

Sustaining K-12 Professional Development in Geology: Recurrent Participation in RockCamp

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ABSTRACT

A reconnaissance study of the geology professional development program known as RockCamp was initiated to examine the sustained, or recurrent, participation of K-12 science teachers. Open-ended interviews, concept mapping, and creative writing assignments were used to explore the perceptions of six teachers possessing an exceptional record of participation. Efficacy, fun, right time of life, and support emerged as unanimous reasons for recurrent participation. Content, friendship, and methodology were very important. College credit was not critical. These teachers' perceptions suggest their sustained involvement in the RockCamp Program is stimulated by situated learning experiences stressing a compare, contrast, connect, and construct pedagogy within a supportive learning community.

INTRODUCTION

Entering its second decade, RockCamp continues to offer West Virginia K-12 science educators on-going professional development experiences in geology. Three primary reasons have contributed to the program's longevity. First, RockCamp has tried not to become just another short-term operative in K-12 professional development. Sequentially designed events offer abundant opportunities for continued participation. Second, by obtaining a modest but sustainable annual budget with a full-time director, the program has become institutionalized.

Third, through lessons learned we have come to recognize that K-12 professional development in geology requires more than an attitude of "bestowing knowledge." It requires a collaborative effort between the professional development facilitator and K-12 educator. As a result, we have come to appreciate the importance of repetitive interaction with fewer teachers versus single interactions with a large number of teachers.

Several years ago, while recruiting applicants for sessions beyond RockCamp II, we began to ask, "Why do the same participants continually return?" A review of published work revealed efforts to understand the nature of sustainable (also called recurrent) professional development for K-12 science educators. Dass, 1999; Loucks-Horsley, Hewson, Love, and Stiles, 1998; Darling-Hammond, 1996; Kyle, 1995; Miles, 1995; Little, 1993; and Birnbaum, Morris, and McDavid, 1990, agree "one-shot" (i.e., terminal) teacher enhancement programs are inadequate, ineffective, and out of step with ideas promoted by current educational research. Gibson, Ortiz, Gibson, and Teeter (1992) link non-sustainable professional development for earth science teachers to

the practice of finite grant funding. They found, once money expires, programmatic-derived improvements eroded because participant encouragement, support, and additional educational opportunities were no longer available. In spite of this ample research, little research demonstrating the participant's perceptions on recurrent participation in K-12 geology professional development programs is available. Thus, our question became: "What reasons for recurrence are most critical to RockCamp participants?"

THE ROCKCAMP PROFESSIONAL DEVELOPMENT PROGRAM

RockCamp (Table 1) began in 1992 with funding from the National Science Foundation (NSF) and the West Virginia Department of Education (WVDE). In 1996 the NSF grant ceased and the cost of the program was absorbed by the State of West Virginia through the West Virginia Geological and Economic Survey (WVGES). In addition to Survey geologists, project staff includes instructors from both geology and science education departments of West Virginia University and Fairmont State College. Carefully screened RockCamp graduates are asked to return as facilitators. We do not consider them content mentors because they are still learning themselves. Their mission is to enhance dialogue among new participants, between participants and staff, and bring potential problems to our attention.

Participants may earn graduate credit at every level of the program. This is made possible by a strong affiliation with the Geology and Geography Department of West Virginia University (WVU). All expenses are paid and stipends provided for RockCamp I and II participants. Reimbursement of travel expenses is provided to RockCamp III, IV, and V participants.

Organizationally, each RockCamp I session is a 12-day residency experience (Table 2). Up to 20 participants receive basic instruction on rocks, minerals, fossils, plate tectonics, structural geology, stratigraphy, and economic geology. The focus of each topic is a cumulative development of a personally useful framework on West Virginia geology. Concepts are complimented and expanded upon by numerous day and evening field sessions and a four-day field trip. A major component of RockCamp I is the connection between West Virginia's geology and the State's cultural, economic, and historical development. Participants occasionally refer to RockCamp I as "Geology Bootcamp."

RockCamp I graduates are encouraged to apply to RockCamp II. This five-day session (Table 3) encourages participants to use their RockCamp I experiences as scaffolding to organize a better understanding of the geology of their home county. To assist them, all WVGES publications and maps are made available. As a result of

