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The Function of Field Study: Comparison of Limited and Full Field Experience Courses

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The Function of Field Study

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Abstract

Fieldwork, an experiential and outdoor component of a traditional lecture class, has been effective in improving students' content knowledge and attitudes. However, most studies of these courses use a full lecture course as the comparison group rather than comparing amounts or types of fieldwork. This study compares two classes that incorporate fieldwork (n = 18 and 12 participants, respectively) and uses both quantitative and qualitative methods to analyze changes in content knowledge, self-efficacy, and perceived value of the subject (entomology). Pre- and post-test scores suggest that information memorization is best taught in a traditional classroom environment. Qualitative data illustrate that the most meaningful parts of the intensive field study course are regular interaction, curriculum flexibility, and a constant connection with nature. Thus, the data suggest that more intensive field study leads to self-actualization, learning from others, ecological awareness, and flexible thinking.

Keywords: fieldwork, comparison, self-actualization, interaction, nature

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Introduction

Debate has long occurred regarding the importance and impact of traditional classroom-based learning experiences versus more experiential field study opportunities (Duerden & Witt, 2010). While the common assumption of experiential educators is that field study experiences provide added value over traditional classroom learning (Alagona & Simon, 2010), data from studies examining both contexts does not conclusively support this claim. For example, research findings exist to support the effectiveness of classroom learning (e.g., Dettman-Easler & Pease, 1999) and field study learning (e.g., Zelezney, 1999). Even the experiential and outdoor education literature acknowledges the complexities associated with understanding the unique processes and impacts associated with field study experiences (Warren, Mitten, & Loeffler, 2008).

Accordingly, more research is needed to understand the intricacies of field study learning experiences. Mixed-methods research appears especially appropriate for these types of studies because questions of outcomes and the processes producing observed outcomes are both relevant. Therefore, the purpose of this study was to test whether increased fieldwork would continue to increase content knowledge and enhance attitudes about the discipline. Researchers compared a standard entomology class taught at a large western university with the same class taught as part of a course that integrated field study, lab work, and classroom lecture at a research preserve owned by the university.

The traditional class included a couple of field trips to local areas to collect insects, while the field study group lived, attended class, and researched on the research preserve, located on the edge of the Mojave Desert. While both classes involved field study, the field study group had an easier and more intensive experience in the field, with daily exposure to desert, riparian, and water-dwelling insects. These students were immersed in the ecological interactions of the insects they studied. Unlike many field-intensive programs, this group also had constant access to on-site laboratory equipment. Additionally, the class at the research preserve was taught alongside a visual arts class and a writing class, and their curriculum included a shared group assignment of creating a field guide to insects in the area.

Literature Review

For half a century, international scholars of biology pedagogy have explored field study with students as an alternative to the lecture/laboratory model (DfES, 2006; National Conservancy, 1963). Hart and Nolan (1999) surveyed international research that showed that knowledge, behavior, and attitudes of field study students changed for the better. Many of these studies show that experiences in the field increase content knowledge (Hamilton-Ekeke, 2007). Taraban, McKenney, Peffley, and Applegarth (2004) found that students learned plant identification more effectively by studying living plants in greenhouse and field environments than by online learning. A survey by Lindquist, Fay, and Nelson (1989) found that learning to identify weeds included fieldwork in 19 out of 20 US universities. Similarly, Easton and Gilburn (2012) discovered that students involved in a 10-day biology field study program achieved higher grades than their peers who did not participate in the field study program. The primary advantage of field study is that students can observe how organisms function in an ecological system (Hart and Nolan, 1999; Kinchin, 1993; Lock and Tilling, 2002; Magntorn and Hellden, 2007). Nabhan (1995) wrote that the conditions of our world demand that every student should engage in field study in order to appreciate biodiversity and ecology. Field experience gives students the ability to make good environmental decisions (McCormack,1974) and provides the motive to do so (Manzanal, Barreiro, & Jimenez, 1999; Zervanos & McLaughlin, 2003). Magntorn and Hellden (2007) argued that learning gained in one ecological setting transfers to other environments. Consequently, fieldwork promotes deep learning that continues after schooling is finished (Goulder & Scott, 2009).

