2013

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Thomas, Julie; Ivey, Toni; and Puckette, Jim, "Where Is Earth Science? Mining for Opportunities in Chemistry, Physics, and Biology" (2013). *Faculty Publications: Department of Teaching, Learning and Teacher Education*. 262.
https://digitalcommons.unl.edu/teachlearnfacpub/262

JOURNAL OF GEOSCIENCE EDUCATION **61**, 113–119 (2013)

Where Is Earth Science? Mining for Opportunities in Chemistry, Physics, and Biology

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ABSTRACT

The Earth sciences are newly marginalized in K–12 classrooms. With few high schools offering Earth science courses, students' exposure to the Earth sciences relies on the teacher's ability to incorporate Earth science material into a biology, chemistry, or physics course. "G.E.T. (Geoscience Experiences for Teachers) in the Field" is an exploratory program funded by the National Science Foundation aimed to increase teachers' geoscience interest and content knowledge. Participant teachers ($n = 7$) included non–Earth science teachers from underrepresented groups and/or high schools with a high percentage of students from underrepresented groups. A variety of quantitative and qualitative measures assessed changes in teachers' readiness and propensity for incorporating geoscience concepts into their current curricula. Findings are compelling, though these results are based on a small sample of teachers. In light of current politics, where Earth science is largely disregarded, professional development workshops like this one can help science teachers become knowledgeable enough to incorporate and expand on geosciences connections in biology, chemistry, and physics. © *2013 National Association of Geoscience Teachers*. [DOI: 10.5408/12-319.1]

Key words: secondary teachers, curriculum

INTRODUCTION

Although the *National Science Education Standards* (National Research Council, 1996) place the geosciences on par with the physical and life sciences, the Earth sciences are currently marginalized in K–12 classrooms: Only 7% of the nation's high school students take Earth science courses (Lewis and Baker, 2010). With few high schools offering Earth science courses, students' exposure to the Earth sciences relies on the teacher's ability to incorporate Earth science material into a biology, chemistry, or physics course. However, few teachers have sufficient background in the geosciences to understand the complexity and rigor of Earth system science and its connectivity to other science disciplines. Moreover, the general public believes that Earth system science courses do not include the rigor, depth, and breadth of biology, chemistry, or physics courses (Hoffman and Barstow, 2007).

Lewis and Baker (2010) reviewed the last seven years of the *Journal of Research in Science Teaching* and found no studies "directly related to the issue of advancing geoscience education as a part of scientific literacy, the problem of low K–16 student enrollment and class offerings, or the national supply of geoscience teachers" (p. 122). Further, Lewis and Baker's examination of the subject index of the *Journal of Geoscience Education* revealed limited research that addressed K–12 geoscience education and the preparation of secondary Earth science teachers. Though some studies focused on geoscience professional development for teachers, these programs included only Earth science teachers.

LITERATURE REVIEW

The Earth sciences are increasingly marginalized. In fact, geosciences are now the most underrepresented area in all of the science, technology, engineering, and mathematics (STEM) areas. Many schools in the United States disregard the geosciences while considering them less rigorous than other laboratory-based science classes (Underwood, 2008). According to the 2003–2004 *Schools and Staffing Survey* (SASS), just 10% of high school science teachers identified their main teaching assignment as Earth science. Of that 10%, about half noted that Earth science was their only teaching assignment (Morton et al., 2008). High schools typically require only two or three science credits for graduation requirements, and in Oklahoma, high schools encourage students to take biology, chemistry, and physics to complete their science requirements. Little to no mention is given to Earth science (Oklahoma State Department of Education, 2010). Some state policies, however, require an Earth science course. For example, 67% of all New York ninth graders take an Earth science class (American Geological Institute, 2002). Comparatively, in a state like Oklahoma, with no policy requiring an Earth science course, just 10% of seventh and eighth graders and 3% of ninth to twelfth graders take an Earth science class (Blank and Langesen, 2005).