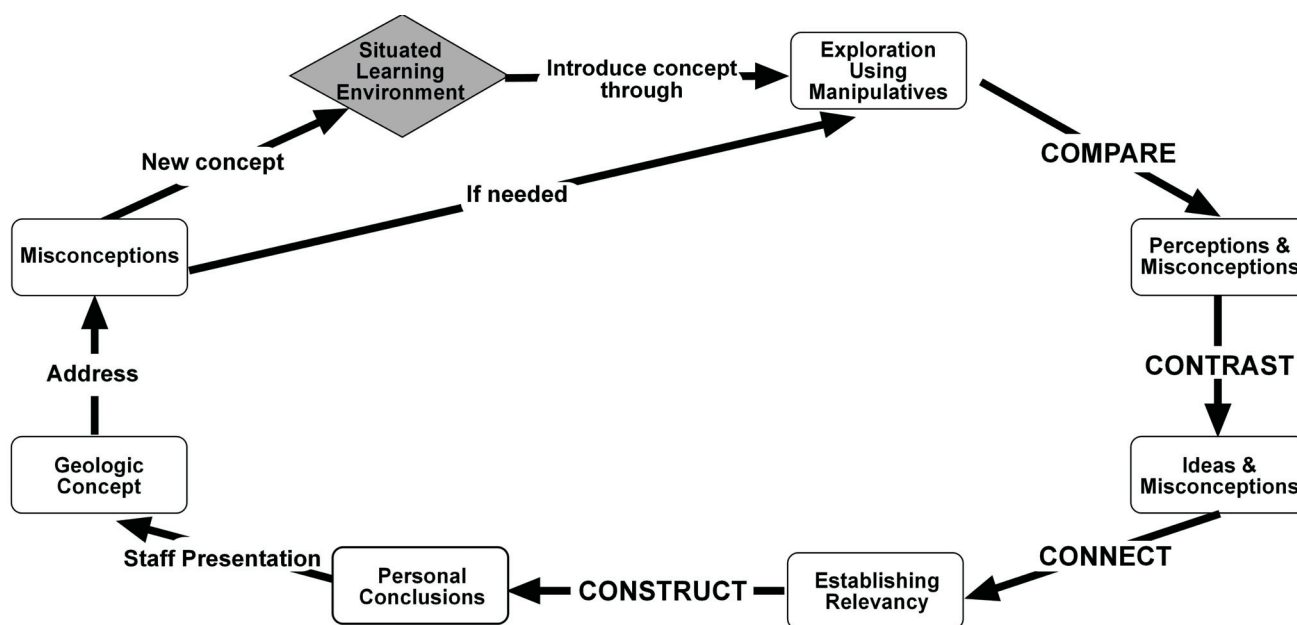


Figure 1. RockCamp's 4C learning cycle approach to situated learning. Personal construction of relevant knowledge and skills enhances participant content mastery and pedagogical methods and addresses strongly held misconceptions by comparing, contrasting, and connecting ideas.

Session Name	Description	Sessions Offered (1992 - 2002)	Number of Participants
RockCamp I	12-day residence with 4 days in the field	13	223
RockCamp II	5-day residence with 2 days in the field	6	72
RockCamp III	10 field days in North Carolina, Virginia, and West Virginia	1	29
RockCamp IV	10 field days in Pennsylvania, New York, Vermont, and New Hampshire	1	19
RockCamp V	10 field days in Wisconsin and Minnesota	1	20

Table 1. Summary of the 1992-2002 RockCamp sessions serving as the focus of this study

questions asked, participants routinely become engaged in extended one-on-one discussions with professional geologists. Participants also spend two days extending their knowledge of field techniques which includes practicing methods to engage peers in field discussion. The participants' investigative phase and data organization are not completed in a single RockCamp II session. Once familiar with the available resources, they are given six months to complete their literature research. The culmination of their work is the sharing of their knowledge with peers in individually planned and led workshops and field trips.

Events above the RockCamp II level are completely field oriented. At this level, we limit participation to those who have successfully fulfilled all RockCamp I and II requirements. Each field experience is designed to adhere to the RockCamp "4C" pedagogy (Figure 1). This philosophy encourages participants to construct their own levels of understanding using the active processes of comparing, contrasting, and connecting. This process fortifies content knowledge and helps all of us deal with strongly-held misconceptions such as those related to the cyclic and periodic nature of plate tectonics and strike

and dip. In addition, the 4C philosophy models effective methods of implementing what they have learned into their classroom environments. For example, with one eye focused on West Virginia geology, RockCamp III participants explored the geology of Virginia and North Carolina headwaters of West Virginia's New River. RockCamp IV was designed to demonstrate relationships between New England metamorphic units and West Virginia's sedimentary rocks. Finally, RockCamp V demonstrated connections between the geology, history, and societal influence of West Virginia coal mining and Wisconsin and Minnesota iron mining.

RESEARCH METHODOLOGY

Successful completion of RockCamp I and II is required for participation in advanced sessions. As Table 1 illustrates, RockCamp recurrence is not uncommon. According to Howard (1994), tightly defining the "text" or characteristics of the members of a qualitative study group is critical to successful data analysis. Thus, six West Virginia science teachers (Table 4) who, as a result of their voluntary participation in all five sessions boast