Other studies emphasize that the advantage of taking students into the field is that it necessitates them interpreting data and constructing meaning, not just memorizing information (McLaughlin, 2005; McLaughlin & Johnson, 2006). According to Carl Sagan (1990), "Science is much more than a body of knowledge. It is a way of thinking." (265). Eves, Davis, Brown, and Lamberts (2007) wrote that field study is more effective in teaching students to adopt a methodology, create a problem to investigate, do the research, and communicate their findings. This is because field study programs are generally more self-directed than non-field-oriented courses, so students must determine how to interpret data and learn how to collaborate with other students (Boxerman, 2013; Hammer, 2001). Another advantage is that many field study programs are integrated. Integrated learning uses multiple disciplinary approaches to solve a problem rather than viewing the data from one perspective (Eves et al. 2007).

Having a solid field study experience takes careful planning. Goulder and Scott (2009) wrote that elements that prevent ideal field study include too much course material, too much lecture and lab teaching methodology, and examinations that depend on memorization. Their study showed that the whole-class base of knowledge was greater in a curriculum that integrated lecture/laboratory and field study than a class that used only lecture and labs. This greater collective knowledge gave students more freedom when they planned their own experiments. Their study also found that students maintained interest because they could choose what specimens they worked on. One disadvantage was that the amount of work done by the students varied more than in a traditional class because there was more freedom to fail or succeed. Despite these studies, field study programs have diminished, primarily because of the expense (Barker, Slingsby, & Tilling, 2002; Fisher, 2001). McLaughlin and Johnson (2006) proposed the "Field Course Experiential Learning Model," which is a paradigm for combining the best aspects of both the lecture/lab and the field study models. The first step is receiving web-based instruction and completing open-ended assignments, the second is participating in field study experiences, and the third is processing and writing up findings in a web-based environment.

Unlike the programs described above, the faculty of Insects, Writing, and Art (the name of the field study program) proposed that rather than having classroom work, field study, and laboratory work at different locations, they would combine these into one location. While the program involved some lecture and laboratory at the university before the field study program at the research preserve, most of the instruction was given at the field facility, which had a classroom that the faculty stocked with laboratory equipment. Faculty could lecture students, giving them a knowledge base, and then students could immediately move freely between fieldwork and laboratory work. The curriculum was project driven and focused on producing a field guide to arthropods in the area. Because the students could choose the orders of insects they would work on, this program provided some independence and self-direction but not as much as when students choose and design their own experiment. The curriculum was interdisciplinary because it looked at arthropods from the perspective of biology, art, and writing.

Methods

Researchers obtained results by comparing pre- and post-tests of entomological knowledge and pre- and post-tests about writing and entomological self-efficacy. They also administered a satisfaction survey and open-ended, written surveys about the field experience. The study seeks to answer the overarching question of "How does the more intensive and more integrated field study experience differ from the classroom experience?" This question includes subtopics exploring whether the students learned the material

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better (entomological content), whether they had a different level of self-efficacy (regarding writing and entomology), whether their perception of the value of the subject was different, and whether the field study provided additional learning opportunities outside of the traditional subject of the class. As researchers analyzed the results, another central question became "From the student's perspective, what made their field study experience unique?" The main differences in the classes were the location as well as the correlation with other classes through the shared assignment, so the analysis particularly addresses the effects of those differences.

The study employed a quasi-experimental, concurrent nested mixed-method design (Hanson, Creswell, Clark, Petska, & Creswell, 2005) to address questions related to differences between the field study and traditional classroom group educational experiences. Quantitative data (including a satisfaction survey and data about attitudes and intentions) was collected from both groups, while only the field study group provided qualitative data. Our aim in this part of the study was to allow those participating in the intensive field experience the opportunity to give open-ended responses so that we could make better observations about their subjective experience. In addition, as educators, we wanted to gain insight concerning how to better design such intensive field experiences in the future.