Concern for Geoscience Knowledge

Currently, high school science teachers demonstrate limited knowledge of the geosciences. In the 2003–2004 SASS study, cited earlier, only 40% of the teachers who identified Earth science as their main teaching assignment had obtained a major in an Earth science, and only a third had teaching certification in the Earth sciences. Moreover, 60% of those teachers whose main teaching assignment was Earth science did not have a comparable major. Additionally, only 20% of nonmajors held a teaching certificate in the Earth sciences (Morton et al., 2008). In Oklahoma, only 35% of high school science teachers whose main teaching

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Received 1 May 2012; revised 27 October 2012; accepted 15 November 2012; published online 21 February 2013.

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assignment was Earth science were also certified in Earth science (Van Zee and Roberts, 2001). One can conclude that the few students who do take an Earth sciences course in high school may not be receiving instruction from teachers who have had authentic experiences in the geosciences themselves. Consequently, if teachers have not had authentic geosciences experiences, how can they provide authentic geosciences learning experiences for their students?

Best Practice in Teacher Professional Development

Consensus suggests that, in order to have lasting effects on teachers' practice, professional development programs need to be long term and situated (e.g., Putnam and Borko, 2000; Loucks-Horsley et al., 2003). Van Driel et al. (2001) suggest that "long-term professional development programs are needed to achieve lasting changes in teachers' practical knowledge. . .strategies that are potentially powerful are learning in networks, peer-coaching, collaborative action research, and the use of cases" (p. 137). Additionally, they point out that "teachers' ideas about subject-matter, teaching, and learning do not change easily or rapidly" (p. 140). Garet et al. (2001) indicated "three core features of professional development activities that have significant, positive effects on teachers' self-reported increases in knowledge and skills and changes in classroom practices: (a) focus on content knowledge; (b) opportunities for active learning; and (c) coherence with other learning activities" (p. 915–916). Additionally, Garet et al. found that teacher learning was significantly affected by "(a) the form of the activity (e.g., workshop vs. study group); (b) collective participation of teachers from the same school, grade, or subject; and (c) the duration of the activity" (p. 916). Given that teachers' opportunities for professional development are often isolated events, much professional development has little effect on changing classroom practices. Present theory in professional development encourages the amalgamation of practice with "critical, dialogic reflection" between educators (Nelson et al., 2008).

Best Practice in Geoscience Teacher Professional Development

Some models of Earth science teacher professional development are present in the literature. In one program for in-service teachers seeking a master's of education in curriculum and instruction with an emphasis in Earth science, researchers involved the teachers as researchers. O'Neal (2003) concluded that, "Field-based research experiences in Earth science education can effectively promote the development of content-qualified, technologically-literate, scientifically confident, and enthusiastic secondary level Earth science teachers" and that "direct, meaningful experiences in field-based research transform Earth science teachers into Earth science experts in the classroom" (p. 69). Responding to the constraint of Earth science as a marginalized curriculum and with an understanding of effective teacher professional development, this research study focused on the potential for integrated Earth science instruction. Little other research in teacher professional development documents ways in which geoscience in-service experiences can help non–Earth science teachers integrate geoscience content into the biology, chemistry, and physics curricula.

RESEARCH QUESTIONS

The "G.E.T. in the Field" program sought to explore ways to help non–Earth science high school teachers incorporate the geosciences in their classrooms. While most high school teachers and students are limited to biology, chemistry, or physics, increased geoscience knowledge and awareness might help identify geoscience connections within other science coursework. In this study, we used a variety of quantitative and qualitative measures to assess changes in teachers' readiness and propensity for incorporating geoscience concepts into their current curricula. In this article, we particularly address how the "G.E.T. in the Field" program affected the participants' Earth science teaching efficacy, teaching beliefs, and content knowledge.

METHOD

The research team (one geologist and two science teacher educators) joined efforts to provide professional development experiences for secondary science teachers. The researchers planned workshop activities around the geologist's research expertise and access to field sites. As such, this workshop content was focused on groundwater geochemistry, and participants visited field sites of interests in Oklahoma. Additionally, researchers purposefully referenced explicit connections to high school science courses (i.e., biology, chemistry, physics) to help encourage the participants' integration of the Earth sciences into their high school science courses. National Science Foundation funding supported this 10 d geoscience experience to (1) increase teachers' geoscience interest and content knowledge and (2) enhance teachers' ability to incorporate geoscience concepts into their biology, chemistry, or physics curricula. Ten days and 12 h per day, of intensive geology laboratory and field investigations provided rich opportunities for these teachers to visit geosciences researchers' laboratories ($n = 3$). Mornings and afternoons were spent in the geology laboratory or in the field. In the laboratory, teachers engaged in hands-on experiences with groundwater models, ion chromatography, and bacterial culturing.