Day	Pedagogical Focus	Activity
1	Skills Exploration Using Hands-on Inquiry	Modeling Geologic Time; Earth Science Information Center Maps and Aerial Photos; RockCamp Preview: Past-participants' Perspective
2	Content Sessions Modeling Constructivist Pedagogies	The Color of Rocks and Minerals; Identification of Minerals; Identification of Rocks; Topographic Maps; Geologic Maps; Local Trip Connecting Day's Discoveries with Field Observations
3	Introduction of Conceptual Ideas Using Day 1 & 2 Explorations as Basis for Comparing and Contrasting	Questions from Yesterday; Plate Tectonics Basics (Lecture); Modeling Plate Tectonics and West Virginia (Lecture); Explore West Virginia's Geologic Past (CD-ROM); Local Walking Trip to Emphasize Field Work Processes; Local Trip to Reinforce Events of Day 1 and 2; Alumni Suggestions for Four-day Trip and Distribution of Guidebook
4, 5, 6	Generation of Personal Conceptual and Skills Comfort Level By Making Connections Through Experiential Field Work	Geology of West Virginia Field Trip with Alumni Field Assistants; Regional Differences: Plateau, Valley & Ridge, Great Valley, and Blue Ridge Provinces; Physical Geology: Dip, Structure, Accumulation of Sediments, Rock Formation, and Stratigraphy; Tectonics: Episodic Mountain Building and Rift Valleys; Historical Geology: Paleoenvironments, Sediment Deposition, Fossils, and Sedimentary Structures; Social and Historical Influences of Geology
7		No events. Alumni Assistants Available. Collection of Field Books
8	Constructivist-based Content Sessions with Emphasis on Use of Compare, Contrast, Connect Skills to Construct Skills Required to Modify Activities for Classroom Implementation	Interactive Review of Field Trip; Molds, Casts, and Insects; Fossils, Using Technology to Do Geology; RockCamp Alumni Shar-a-thon; Introduction of Classroom Implementation Notebook; Optional Evening Field Trip: Fossil Collecting
9		Classroom Implementation Session; Fossil Footprints; Even Simple Ideas Are Worth Sharing; Ohio River Sands & Gravels: Geological Potpourri of Rocks & Fossils; Water Activities for West Virginia; Using the West Virginia Geological Survey's Web Site; Classroom Implementation Session; Optional Evening Field Trip: Local Rock Shop
10		Classroom Implementation Session; Coal Geology; How Much Coal Is Under There?; GIS and Geologic Mapping of West Virginia's Coals; Connections; Fasten-A-Saurus; Field Trip to Surface Coal Mine and Plant Fossil Collecting
11		Earthquakes in West Virginia; Mont Chateau Seismic Detector; Time in Publication Sales Office; Field Study of Environmental Geology & Geochemistry of Quarry Run; Classroom Implementation Session; Reflective Assignment; Optional Evening Field Trip: Archeological Site
12		Making the Grade: Assessing Earth Science Activities; Capstone Event: Depositional Environments of A Typical Sequence of West Virginia Sedimentary Rocks; Connections: Earth, Water, Wind, & Fire: Collection of Implementation Notebooks & Workshop Reflections

Table 2. RockCamp I pedagogical focus and situated experiences and activities.

the greatest breadth and depth of affiliation, were selected as the focus of this exploration. Teacher names used in this paper are pseudonyms chosen by the participants.

Each participant was interviewed on three different occasions. An increasingly reflective process was implemented using concept maps (second interview) and creative writing assignments (third interview). Twenty-seven hours of audio tape were transcribed and, along with the participant-generated concept map and the participant-generated creative writing assignment, analyzed using emergent and open coding schemes outlined by Taylor and Bogdan (1998), Hammersley and Atkinson (1995), and Glesne and Peshkin (1992).

DATA

Interviews - The interview sessions produced 25 reasons for recurrence among the six study participants (Table 5). Analysis of participants' reasons for recurrence could be categorized into seven themes. In order of frequency of citation they are: content, efficacy, friendship, fun, methodology, right time, and support. During the interviews, the group did agree being a recurrent participant is a matter of the "right time." Fun and friendship were only one vote short of unanimous selections.

Concept Mapping - Concept maps were less structured than the interviews. The only prescribed restriction was the given domain topic of "Recurrent RockCamp Participation." Coding of participant thoughts on

Day	Pedagogical Focus	Activity
1	Exploration	Discuss goals for RockCamp II, round robin discussion of participant ideas and needs for field trip and work shops
2	Exploration, Reinforcement, and Remedial Efforts to Apply RockCamp I Skills by Comparing, Contrasting, Connecting, and Constructing	Literature review using WVGES resources, Web site, and staff to assemble understanding of participant's local county including: <ul style="list-style-type: none"> · Topographic setting: geography, topography, elevations, minor and major streams, gradients and important confluences streams, special areas, valley relief, mountain names and trends, effects of human impact since date of resource, etc. · Geology: province, structures and trends, attitude of units, types of rock, distribution of various types and thickness and ages of rock, stratigraphic names and relationships, fossil (plant and animal) bearing zones, dominant rock types, interesting outcrops and exposures, best places to find exposures of rocks, etc. · Mineral Economics: oil, gas, coal, limestone, gravel, clay, sandstone, mills, quarries, mines, etc. · Towns: relationship to geology and mineral economics · Transportation: influence of hills, valleys, streams on movement of important products including minerals · History: relationship to geology and geography · Soils and agricultural relationships to geology · Evening: Required remedial local field trip
3, 4	Introduction of Conceptual Ideas	Two-day field trip to offer first-hand experiences on how a field trip is organized, conducted, and focused
5	Small Group Application of Compare and Contrast Techniques	Analysis and presentation of field stop techniques; resumption of literature research
6	Individual Construction of Compare, Contrast, Connect Techniques	Continue work on outlines of workshops and field trips; individual oral summary of field trip and workshop ideas; group discussion of first draft of field trip and workshop ideas; abstracts submitted
On Own	Exploration of Local Opportunities and Needs	Monthly update of progress of planning until events conducted; on-going utilization of RockCamp resources and personnel
?	Constructive Capstone Event	Conduct field trip and workshop for peers; file report: What worked and what did not?