Settings and Samples

Both the field study and traditional classroom groups chose the study because they wanted to take the entomology class, which is available as an elective to all biology majors but is particularly required for those in the biological science education degree plan. In both the field study and the traditional classes, a mix of both types of majors was present (biology and biological education). Additionally, a few students of majors outside biology were included in the classes when appropriate prerequisites had been taken or waived by the instructors. The field study section, taught during spring term 2014, consisted of 12 students, while the traditional classroom group of Fall 2013 included 18 students (see Table 1).

Both entomology classes were taught by the same professor and covered how to collect, identify, and classify insects, with a focus on preservation and appreciation of the natural world. The professor's teaching methods consisted of lectures, tests, quizzes, papers, and, for the traditional class, five field trips of about three hours each to nearby sites and one longer trip of three days to southern Utah.

Rather than taking separate field trips, the field study group lived on the university preserve. In this entomologically diverse setting, students in

Table 1 Sample Demographics

	Male	*Female*
Field study	5 (41.67%)	7 (58.33%)
Traditional classroom	10 (55.56%)	8 (44.44%)

the field study group could go outside, observe, and apply what they had just learned. The field study students also had continuous access to the tools of the entomologist: gathering and curating equipment such as dry nets, aquatic nets, aspirators, various kinds of traps, pinning boards, and microscopes. The writing component differed in that instead of producing papers without any obvious use outside the class, all writing assignments had a specific audience and purpose, which was to create a field guide for students and other visitors to the university's preserve. This assignment required students to become specialists in their assigned families of insects and allowed them to apply their entomological knowledge for a practical purpose. To improve their writing and sketching abilities, the members of the entomology class studied technical writing and drawing. All three disciplines had their own curriculum but were focused on the shared task of completing the field guide. Finally, the field study group differed from the traditional classroom group in that all the members of the class, along with the professors, lived on site together, sharing the responsibilities of meal preparation and housekeeping, which means they spent almost all of their time together.

Quantitative Data Collection

Researchers asked students in both the traditional classroom and field study groups to complete pre- and post-tests of entomological knowledge, pre- and post-tests about writing and entomological self-efficacy, and a satisfaction survey. Table 2 contains a description of all measures.

Qualitative Data Collection

With the field study group, we also analyzed open-ended, written surveys. Students responded in writing to five open-ended questions about their field study experience:

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Table 2 Number of Items Associated with Evaluation Measures and Their Definitions

Measure	*# of Items*	*Definition*
Test scores	1	Pre- and post-test scores
Satisfaction instructor	14	Overall satisfaction with content and
Attitudes	6	Students' feeling of the personal importance of entomology
Behavioral intentions after the course	6	Intentions of proceeding with entomology
Gathering ideas	30	Ability to collect ideas to write about
Writing environment	20	Ability to write under any circumstance
Research	24	Ability to find, collect, implement, and correctly cite information found during gathering
Early stages of drafting	24	Ability to identify and effectively write an outline positioned toward a specific audience
Later stages of drafting	18	Ability to analyze and synthesize ideas in a clear, understandable fashion
Editing and proofreading	10	Ability to complete the final product
Entomology Content Self-efficacy	34	Ability to correctly recall entomology course content

- What are some of the most significant principles you learned while in this course?
- What activities felt most significant?
- What did you enjoy about the way this course was structured?
- What activities best facilitated learning?
- How would you change the course if you were the teacher?

All qualitative data were collected at the end of the class from the field study group (12 participants); these questions were designed to capture what the students found significant in their experience with intensive field study.