Field trip sites included domestic water-supply springs, a perched aquifer, and an acid-mine drainage area associated with a Superfund site. At each of these sites, teachers measured field parameters (total dissolved solids, electroconductivity, temperature, pH, presence of metals, and dissolved oxygen). Finally, a gypsum aquifer trip allowed teachers to sample water that discharges from a cave system that is also home to a large colony of Mexican free-tailed bats. In the field, teachers learned to differentiate aquifer stratigraphy, groundwater chemistry, and surface water as well local water-quality issues (e.g., animal waste, strip mining, acid rock drainage, and metal contaminants).

Evening activities focused on pedagogical skills such as developing and managing inquiry instruction, designing assessment rubrics, reviewing state standards, and geosciences lesson resources. In particular, researchers introduced the participants to the Earth Science Literacy Principles (Earth Science Literacy Initiative, 2010), which connect big ideas in geoscience education across the National Science Education Standards (NSES; National Research Council, 1996) for grades K–12. Participants used this document, and the matrix of NSES correlations found at their Web site, to help make geoscience connections to their classroom content.

Participants

Participant teachers ($n = 7$) included non–Earth science teachers from underrepresented groups (i.e., Native American, women) and/or high schools with a high percentage of students from underrepresented groups. Student enrollment at teachers' campuses ranged from 96 to 2,243 students. Teachers' underrepresented students were classified as (1) American Indian (ranging from 10% to 52%) and (2) economically disadvantaged (ranging from 18% to 71%). Three of the participants held teaching certificates in Earth science; one of these teachers had not taken any college geology courses but had passed the state certification exam.

Teachers primarily identified themselves as biology ($n = 4$), chemistry ($n = 1$), and physical science ($n = 2$) teachers (though most taught in multiple content areas). Generally, teacher participants had competed limited undergraduate coursework in the Earth sciences. Interview data suggested these teachers came into the workshop experience with varied Earth science backgrounds and experiences. One of the participants taught physical science and Earth science; he became interested in geology in college and continued to "pursue it at every opportunity." Another of the participants taught biology and chemistry, though she did teach Earth science infrequently; she took 12 h of geology/Earth science courses in college. Another participant, who taught biology, had a bad experience in the "rocks for jocks" course as a college freshman and had avoided geology ever since. Two additional teacher participants referred to limited or unenjoyable geology classes in college. One teacher participant had not taken a single Earth science course in her teacher preparation program, but she had taken (and passed) the teacher certification test in Earth science. The majority of teachers, however, admitted to a variety of enjoyable geology experiences outside the school walls—traveling to National Parks, collecting books, watching geology programs on television, and/or gathering rocks with their families on vacation.

Design

This case study followed the *participant-as-observer* model (Spradley, 1980), as researchers were also project leaders. According to Yin (1995), the case study component allows this research to "explain causal links in real-life interventions that are too complex for the survey or experimental strategies" (p. 25). This case study also followed mixed methods (Creswell, 2003) procedures, where both quantitative and qualitative data were collected simultaneously.

Measures

A variety of measures assessed changes in teachers' readiness and propensity for incorporating geoscience concepts into their current curricula. This paper will focus on the instruments that measured treatment effect by the end of the summer workshop. Teacher participants also created integrated lessons (geosciences concepts linked to biology or chemistry concepts), which they intended to implement during the school year. These lesson enactments and reflections will provide long-term effect data at a later time.

Qualitative data included researchers' field notes and teachers' end-of-project interviews, daily reflections, workshop video documentaries, and field journals. Data, collected and analyzed within a constructivist framework, included multiple resources to strengthen reliability as well as internal validity (Merriam, 1988). These narrative data were analyzed by constant, comparative analysis, and results were organized into themes as guided by this analysis. Verification of truth was ensured in the detailed research plan, triangulation of data, member checks (inherent in collaborative research), and the detailed descriptions of researchers' experience and understanding (Enochs and Riggs, 1990).