Table 3. Pedagogical focus and experiences used to introduce RockCamp II participants to becoming outreach operatives for local peers

recurrence depicted in the six concept maps produced 22 reasons for recurrence (Table 6). Further analysis revealed themes similar to those actualized by the interview data with two exceptions. The theme of "right time" was not present while a new theme of "credit" emerged.

Creative Writing - Analysis of the creative writing assignments yielded 19 reasons from which six themes were constructed: content, efficacy, friendship, fun, methodology, and support (Table 7). The themes of "right time" and "credit" were not represented.

DISCUSSION OF THEMATIC REASONS

Close examination of the data suggests the non-verbal (concept mapping and creative writing) data collection methods employed may have skewed some responses. A good example of this is the near unanimous notion of "efficacy" revealed by the concept mapping and the constant use of "friendship" in the creative writing exercise. One preliminary explanation of this phenomena is that these six participants harbor the opinion that concept mapping is a mechanism for self-reflection while creative writing is a useful tool for stressing communal roles and interaction.

Synthesis of all data yields a cumulative view of possible agreements on thematic reasons for recurrence. Based on our analysis, the study group unanimously agreed efficacy, fun, right time, and support are key reasons for their RockCamp recurrence (Table 8). Although consensus was not established, this research suggests content, friendship, and methodology are important to a majority of the study participants. Desire for graduate credit was inconsequential. Discussion of these thematic reasons for recurrence will proceed in alphabetical order beginning with the unanimous themes.

Efficacy - As a reason for recurrence, the theme of efficacy includes categories such as contentment, professional development, usefulness, abolition of intimidation, comfort, confidence, freedom, ownership, self-respect, curiosity, individual research efforts, and students. The connection between all of these is the participant's desire to feel better about one's self and one's abilities, to be comfortable about their place and role, and with how they are treated. It is part and parcel of how each person differentiates between the usefulness and the meaningfulness of recurrent participation. For example, Lou's perception of his place and role within RockCamp evolved as he recognized ownership.

Name	School Level/Subject
Grace	Middle School/Coordinated and Thematic Science 8
Lou	High School Science/Coordinated and Thematic Science 10
Melissa	Middle School Science/General Science 5 and Coordinated and Thematic Science 8
Rocky	Upper Elementary School Science / General Science 5
Sandy	Middle School Science/ Coordinated and Thematic Science 8
Sarah	High School Science/ Chemistry and Coordinated and Thematic Science 9

Table 4. Name and teaching level of the six recurrent RockCamp participants in this study. Names are participant-chosen pseudonyms.

Ownership builds meaning because he is an active contributor to the program and his peers. Recurrence is encouraged when he feels “[I’m] a part of this now. I can’t miss [the next session].” Another aspect of Lou’s self-efficacy is his communication with the staff. This has become effortless since “I have learned to ask the better question.”

Growth is also the key to Grace’s efficacy. The perceptible change from “student” to “student researcher” to “active co-experimenter” initiated a “feeling of no longer being just a student. Now we [staff and participants] figure it out together.” Moving beyond the student realm places her in a position of increased confidence in her own abilities to become an “amateur geologist.” The most important by-product of increased self-efficacy is an acknowledgment that she is no longer intimidated by the staff. On the other hand, Rocky’s efficacy is based on personal and professional respect rooted in feelings of gratification of his personal growth and success. To him, self-efficacy is a spiritual empowerment he finds emanating from a “programmatically enticing teachers to return to carve his or her signature into the success of RockCamp.”

Efficacy is perceived as a powerful reason for Melissa’s recurrence because RockCamp, given her “shyness,” is a place she can be confident “it is OK not to have definitive answers. [This is important] since I am slowly learning to fly on my own.” Sarah noted feeling good about herself “opens up new dimensions which lead to making connections to something I already know and seeing the whole thing in a new light.” Professionally, she wants to be in a “feel good about yourself situation [because] that’s how I make my living. It would not make any sense to go [to RockCamp] if it wasn’t going to help me with my students.” To accomplish this, she looks for professional development opportunities where learning more leads to more chances to learn.

Self-efficacy, for the six study participants, is a recurrence determinant when perceived as providing increased feelings of self-worth. This is obtained through useful experiences effecting changes in personal appreciation of how science is done and ways in which it can be taught. In other words, these six participants have

found RockCamp experiences to be meaningful, not just useful.

Fun - As a theme for recurrence, fun was described in a variety of ways. Obvious descriptors like “fun” and “enjoyment” exist along with ideas of fun subsumed within thick conceptual descriptors such as obsession, travel, enthusiasm, look forward, and tantalize. For example, the enthusiasm Lou cites as a reason for recurrence was not initially his. Instead, “the enthusiasm of the RockCamp staff got me hooked on geology.” Geology has become so “tantalizing [I now] look forward to the next journey.” At one point, Lou admonished the authors for trying “too hard” to deconstruct “something I simply enjoy doing.” As his reprimand indicated, we did have reservations about accepting fun as a reason for recurrence. Sandy rebuffed these attempts by asking, “Weren’t you ever in kindergarten? Didn’t you play? I think it’s so basic and simple... I’m sorry. I am a very uncomplicated person; that’s all there is to it.” When pushed, she admitted recurrence is fun because it allows her to share time with people of similar interests, travel, and “poke around.” Sandy links recurrence to fun because it lets her be “outside, doing fun stuff all the time and working with people... It’s really fun because the positiveness of each experience creates a backlog of good experiences.” To back up this claim, she admitted RockCamp lets her be the naturalist she wishes to be.