Quantitative Analysis

We entered results from the content and self-efficacy tests into Excel spreadsheets and calculated average and change scores. Due to lack of statistical power and concern with family-wise error rates (as a result of our small sample size and the number of analyses needed to test differences across all measures), the analysis focused on descriptive rather than inferential statistics.

Qualitative Analysis

All survey response questions were transcribed and coded. The analysis employed a grounded theory analysis approach (Creswell, 2013) and began with open coding of each response question separately. After this first round of coding, Question 5 was separated from Questions 1–4 due to lack of comparability and was instead analyzed separately and compared to the results from Questions 1–4. In the first four questions, as common themes emerged from the initial coding, codes were combined or divided to show distinctions and commonalities across questions. Codes were then grouped into categories and divided into codes that represented *what* was most significant or enjoyable and *why* certain things were significant or enjoyable. Finally, categories were grouped to show the relationship between different categories, and these results were then analyzed in context of our original research questions.

Results

Satisfaction

Both field study and traditional classroom group members indicated high levels of satisfaction with their course experiences. On average, members of the field study group rated their course slightly higher than did traditional classroom group members, as can be seen in Table 3.

Table 3 Attitudes and Satisfaction Toward Course as a Whole

Satisfaction Measure	*Field study*	*Traditional Classroom*	*Diff*
I liked the entomology course.	95.83	91.56	4.28
Taking the course made my life better.	93.75	88.89	4.86
This course challenged me, and the challenge helped me grow.	96.67	89.72	6.94
I gained significant knowledge from taking this course.	96.67	92.83	3.83
I would recommend this course to other students.	90.83	90.78	0.06
I would take another course like this again.	87.08	84.94	2.14
I would take another course from these teachers again.	98.33	90.22	8.11

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Table 4 Average Outcome Change Scores

	Group	*Pre M/SD*	*Post M/SD*	*Δ Pre-Post*	*Field. −Trad. Δ*
Test scores (entomology content test)	Field	11.25/.49	87.75/.03	76.5	−5.5
	Trad.	12.00/5.55	94.00/3.09	82	
Attitudes	Field	86.47/3.83	88.97/4.22	2.5	−3.36
	Trad.	84.29/2.14	90.15.2.58	5.86	
Behavioral intentions	Field	88.44/1.50	88.81/3.83	0.37	3.5
	Trad.	80.95/2.89	77.82/7.52	−3.13	
Gathering ideas self-efficacy	Field	67.62/7.34	84.52/4.59	16.9	6.62
	Trad.	66.17/7.27	76.46/4.90	10.28	
Writing environment self-efficacy	Field	61.46/6.30	78.41/8.35	16.95	10.05
	Trad.	64.42/6.77	71.31/6.72	6.9	
Research self-efficacy	Field	79.34/4.92	88.52/4.39	9.18	−2.32
	Trad.	72.99/7.02	84.49/4.49	11.5	
Early stages of drafting self-efficacy	Field	74.42/5.36	83.02/6.81	8.6	1.58
	Trad.	71.51/6.69	78.54/6.22	7.02	
Later stages of drafting self-efficacy	Field	71.15/3.22	78.11/4.64	6.95	−1.54
	Trad.	70.21/6.66	78.7/4.81	8.49	
Editing and proofreading self-efficacy	Field	76.67/0.81	82.13/5.12	5.45	−2.79
	Trad.	77.56/4.61	85.8/3.08	8.24	
Entomology content self-efficacy	Field	45.53/22.02	90.69/6.45	45.15	7.63
	Trad.	45.41/18.57	82.93/10.22	37.52	

Outcomes

We analyzed an overview of all pre- and post-course average and change scores across all measures (Table 4). In general, scores for field study and traditional classroom group members were generally similar. Field study group members experienced a greater positive change in their desire to continue studying entomology, their ability to gather ideas, and their ability to write in any environment. In addition to gaining more positive attitudes toward entomology, traditional classroom group members experienced greater increases in certain skills, including editing and proofreading, later stages of drafting, and general research skills.