Quantitative measures included initial and final measures of teachers' efficacy beliefs and content knowledge. An adapted version of the Science Teacher Efficacy Beliefs Instrument (STEBI; Enochs and Riggs, 1990; Riggs and Enochs, 1990) measured changes in teachers' Earth science teaching self-efficacy. The original STEBI consisted of the (1) Personal Science Teaching Efficacy (PSTE) and (2) Student Teaching Outcomes Expectancy (STOE) subscales. Researchers modified the STEBI by revising the PSTE subscale items to specifically reference geoscience instead of science in general (examples provided in the following sections). We renamed this scale the Earth Science Teacher Efficacy Beliefs Instrument (ESTEBI). The development of the ESTEBI followed the development of the STEBI-CHEM by Rubeck and Enochs (1991). (The STEBI-CHEM is a modified version of the STEBI, which specifically assesses the self-efficacy and science teaching outcome expectancy in teaching chemistry.) Reliability and factor analysis studies conducted by Rubeck and Enochs indicated that the PSTE and STOE constructs were maintained. Due to the small sample size in this study, determining construct validity of the ESTEBI through factor analysis was not possible. However, we established face validity of the instrument by consulting three different faculty members with expertise in geoscience education and teacher efficacy.

Additionally, researchers measured changes in teachers' content knowledge through concept maps. The researchers provided group instruction on how to create a concept map wherein participants practiced making a concept map together on group prompt: *Who are teenagers?* After the participants were comfortable with concept mapping, they then constructed individual concept maps with the prompt: *Where does geochemistry fit in my classroom?*

Researchers used IBM SPSS Statistics version 19.0 for all statistical calculations. Due to the small sample of teachers ($n = 7$), we used the nonparametric related-samples Wilcoxon signed ranks test to test for differences in initial and final measures.

RESULTS

Earth Science Teacher Efficacy Beliefs Instrument

Initial and final ESTEBI surveys measured changes in teachers' beliefs toward science teaching and learning over the 10 d of the summer workshop. The instrument included 25 items wherein participants responded using a five-point Likert-type scale ranging from strongly disagree to strongly agree. Scoring was accomplished by assigning a higher score to the positively phrased responses (5 = strongly agree, 4 = agree) and a lower score to the negatively phrased responses (2 = disagree, 1 = strongly disagree). (Note: Twelve items

TABLE I: Participants initial and final scores on the Earth Science Teaching Efficacy Beliefs Instrument (ESTEBI).

ESTEBI Subscale[1]	Pretest				Post-test				p
	Min.	Max.	Mean	SD	Min.	Max.	Mean	SD	
PESTE	2.77	4.85	3.78	0.62	3.85	5.00	4.33	0.40	0.018
STOE	2.50	3.58	3.18	0.39	2.50	4.58	3.27	0.72	1.000

[1] PESTE = Personal Earth Science Teaching Efficacy; STOE = Science Teaching Outcomes Expectancy.

were reverse-coded because they were negatively worded items.)

The Personal Earth Science Teaching Efficacy Beliefs (PESTE) subscale included statements such as:

- I look for better ways to teach Earth science concepts.
- I understand Earth science concepts well enough to be effective in teaching Earth science.

The Science Teaching Outcomes Expectancies (STOE) subscale included statements such as:

- When a student does better than usual in science, it is often because the teacher exerted a little extra effort.
- The teacher is generally responsible for the achievement of students in science.

Quantitative data analysis pointed to significant gains in participants personal Earth science teaching efficacy beliefs (PESTE). Table I indicates that teachers made significant gains on the PESTE scale ($p = 0.018$). Of particular interest, the minimum score on teachers' PESTE increased by 1.08 points. Changes in teachers' STOE score were not found to be significant.