Melissa indicates fun, as a reason for recurrence, is about being outside with friends taking advantage of the travel, learning, and social opportunities offered by each new session. In a slight twist on the travel aspects, Grace finds RockCamp is fun, and worth coming back to, because it takes her places her family will not or does not want to visit. A perfect example of this was her family’s incredulous reaction to her whitewater rafting experience in RockCamp III. To them, it was completely out of character but it was something she had always wanted to try. Another explanation for the fun she derives from RockCamp is revealed by her admission that geology became “a hobby [I] enjoy because too often we put things in boxes. [RockCamp] presents the big picture that touches on all things I think about. It even brings in social science aspects which is appealing because I was a social studies major.”

Rocky’s enjoyment with RockCamp is subtle. He has always been “fascinated by the way everything goes together.” As a result, he once thought of becoming an architect. Once he learned how to interpret the structure, texture, and patterns of rocks, he found constructing geologic explanations provided mental enjoyment similar to planning a construction project.

Right Time of Life - A shadowy reason for recurrence lurks within the participants’ comments. Referred to as the right time, good time to be involved, stage of life, and family situation, it is important but must be recognized as biological and social factors beyond programmatic control or influence. For example, being forced to abandon his part-time summer construction job provided Rocky with time for recurrent professional development. Since this happened after his children had grown, child care was no longer an issue. Similarly, Lou’s children no longer live at home. Thus, he is “at a point in my life where I have the freedom to do what I want.”

Family versus recurrent participation was a far more momentous issue for the women of the study group. Sandy directly related recurrence to her “stage of life.”

Theme	Interview Category	Lou	Rocky	Melissa	Sarah	Sandy	Grace
content	Evolution of thinking						√
	Content					√	
efficacy	Ownership	√					
	Self Efficacy	√					
	Confidence			√			√
	Freedom/individual research interests	√			√		
	Real science experiences				√		
	Abolition of intimidation						√
	Comfort			√			
friendship	Core community group						√
	Community				√	√	
	Family						√
	Isolation	√		√		√	
fun	Travel						√
	Obsession				√		
	Enjoyment/fun	√	√		√	√	
methodology	Visual learner		√				
	Compare/contrast		√				
	Immersion		√		√		
right time	Good time to be involved		√		√		
	Stage of life, right time	√		√		√	√
support	Support/support group/supportive environment			√	√		
	Opportunity		√				
	Continuity	√					
	Permanence		√		√		

Table 5. Thematic reasons for recurrence derived from interview categories.

When her children were younger, she “would not have looked at” anything like RockCamp. While she may have attempted to do one session, anything resembling the recurrent participation she now does would have been disruptive to her family. In contrast, Melissa still has children at home. She has avoided the pitfall mentioned by Sandy because her family has adapted to her new-found interest in geology. Surprisingly, to her, this adaptation was harder on her than them. It took her a while to accept “they do fun stuff Mom won’t do when I’m there, like going to a movie or different restaurants.” Much like Melissa, Sarah’s recurrence coincides with “a good time to be involved.” Several years ago her children began developing their own interests and commitments. Furthermore, her husband, “an obsessive fisherman,” understands Sarah’s interest in geology as similar to his love of fishing. Both Melissa and Sarah admit to being “lucky” in arranging schedules to accommodate everyone’s interests.

Much of what has been stated for Sandy, Sarah, and Melissa also applies to Grace. What was most interesting is Grace’s observation that the “right time of life” hypothesis has a bimodal population. To her, women active in professional development are either those with older children who do not require constant maintenance or younger women with no children.

Support - Support as a thematic reason for recurrence was described as continuity, opportunity, permanence, support group, supportive environment, and continued teacher support and opportunity. Continuity, as used by Lou, is a function of RockCamp’s persistence and permanence. However, to encourage recurrence continuity must be more than events. Simple things like periodic letters keeping him informed of future plans represent meaningful connections not experienced with “one-shot” professional development programs. In this sense, recurrence is enhanced by “knowing what is going

Theme	Concept Map Category	Lou	Rocky	Melissa	Sarah	Sandy	Grace
content	Basic knowledge	✓					
	Learning			✓			
	Knowledge		✓	✓			
credit	Credit/academic support	✓					✓
efficacy	Curiosity						✓
	Professional development				✓	✓	
	Personal growth/development		✓			✓	
	Individual research interests				✓		
	Ownership	✓					
friendship	Collegiality				✓		
	Relationships/social network/people	✓		✓			✓
	Peers	✓					
fun	Fun			✓	✓		
	Trips	✓					
methodology	Compare/contrast pedagogy	✓					
	Positive learning environment		✓				
	Usefulness			✓			
	Real science experiences				✓		
	Interactive involvement		✓				
support	Facilitator	✓					
	Continued teacher support					✓	
	Opportunity						✓

Table 6. Thematic reasons for recurrence derived from concept map categories.

on.” Sarah also associated her recurrence with continuity partially derived from periodic update letters allowing her to plan far in advance. Rocky concluded continuity incorporates opportunity and permanence. Remaining involved with a program exhibiting a permanent presence is attractive because “knowing the program will be there, I know [I] can come back if I want to.” Support is also reflected in Lou’s, Sarah’s, and Rocky’s belief that RockCamp’s permanence means future opportunities will be probable.