Table 5 Codes Related to the Key Elements of the Experience

Subject	*Definition of Codes*	*Frequency*	*Total*
Opportunities to interact with the group	Group work/time with the group	12	21
	Class discussions	9	
Writing	Writing activities	21	20
Natural environment	Time outdoors	10	17
	Fieldwork/excursions	7	
Art	Learning and enjoying art	13	13
Free time	Free time	13	13
Specific activities in the entomology class	General entomology knowledge	4	33
	Insect collection*	6	
	Insect identification	5	
	Learning dichotomous keys	4	
	Unscripted moments with Dr. N*	4	
	Being a specialist for field guide*	4	
	Using the gear (microscopes, etc.)*	3	
	Lectures on entomology	3	
Balance between subjects	Balance between the topics of the 3 classes	8	8

Note. * indicates something that was particular to the field study group (not part of the standard entomology class). Insect collection takes place in the standard class as well, but collecting was significantly easier at the nature preserve, and the collections were larger and more diverse.

Qualitative Findings

In their written responses to the field study, students indicated a number of factors that made their experience meaningful. As indicated in Table 5 and explanations below, many of the most important factors were unique to the field study format of the class.

Writing

Writing was mentioned 20 times in the survey, in every question and by 11 of the 12 students. Reflective writing ("writing and reflecting about our experiences and inner thoughts") was mentioned eight times as an activity that felt most significant, and both reflective writing and writing for the field guide was mentioned six times as something that best facilitated learning ("those insects I wrote about . . . are the ones I feel I know the best"). Under the question about significant principles they learned, specific writing

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skills were also mentioned several times ("I have learned easy ways to edit and proofread").

Opportunities to interact with the group

Opportunities to work with the other students, both in group work and in class discussions, was mentioned 22 times in the survey, by 10 of the 12 students. Doing class work as a group, "the team effort" and "team atmosphere," or simply being "together so much of the time" felt very significant to students, who mentioned interaction with others 12 times. Class discussions, in particular (mentioned nine times), were learning experiences for students (e.g., "I also loved sitting in a circle and talking about our different opinions and letting other people share their wide variety of other opinions").

Natural environment

A particularly unique part of the field study class was its setting in the tan rocks and dirt of the Mojave Desert, and the opportunity to experience this natural environment as part of their learning was listed as significant and useful 17 times by 11 of the 12 students. Learning "out in the field" where they could collect insects and "apply what they had just learned" was listed seven times, and less structured time to "explore [nature] for [them] selves" was mentioned 10 times as something that felt significant and best facilitated learning.

Art

Drawing and painting insects was mentioned 12 times by eight students as something that facilitated learning (e.g., "I learned so much about the insects from having to draw them in a scientifically precise manner") and was enjoyable (e.g., "I also learned more about the creative and enjoyable nature of art."). It was second only to writing under Question 2, "What activities felt most significant?"

Free time

Free time was the most common answer to the question "What did you enjoy most about the way the course was structured?" which was mentioned six times there, and four times in Questions 1, 2, and 4 (by seven of the 12 students, total). The fact that "the entire day [was] not scheduled out perfectly" was positive for these seven students, but it is worth noting that three students also mentioned the lack of structure as something they would change about the course (Question 5), so feelings on that matter were mixed.

Entomology class

Eight aspects of the entomology course were mentioned as significant, a total of 33 times. General entomology knowledge was mentioned four times (e.g., "color patterns," insects' role in a "healthy ecosystem," etc.), entomology lectures were mentioned three times, learning dichotomous keys was mentioned four times, and insect collection and identification were mentioned six and five times, respectively. All of these elements are part of the traditional class as well as the field study class, although the collection and identification were more immediate and constant at Lytle ranch, which two students specifically mentioned as being significant to their experience (e.g., "We were constantly applying what we were learning about"; "It was significant to have the lectures about insects and then go right out to collecting").