Concept Maps

Researchers followed the Hough et al. (2007) method for scoring teacher' concept maps. These included the following items and calculations: (1) the number of concepts or idea nodes shown on the map (circles or boxes), (2) the complexity (Hierarchical Structure Score [HSS]) as measured by the width of the concepts + length of the longest chain, (3) the number of concept chunks or those nodes that are linked by two or more concepts, and (4) the number of cross links or links between chunks. Scores were computed separately by three researchers, and then differences were discussed until consensus was reached on each concept map. Descriptive statistics (mean scores, standard deviations, and range of scores) were computed for each of these four areas (see Table II). Teachers made significant increases in the depth ($p = 0.40$) and approached significance in the number of concepts ($p = 0.58$).

Field Observations and Teacher Interviews

Qualitative data (particularly researchers' field notes and teachers' end-of-project interviews, daily reflections, video documentaries, and field journals) organized a descriptive accounting of teachers' increased enthusiasm over the 10 d of the workshop. The weather was quite uncomfortable (triple-digit temperatures every day), but teachers relished the field experiences. Though teachers did not expect much excitement in the geology laboratory, they grew increasingly enthusiastic about initiating scientific investigations of their own. With their second and third opportunity for open-ended investigations in the geology laboratory, teachers clearly enjoyed the experience and came to realize biological and chemical connections they could include in the content they were already expected to teach.

New affinity developed between the project geologist and the participant teachers. While teachers were somewhat overwhelmed by the project geologist's introductory lectures, they came to enjoy his great passion for geology, his interest in helping them in the classroom, and his kid-like behavior in the geology laboratory. Though some participant teachers felt the workshop schedule was too "loosey goosey," the schedule intentionally allowed flexibility. For example, once teachers learned of the department "bone pile" (cast away rocks outside the back door to the geology building), the geologist's lectures came to include hands-on opportunities for teachers to gather up personal rock collections to take back to their classrooms.

While the initial laboratory activities followed a prescriptive plan, the geologist was intrigued by teachers' questions. Science educators helped to prompt the geologist about how to manage new inquiry processes in the geology laboratory. So, the laboratory explorations came to be more open-ended, and teachers were allowed to explore interesting variables. The geologist enthusiastically located the materials and equipment teachers needed. For instance,

TABLE II: Initial and final concept map scores of participants ($n = 7$) in response to the prompt, "Where does geochemistry fit in my classroom?"

Concept Map Item	Pretest				Post-test				p
	Min.	Max.	Mean	SD	Min.	Max.	Mean	SD	
Concept number	13.00	26.00	19.57	4.67	15.00	40.00	25.71	8.71	0.058
Width	8.00	16.00	10.43	2.57	5.00	15.00	10.43	3.31	0.916
Depth	3.00	4.00	3.57	0.54	2.00	7.00	5.14	1.68	0.040
Hierarchical Structure Score (HSS)	12.00	20.00	14.00	2.77	10.00	21.00	15.43	3.46	0.462
Chunks	3.00	5.00	4.00	0.82	2.00	11.00	5.14	2.91	0.276
Cross links	0.00	17.00	7.71	6.10	0.00	15.00	7.71	5.16	1.000

while working with a groundwater model, teachers wanted to inject brine into the system to test the concentration of the aquifer "contaminant" as it moved through strata. The geologist, encouraged and impressed by the teachers' ingenuity, ran to get the salt and worked with the teachers to determine appropriate salinity for the initial injections into the model.

Postworkshop interview data provided reflections on teachers' initial and final concept maps and gave particular insight into teachers' changed awareness. Three important ideas became clear: (1) Teachers now realized there was more to Earth science than rocks and the geologic timescale, (2) teachers were amazed to realize how little they previously understood about underground water (aquifers), and (3) the project-required integrated lesson plans helped teachers personalize their geosciences learning.