Melissa and Sarah portray continuity in terms of support groups. RockCamp peers and family members support their involvement and their efforts to learn encourage recurrence. Melissa explicitly stated recurrence “boils down to my support group; without it I would not come back all the time.” Melissa’s most important support group was her family. Yet, she also derives support from “a group of people who have become friends...This group of friends has become a support group...This group has become like a second family where each is safe sharing thoughts.” A safe place is important to Melissa’s confidence and self-efficacy. Sarah differentiates between support and a supportive environment. She receives and uses the support of study group peers to keep her interested and returning. In reality, this is often a two-way street where participants “feed off of each other by saying, ‘Look what I figured

out.’” This collegial environment is “a good thing for me [and] it encourages recurrence.” While Sandy made no prominent references to support or support groups during our discussions, the direct support she receives when trying to put students and scientists in direct contact does influence her desire to remain involved.

Content - Content is the traditional reason given for RockCamp I participation. All of the study participants initially came, as Lou puts it, “to fill in holes in my knowledge of geology.” This desire was driven, for the most part, by new content standard and objectives mandated by a new statewide coordinated and thematic science curriculum. This curriculum requires many teachers without formal earth science backgrounds to teach earth science concepts. Perhaps more importantly, it requires them to integrate concepts across sciences. This may explain the success of RockCamp’s “compare, contrast, connect, and construct” pedagogy.

Sandy sees content as centrally important. Everything “centers around [whether] it will be used by my students. It would not have made any sense to go if it wasn’t going to help me with my students. If I wasn’t given the opportunity to learn new things, I wouldn’t be back!” Content is not as domineering with the others. In fact, several admit to decreased relevancy of content. When Rocky first came to RockCamp, it was “75 percent

Theme	Story Category	Lou	Rocky	Melissa	Sarah	Sandy	Grace
content	Knowledge/learning			√		√	√
efficacy	Contentment					√	
	Better teacher		√				
	Students				√		
	Professional development		√		√	√	
friendship	Community/relationships/ social network/people	√		√	√	√	√
	Collegiality/friends			√	√		
fun	Fun				√		
	Enthusiasm			√			
	Tantalize	√					
	Trips/visits	√					√
	Look Forward	√					
methodology	Real Science Experiences				√		
	Paradoxically	√					
	Reflection					√	
	Positive learning atmosphere		√				
	Usefulness			√			
support	Isolation					√	
	Support group			√			

Table 7. Thematic reasons for recurrence derived from story categories.

for obtaining information and activities to use with my students. [Now] it's 75 percent for the personal enjoyment I get pulling facts, ideas, and concepts together so I can help my students see the big picture." Grace stated her initial reason for attending RockCamp was to get facts, but near the end of RockCamp III, it became "about processes." Sarah's concept map indicates acquisition of new knowledge is less important than leadership roles, publications, classroom vitality, and friendship. For her, content has become an "interesting [process of] trying to figure things out."

Friendship - As a thematic reason for recurrence, friendship embraces diverse ideas such as core group, isolation, collegiality, peers, social network, people, relationships, and friends. The collective comfort, confidence, and support extended through RockCamp friendship supports a desire to preserve connections with like-minded learners. For example, Lou likes returning to RockCamp because while there, "I'm hanging out with people of similar interests [who] all bring different things to the table. Each seeing a different part of the same thing makes it more interesting to come back." Melissa recognizes friendship as "the sharing of ideas which makes me think. We all learn by feeding off of each other. [We're] groupies having built a common bond from numerous shared experiences." For Sandy, a sense of friendship leads to "opportunities that cannot be passed up because I could be with people who answer [my questions]... [These] many good friends make [recurrence] double pleasure because of being with

people I enjoy being with." Grace relates recurrence to friendship by saying, "I like to be with people [who have] common interests. I am free to ask for help and not feel strange about it." Similarly, Sarah describes RockCamp friendships as a group of people who "feed off of each other... [Each time I come back] I know I'm going to know many people... This makes it more familiar...and encourages recurrence."

This research found that the importance these six teachers affixed to friendship cloaks a potentially more crippling problem. It has become a tool for dealing with professional isolation. Sandy is one of five science teachers in a very rural county middle/high school. Each teach different subjects. As the only eighth grade science teacher, she regrets having no one with whom to compare notes or discuss ideas. As a result, she commonly wanders the hall in silence because she can find no one with whom to share her experiences. In contrast, RockCamp "is a treat [because] the creativity of being with other participants is inspiring when compared to my everyday drudgery... Recurrence has helped me become more confident by promoting more interaction with peers outside my own school." She also indicated that the "cumulative give and take of hearing other participants doing similar things" has helped her value herself a "little bit more." Grace has remained involved with RockCamp because it provided her with options for overcoming isolation. This first occurred during her RockCamp II session. Her experiences required her to become a "student-researcher." Although "not always fun, it was a good experience [because] it was neat to see how