In addition to the insect collecting being more immediate in the class at the research preserve, several aspects of the entomology class were only possible at the preserve, including having ready access to equipment like microscopes, which was mentioned three times. Becoming a specialist in certain bugs, a requirement due to the field guide assignment, was mentioned as helpful to their learning four times (e.g., other people would ask the specialists questions, which "forces the expert to know his stuff"). Finally, unscripted, out-of-class moments with the entomology professor were mentioned four times, by three students, as something that helped them appreciate the subject (students mentioned him sharing "neat" or "random facts" when they were exploring).

Topic interaction

The interaction between entomology, writing, and art was mentioned eight times by six students as something significant, specifically enabling them to see the connection between the subjects and the value of each (e.g., "Art gives us increased perspective, writing helps us describe what we see, science tells us how it works, and religion tells us why. I think this was the major principle that stuck out throughout the experience").

In addition to revealing what was meaningful about the field study, the surveys revealed why those elements were meaningful—what the experience did for the students. Table 6 and the explanations below report why students appreciated the field study.

Self-actualization.

Codes related to self-actualization were mentioned 25 times by nine students to explain why certain activities felt significant or useful to students. Certain events/activities encouraged students to reflect and learn moral or

Table 6 Codes Related to Why Key Elements Were Meaningful

Subject	*Definition of Codes*	*Frequency*	*Total*
Self-actualization	Reflection	11	25
	Personal growth	8	
	Life lesson	3	
	Time-management/work ethic	3	
Opportunity to learning from others	Collective learning	10	17
	Understanding others	7	
Appreciation for nature	Appreciation for beauty of the world	9	9
Observation	Gave them a chance to observe/ increased ability to observe	7	7
Flexible, out-of-the-box thinking	Flexibility, fluidity, slower pace	4	6
	Promotes creativity	2	

emotional lessons about themselves and the world. One student mentioned being able to "stop and think about what we were doing and why we were doing it." Another said she was more able to "express how she felt" on the trip. Another mentioned "building confidence within myself." In answer to Question 1 ("What are some of the most significant principles you learned in this course?"), several students mentioned self-improvement in areas such as overcoming "perfectionism" and "taking advantage" of the talents they realized they had. Three students specifically mentioned developing better "discipline and self-control."

Opportunity to learn from others

Ten out of 12 students mentioned learning from others 17 times as an effect of certain aspects of the course. This included both learning better as a result of learning together (e.g., "[Working together] allowed us to compare and contrast our results or styles so we could learn from each other") and understanding others better (e.g., "Conversations widened my understanding and interest in other people and their experiences").

Appreciation for nature

An increased appreciation for nature was mentioned as one result of this course nine times by five students. One student said, "I learned to appreciate the diversity of my surroundings," and another said, "Sleeping under the stars showed us the beauty of the night."

Observation

The opportunity to observe or the increased ability to observe was mentioned seven times by five students. One student said, "At the start of the course, I hardly noticed [insects]. Now I see them everywhere."

Flexible, out-of-the-box thinking

Six students reported that the structure of the course (Question 3) resulted in more flexible, creative thinking. It allowed them to see that "everything is connected and fluid," which "contributed to a relaxed atmosphere and encouraged creativity."

Discussion

The primary research questions for this study were: (a) How does the more intense field study experience differ from the classroom experience? and (b) What, specifically, about the field study might account for the differences, according to the students' perceptions?

In terms of answering these questions, the qualitative data appear more helpful than the quantitative data. The small sample size along with potential response shift bias makes interpreting the quantitative data somewhat difficult (Sibthorp, Paisley, Gookin, & Ward, 2007; Drennan & Hyde, 2008). Response shift bias occurs when individuals overestimate their abilities on a pre-test and then, after experiencing the intervention, recognize their overestimation and more accurately rates themselves on the post-test. Such overestimation is fairly common, especially when individuals are assessing their knowledge, attitudes, and abilities before they participate in a novel experience (Pratt, McGuigan, & Katzev, 2000), like an entomology class. For example, both groups of students may have overestimated their abilities on the pre-course questionnaire related to writing and entomology skills. After actually engaging in those tasks, they realized the tasks were more difficult than expected and corrected their estimates on the post-course questionnaire. This leads to pre- and post-course results based upon completely different perspectives, thus making comparison attempts less meaningful.