More to Earth Science than Rocks

As one teacher expressed, "I just didn't think much about Earth science before." When teachers came to identify Earth science links in biology, chemistry, and physics, they wrestled with the *one* link they would focus on in the workshop-required lesson plan. One teacher realized that geochemistry involved more biology than she once thought. Another participant, who taught biology, noted, "I didn't think much about Earth science before [this experience]. I'm so surrounded by biological concepts that I didn't really make the [broader connections]." Several teachers began to think about Earth's formation as a lesson focus, but by the end of the 10 d, teachers realized they could connect geology to biology, environmental science, chemistry, and physics. As one participant explained, "It is really interesting to see that everything ties into Earth history, and you don't have to focus on rocks being formed." Importantly, biology teachers came to realize this project experience helped them to newly consider the biotic and abiotic factors together. Teachers talked about how easy it would be to expand on geologic concepts they had been previously skirting, without realizing what they were leaving out of the lessons and how important the geology was to the lesson. One enthusiastic teacher summed it up, saying, "Life on Earth would not be possible without the nonliving." Another noted, "G.E.T. in the Field pulled all the sciences into one subject. It is all one world, one process."

New Understanding about Aquifers

The ground water model was particularly impressive to these teachers—helping them make the biology-to-geochemistry connections themselves and thinking about their unique student populations. Admittedly, teachers began the workshop with limited knowledge of aquifers. Two participant teachers "had no clue" about aquifers. One participant, the Earth science teacher, "had no idea" about aquifers. He initially thought, "an aquifer was a Kansas phenomenon" and that "if you polluted water, it just ran downstream and as long as you were upstream you were okay." Conducting field tests and experimenting with the water model in the laboratory, this teacher and others came to realize that lakes can recharge from aquifers. By the end of the workshop experience, teachers expected students will "make connections" when they can "see what they gain by how aquifers recharge."

Lesson Plans and Personalized Learning

Teachers recognized time-mandated end-of-instruction (EOI) exam regulations, and their own limited knowledge and understanding of Earth science concepts as barriers to broad adoption of geoscience lessons. Lesson plan development, however, led project teachers to realize how easily they could incorporate their newfound geoscience knowledge into the lessons already defined by their district curricula. Interestingly, researchers found a parallel between participant teachers' lesson plans and final concept maps; the lesson plan effort seemed to help organize new geoscience content knowledge wherein teachers tailored their final concept map to the lesson they had developed. Noting the gain in initial to final concept maps, researchers concluded that teachers had mastered project content to fit their instructional responsibilities. Lesson plans also provided insight into teachers' new content knowledge.

A qualitative review of the initial to final concept maps provided more evidence of the ways in which teachers lesson plans and final concept maps mirrored one another. In the postworkshop interview, teachers reviewed and compared their concept maps and generally noted their initial limitations and increased conceptual understanding on completion of the G.E.T. in the Field experience. Teachers used words like "simpler" and "new ideas" and "classroom focus" to describe their final concept maps.

Figure 1 depicts a representative pairing of initial to final concept maps in response to the prompt, *Where does geochemistry fit in my classroom?* Note that the participant's initial concept map reveals three concepts (life choices, environmental concerns, and jobs and careers) connected in one position. These concepts focus on careers and human interaction and provide little evidence of conceptual understanding of geochemistry and its relationship to the participant's physical science classroom. The final concept map differs vastly from the initial concept map in that (1) many more concepts are displayed, (2) the concepts are interconnected, and (3) the topics provide evidence of the ways in which geochemistry concepts fit into his physical science classroom.

DISCUSSION

Results indicate that teachers entered the program with varying amounts of geological concept knowledge. However, all teachers increased in their (1) content knowledge of aquifers and geochemistry and (2) personal Earth science teaching self-efficacy. Comparison of teachers' initial to final concept maps indicated that teachers increased the number and depth of their geoscience concepts. The STEBI-A (Minstrell and van Zee, 2000) analysis indicated that participants had significant gains in their personal Earth science self-efficacy beliefs. Most importantly, teachers' PESTE scores improved from being uncertain in their ability to teach Earth science to having more positive self-efficacy in their ability to teach Earth science. Moreover, the range of participant scores on the final ESTEBI indicated that all of the participants had a positive PESTE score, whereas the initial PESTE scores indicated some participants had negative PESTE prior to the intervention. This statistically significant result was impressive to researchers given such a short-term intervention. Although the same intervention did not significantly increase participants STOE scores, this was