Theme	Lou	Rocky	Melissa	Sarah	Sandy	Grace
content	✓	✓	✓		✓	✓
credit	✓					✓
efficacy	✓	✓	✓	✓	✓	✓
friendship	✓		✓	✓	✓	✓
fun	✓	✓	✓	✓	✓	✓
methodology	✓	✓	✓	✓	✓	
right time	✓	✓	✓	✓	✓	✓
support	✓	✓	✓	✓	✓	✓

Table 8. Thematic reasons for recurrence triangulated from all three data collection methods. Consensus expressed on efficacy, fun, right time, and support.

people do their jobs.” Her post-session assignment of planning and conducting a field trip and workshop for peers in her home county was unsettling. First, she had never done anything like it. Second, and more importantly, she imagined her rural location effectively isolated her from help and potential participants. At this time, she had serious thoughts about completing the assignment, let alone returning for another session. The “turning point was finding another RockCamp participant [from another county] who was willing to help me.”

Among the hundred of students, the numerous teachers, and the constant background activity, Lou finds teaching a “confining” occupation: “In a strange way, I am isolated within my own school. Conversations with other teachers, especially science teachers, are few and often non-productive.” Reacquainting himself with the RockCamp community is an anticipated reprieve from the isolation. In a novel twist, he conceded his RockCamp involvement may contribute to his isolation because “I’m doing stuff in summer others cannot relate to. We can’t talk about it because we have nothing in common to talk about.”

Melissa characterized RockCamp as an “anchor” offering the continued involvement she needs to “combat the isolation experienced within my own school” magnified by being around peers with little interest in sustained involvement in any professional development. As a result, she cannot find anyone with whom to share her enthusiasm for new ideas. In contrast, interacting with exuberant members of the RockCamp community stimulates her desire “to do.”

These study participants believe recurrence plays an important role in diminishing the effects of real or imagined isolation. Admittedly, this is a small sample size. However, our interpretation suggests a third-party professional development provider (1) has a conspicuous and positive impact on a community of science teachers, (2) must not overlook the potential ramifications of K-12 isolation, and (3) should never lose sight of science teachers’ need for immediate give-and-take.

The ability to offer participants the opportunity to engage in meaningful peer-to-peer and peer-to-geologist communication may prove to be one of the most valuable tools we have developed. Using this acquired awareness, RockCamp maintains a proactive policy of diligent two-way participant communications. Instead of serving as a mere distributor of ideas who may never be seen again (i.e., “one-shot” or terminal session), we

serve as a statewide geology clearinghouse. These conversations reveal the often hidden needs and wants of many science teachers. More importantly, they drive us to continually ask if we still possess the mechanisms needed to permit sustained participation for that cadre of passionate teachers wanting to be active scientists instead of passive observers.

Rock Camp Methodology - Given the almost unanimous melancholy that surfaced every time the idea of epistemology and pedagogy was raised, it came as no surprise that the participants never actually used the word “methodology” as a recurrence referent. However, the word most appropriately describes what they were saying. Discussions, concept maps, and stories reveal a positive participant acceptance of RockCamp’s attempts to use specific pedagogical ideas. Lou indicated one attractive aspect of RockCamp is its “compare and contrast” pedagogy. Being provided the opportunity to be a visual learner in a positive learning atmosphere brings Rocky back because he learns by crafting mental images of his experiences. Recurrence affords the opportunity to modify and correct these images.

Sarah places high regard on learning by “doing real science... [It makes geology] more interesting [and] promotes a desire to participate in future sessions.” Her perception that RockCamp’s educational philosophy encourages her to pursue connections between geology and other sciences she likes is also an enticing reason for recurrence. Methodology is a reason for Sarah’s recurrence in that it provides and reinforces educational techniques she can adapt for her classroom. Learning how to conduct a field trip, design an activity, or develop the flexibility to consider alternative student responses is important because, “if I focused solely on content it would not be as enticing and as useful.” A good example of her interest in adapting ideas was the concept mapping technique used to gather data for this study. Within a week of our concept mapping interview, she was using concept maps as an alternative assessment technique with her eighth graders. For Grace, a methodology stressing technique and pedagogy taught by “example [and] integrated with content” is attractive. Because these techniques are embedded as part of the teaching, she does not feel they are being forced upon her. Thus, she remains “free to learn in my own way.” The attraction for coming back is finding new ways to work with her students.

RockCamp's immersive pedagogy was readily apparent to the study participants. Lou conceives of immersion as a method of enhancing interaction with the staff. This gives him an added reason to return. In Rocky's case, immersion is an appropriate method of applying his visual learning because he must have the time to "pull it all together." Sarah regards immersion as a draw because it provides her with the time and space away from outside distractions. Her teenage recollection of a family hike down and up the Grand Canyon's Bright Angel Trail typifies her attraction to "doing, not talking." Sandy suggests, "being immersed in experiences where it is used and relied upon reinforces understanding, and later implementation if it keeps me mulling over stuff until I assimilate it." She pointed out she forgets much of what she is told at passive professional development sessions.

Credit - This item is more important for what it does not do. For Lou, Sandy, and Grace college credits were important enticements for RockCamp I participation. Credits remained important for Lou and Grace's RockCamp II involvement as they pursued advanced degrees and "plus" hours. However, as a reason for sustained involvement, the lure of credits dramatically diminished as participants gained degrees, certification, income incentives, or, most importantly, became "hooked" on RockCamp.