Despite the disparity in perspective, these pre- and post-test scores show an interesting correlation. The findings illustrate that students in the classroom setting tested better on average in their post-test scores than their field participant counterparts (87.75% field study group versus 94.00% traditional classroom group). The data also display that participants in the traditional classroom group on average increased their test-score percentage more from pre- to post-scores than their field participant counterparts (77.27% Traditional versus 77.36% Field Study change in score). While any conclusions are tentative because of the small sample size, this result (the higher traditional classroom group scores) could indicate that memorizing material might be better suited to a classroom and that integration of learning to develop an understanding of ecological connections might be better learned in the field (McLaughlin & Johnson, 2006).

The qualitative data, on the other hand, provide some helpful insights related to the evaluation's main questions. In response to the first question, the students pointed to many meaningful parts of the program that are not part of a typical entomology class. This included parts of the curriculum such as writing and creating art alongside the study of entomology (the integrated nature of the three subjects) and the freedom and flexibility within the class. It also included benefits that came from living at the research preserve, such as the constant interaction with classmates and professors, the experience of cooking for each other and cleaning the facility, and the ease of research due to on-site equipment like microscopes and a diverse insect population.

These were aspects of the program that students said were most significant or enjoyable for them, but *why* they found these aspects of the program significant is perhaps even more telling. The program led to reported positive changes in participants, such as learning about themselves (self-actualization), learning from others, and connecting with nature. In order for this information to be useful, however, we must also consider which "what" codes led to which "why" codes. Figure 1 represents the common associations we found in the field study group's responses.

The figure illustrates that writing, free time, and the natural environment encouraged self-actualization; opportunities to work with the group encouraged learning from others; the natural environment encouraged an appreciation of nature; and free time and balance between subjects encouraged flexible thinking.

This has important implications for the design of future experiential learning courses, most particularly courses that must blend field study and traditional lecture methodology because of limited funding or program objectives that focus on mastering information. Courses and programs that involve extensive field experience are more powerful in changing participants' ecological outlook, which is of growing importance when the world faces drastic changes because of climate change (Payne, 2015). Learning in a natural environment, especially when combined with free time and built-in reflection through writing, also leads to important personal growth for students, even though positive change in test scores might not reflect

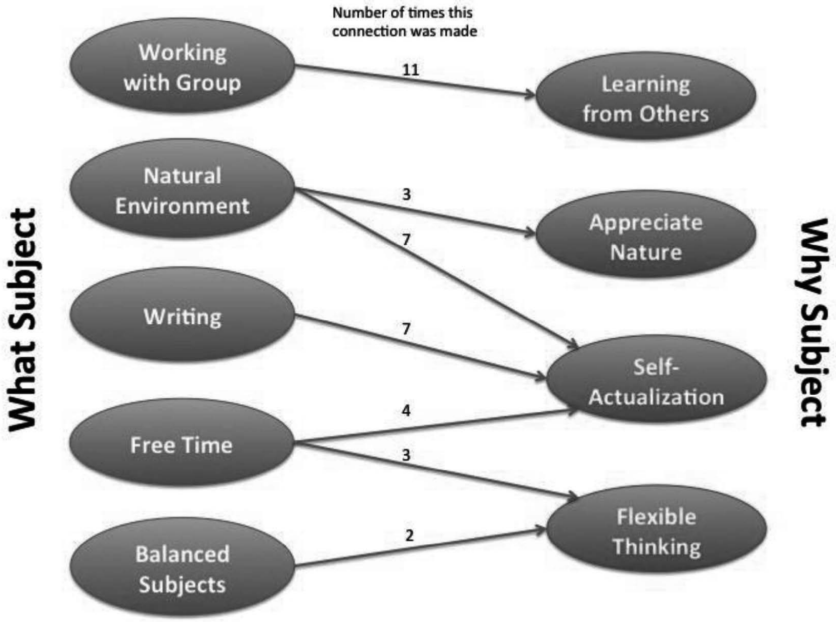

Figure 1 Common Associations between "What" and "Why" Codes.