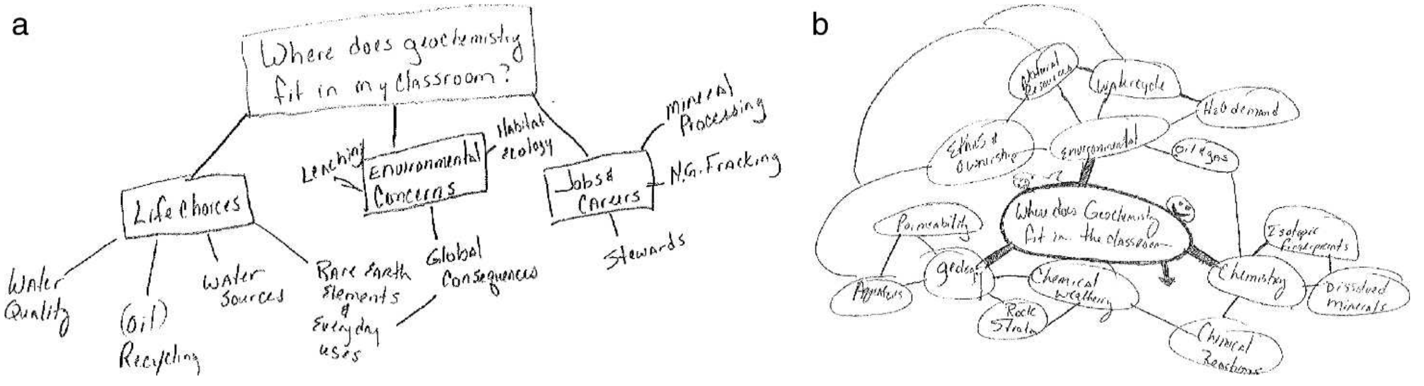

FIGURE 1: Example of (a) initial and (b) final concept maps depicting "geochemistry in my classroom" from one participant.

not unexpected, as the intervention focused primarily on geoscience content and less on pedagogy. So too did teachers' project lessons reflect increased content knowledge.

Although the quantitative analysis of the participants' initial to final concept maps provided some statistically significant measures of increased knowledge of geochemistry, researchers believe that these measures did not fully capture what the participants gained from the workshop. The example concept maps (refer to Fig. 1) provide evidence that participants' final concept maps were highly influenced by the way in which they internalized the project and processed the experience in personal ways that were directly connected to their high school classrooms. Further, the final concept maps were also directly related to the lesson plans developed by the participants. Therefore, a quantitative analysis of concept maps does not provide a complete analysis, and further qualitative measures (especially those that cross examine the developed lessons) are warranted.

These data (1) help to illuminate teachers' perceived barriers, roadblocks, and land mines with regard to integrating the Earth sciences into their high school science classrooms and (2) provide significant, new understanding about ways in which to help biology and chemistry teachers incorporate natural Earth science connections in their classrooms. Certainly, these data, based on a small sample of teachers ($n = 7$) and an abbreviated summer workshop (10 d), do not provide conclusive evidence about the benefit of programs such as this one. These data are, however, compelling. In light of current politics, where Earth science is largely disregarded or considered less rigorous than other laboratory-based science classes (Dodick and Orion, 2003; Smith, 2005), professional development workshops like this one can help science teachers become knowledgeable enough to incorporate and expand on geosciences connections in biology, chemistry, and physics. In Oklahoma, no policy requires students to take an Earth science course. The percentages of students taking Earth science classes, 10% of seventh to eighth grade and 13% of ninth to twelfth grade students, are considerably lower than the already low national average of 28%. The latest report by Blank et al. (2007) indicated that the percentage of seventh to eighth graders and tenth to twelfth graders that had taken an Earth science course had fallen to 8% and 12%, respectively. This is not a promising sign for a world that is very dependent on Earth's natural resources.

This collaborative effort of geoscientists, science educators, and classroom teachers can lead to the development of improved geoscience learning experience for science teachers. This model for collaboration between schools of geology and education can help to provide important experiences for non–Earth science teachers that integrate the geosciences, curriculum development, and integration of experiences into non–Earth science classrooms. Helping non–Earth science teachers gain the necessary content knowledge and the pedagogical skills to incorporate the geosciences into their biology, chemistry, and physics classrooms will provide the geoscience education community a backdoor into the Oklahoma high school science curriculum.

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