IMPLICATIONS OF THE STUDY

Building a Learning Community - The ideas revealed by this research have enhanced our understanding of a small group of teachers' sustained participation in RockCamp. We suggest that the reasons uncovered can, and do, reinforce how RockCamp operates. As made clear by their comments, much of their commitment and interest in recurrence is linked to an emotional attachment to the program and colleagues. Imel (1991) contends collaborative learning assumes knowledge is socially, rather than individually, constructed. Referring to learning communities as "learning networks," Kellogg (1999) and Holmes (2000) argue these arrangements are not the result of haphazard social interaction. Instead, they routinely reflect associations of individuals with shared enthusiasms and interests promoting the formation of support networks, friendships, and connections with institutions. Laszlo and Laszlo (2000) describe a learning community as a synergistic collaboration where learning and teaching happen side-by-side when learners become teachers at a moment's notice to share wisdom, knowledge, skills, and perceptions with those in need or want. As a result, learning and teaching paradoxically empower every member of the community. Learning communities are suggested as one method of accomplishing improved teacher competency because too often, teachers work and learn within isolated, individualized environments limiting the acquisition of new information and idea sources. When alternative solutions to common problems are never encountered, new insights and understandings leading to possible solutions are not usually generated. (Gabelnick, MacGregor, Matthews, and Smith, 1990). The profusion of ideas offered within an interactive and collaborative environment expands iteratively, continually testing what is being learned. As

a result, the professional development context is richer and more stimulating (Morrissey, 2000). Citing the complimentary nature of literature discussions on learning communities and our study participants' reasons for recurrence and characterizations of recurrence, we suggest recurrent participants are drawn toward RockCamp because it offers inclusion in a community of like-minded learners. While a learning community environment can provide experiential learning opportunities, this study suggests RockCamp has gone beyond that. Thus, a more appropriate way to characterize our results is provided by situated learning theory.

Utilizing Situated Learning - Situated cognitive theory conceives of learning as a result of the individual's social and cultural actions (Wilson, 1993). Adult situated learning differs from other forms of experiential learning if it provides opportunities to learn through truthful activities as opposed to solving pre-arrayed discovery packages. Anderson, Reder, and Simon (1996) describe situated learning as learning through "robust, complex, social environments made up of an individual's actions in situations." Stein (1998, p. 2) links situated learning to professional development for teachers when they "experience the complexity and ambiguity of learning in the real world [by] creating their own knowledge out of the raw materials of experiences, i.e., the relationships with other participants, the activities, the environmental cues, and the social organization that the community develops and maintains." Lankard (1995) and Lave (1997) describe situated learning as immersive and dilemma-driven, not content-driven. They contend learning happens as a result of, not in spite of, the noise, confusion, and social interactions of the environment. Application of situated learning within the professional development arena requires skill in ongoing coaching and mentoring (Brown, Collins, and Duguid, (1989) and an accepting that the participant's learning is implicit in the experience rather than in the instructor's organized subject matter (Stein, 1998).

SUMMARY

Comparison of the study participants' recurrent reasons and characterizations with the aforementioned ideals of quality professional development is now advantageous. Six science educators have cultivated effective professional development from a sequential offering of immersive geology workshops and field trips. Each of the six study participants indicated that an overarching reason for recurrence was community-related issues. (i.e., friendship and support). The presence of a community built on the respect of every participant (i.e., fun and efficacy) and composed of like-minded learners immersed in active site-based learning (i.e., pedagogical methodology emphasizing content acquisition through situated learning) was revealed as an attractive determinant for recurrence. All, in one way or another, have indicated that the perceived permanence of the program (i.e., right time) enhances recurrence.

Citing the situated learning experiences encapsulated by the atmosphere and support of the RockCamp learning community, and applying the previously described measures of effective professional development, we propose RockCamp provided effective professional development to the six study participants.

Furthermore, the experience served to promote a situation which directly encouraged the study participants to seek (demand) recurrent participation. We therefore, suggest the RockCamp approach to K-12 geology professional development may serve as a model for the development or improvement of related efforts.

Through our research, we determined the motivations needed to entice our study participants to repeatedly engage in RockCamp geology professional development experiences are those that they, not us, construct over time. Thus, programmatic control over recurrent participation is a function of designing and providing scaffolding coexisting within the realm of individual and group variable dynamics. Based on our participants' implications, we agree effective geology professional development for K-12 educators must go beyond the typical "one-shot terminal experience." Every participant should be offered repeated opportunities to receive more than surficial content and classroom activities. They must be situated in the real, and messy, art of geology within the safe haven of a supportive community where learners are coached and guided, not indoctrinated. They must be given as many opportunities as each individual requires to come to the realization that an appreciation of geologic processes is more important than the accumulation of numerous facts. In conjunction with the ideas presented by our research, it is not appropriate to think of these recurrent participants as apprentices (i.e., individuals indentured to learn at the hand of a master). Instead, we think we have better served them by tailoring a part of our geology professional development programs to "journeyman geologists" (i.e., ones who enhance their ability to practice a freely-chosen trade) looking to augment their skills.

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