Similar Beliefs Concerning the Profound and Lasting Impact on Self and Self Knowledge Expressed by ESEP Undergraduates at the End of the Partnership (* = total number of focus group discussants*;* √ = belief expressed; --- = belief not expressed*)*

Beliefs/Undergraduates	Anna	Badra	Chikara	Dawei	F (11)*	S (9)
(1) Gained new understanding of others' situations; empathy	√	√	√	√	√	√
(2) Gained realization & appreciation for the privilege of their educational background (own education, the education system, and family care/support)	√	√	√	√	√	√
(3) Was relieved of cultural/social isolation experienced at college; sense of connectedness	√	√	√	√	√	√
(4) Raised respect/admiration for elementary school teachers/profession	√	---	√	√	---	---
(5) Had previous biases regarding student ability to learn	√	---	---	√	√	√
(6) Became more open minded, and patient or tolerant of others	---	---	---	√	√	√
(7) Enhanced or gained time management ability	√	---	√	√	√	---
(8) Became more confident communicator and teacher; able to work with others	√	√	√	√	√	---
(9) Enhanced or gained reason for and commitment to study (sense of purpose)	√	√	---	√	√	√
(10) Changed understanding of or thinking about science	√	√	√	√	---	---

Appendix U: Thematic Findings Concordant with the Literature

Table U1

Findings Concordant with the Literature Relevant to Research Question One Involving Expressed Beliefs on Ability of Students to Learn Science

Literature/Undergraduate case participant	Anna	Badra	Chikara	Dawei	Within category pro-portion
(1) Decrease in participants' belief expressions from a deficit thinking perspective on community partners	x	X	X	X	
Category I: Ames & Diepstra, (2006); Eyler et al., (1997); Giles & Eyler, (1994); Hollis, (2004); Rice & Brown, (1998)					19% (5 of 27)
Category II: Barton, (1999); Boyle-Baise & Kilbane, (2000); Boyle-Baise & Sleeter, (2000); Dorfman et al., (2002); Eyler&Giles, (1999); Myers-Lipton, (1996a);Romack,(2004)					54% (7 of 13)
Category III: Bringle & Kremer, (1993); Jones & Abes, (2003)					40% (2 of 5)
(2) Gain of admiration of community partners	X	X	X	X	
Category I: Ames & Diepstra, (2006); Narsavage et al., (2002); Steinke et al., (2002)					11% (3 of 27)
Category II: ---					---
Category III: ---					---
(3) Gain of a sense of connection with community partners & larger community	X	X	X	X	
Category I: Eyler et al., (1997); Narsavage et al., (2002); Potthoff et al., (2000); Rockquemore & Schaffer, (2000); Steinke et al., (2002)					19% (5 of 27)
Category II: Barton, (1999); Eyler & Giles,(1999); Wade, (1995)					23% (3 0f 13)
Category III: ---					---

Category # = Organizing category for service-learning literature (see Appendix E):
Literature Category I = 27 studies in which the service-learning university student provides a certain expertise; Category II = 13 studies in which the community members and university student each had expertise; Category III = 5 studies in which the community members had a certain expertise
*X denotes distinctly modified belief expressed; x denotes partially modified belief
--- = no findings reported for this category of service-learning literature

Table U2

Findings Concordant with the Literature Relevant to Research Question Two Involving Expressed Beliefs by Undergraduates on Social, Cultural, and Economic Factors

Finding/Undergraduate case participant	Anna	Badra	Chikara	Dawei	Within category pro-portion
(1) Increased awareness of social issues that impact community partners	x	X	X	X	
Category I: Ames & Diepstra, (2006); Astin & Sax, (1998); Batchelder & Root, (1994); Eyler et al., (1997); Eyler et al., (1998); Giles & Eyler, (1994); Hollis, (2004); Narsavage et al., (2002); Osborne et al., (1998); Potthoff et al., (2000); Rockquemore & Schaffer, (2000)					41% (11 of 27)
Category II: Barton, (1999); Boyle-Baise, (1998); Boyle-Baise & Kilbane, (2000); Boyle-Baise & Sleeter, (2000); Dorfman et al., (2002); Eyler & Giles, (1999)					46% (6 of 13)
Category III: Bringle & Kremer, (1993); Jones & Abes, (2003)					40% (2 of 5)
(2) Gained awareness of the impact of the dominant culture on community partners	x	X	X	X	
Category I: Rockquemore & Schaffer, (2000)					4% (1 of 27)
Category II: Barton, (1999); Boyle-Baise, (1998); Boyle-Baise & Kilbane, (2000); Boyle-Baise & Sleeter, (2000)					31% (4 of 13)
Category III: ---					---

Category # = Organizing category for service-learning literature (see Appendix E):
Literature Category I = 27 studies in which the service-learning university student provides a certain expertise; Category II = 13 studies in which the community members and university student each had expertise; Category III = 5 studies in which the community members had a certain expertise
*X denotes distinctly modified belief expressed; x denotes partially modified belief
--- = no findings reported for this category of service-learning literature