this growth (Bennion & Olsen, 2002). Being in close quarters with a small group of classmates, especially when combined with group projects and regular, open class discussions, can lead to learning from and understanding others better. Flexibility in both the schedule (free time) and the curriculum (balancing the different subjects), can help students see connections between topics as well as encourage creativity (Clark & Button, 2011). Finally, incorporating art, especially when students are required to observe intricate details, can lead them to a deeper appreciation of the world around them. Aesthetics may be as important as science in changing students' ecological outlook (Carr, 2004; MacEachren, 2005; Yang, 2015). Future instructors hoping for similar learning experiences for students may want to consider including some of these experiential and interdisciplinary elements.

Observations about the Writing and Art Classes

While the focus of this experiment was determining how on-site learning affected the students in their entomology study, it is also interesting to note the faculty perceptions of differences between the field experience and on-campus instruction in all three disciplines. The writing teacher reported being surprised by how easily the students grasped elements of style and correctness in this class compared to other composition classes he had taught in the past. He said he had to spend very little time on those topics, speculating that the knowledge of a real and immediate audience made students much more conscious of how their writing would sound to an outside audience. Having to write very short descriptions of the insects (150 words or less) also made it essential for the students to be precise and concise with their language, so wordiness and vagueness were rarely issues in their writing.

The art instructor also noticed a few differences in teaching the drawing class, noting that because the students did not have to rush to work on another class, they were able to discuss art and work on projects together for longer periods, allowing more contact with the professor and deeper learning. He also said that the knowledge that the field guide would appear in an actual publication led students to take the class more seriously. This unusual focus and precision "resulted in some unusually fine work, especially considering how inexperienced these students were with drawing."

The entomology instructor noticed that the field study group students seemed much more engaged in making the collections and doing the curation for them than students in the similar, on-campus course he teaches. These students were able to quickly make the connections between morphological terms and their use in identifications. He also noted that the students were more closely in touch with using the textbooks that were available. In the on-campus course, he suspects that the students consult the textbook less. Using specimens rather than immediately running to the Internet to make identifications was also a welcome advantage he saw in the field study group students' study methods. But, all said, test scores on content for the field study group did not improve as much as he expected.

Limitations

The study had a number of limitations that deserve further discussion. The sample sizes of both the field study and traditional classroom groups were small, which restricted the degree to which the quantitative findings could inform the study's questions. While a larger group of traditional classroom and field study students would have been ideal, the prohibitive per-person cost and the capacity restrictions of the field study location made the recruitment of a larger group unfeasible. This restriction often hinders experimental design research of these types of experiences. At the same time, even though the samples were small, the inclusion of a traditional classroom group within a quasi-experimental design represents a more rigorous methodological approach than collecting data from only field study participants.

An additional limitation is the fact that qualitative data was not collected from the traditional classroom group. Having qualitative data from both the field study group and the traditional classroom group may have provided additional insight into differences between the experiences of the two groups. Future research in this area should include qualitative data-collection strategies for both field study and traditional classroom group members. While the lack of qualitative data from the traditional class is a definite limitation, insights drawn from the field study qualitative data still provide important findings related to the study's questions.

Future Research and Conclusions

Based upon the study's design and findings, some possible topics for further research include:

- How integrating classes (skill and content classes, humanities and sciences) affects learning.
- How creating a usable product affects each of the classes taught.
- How on-site field work changes how students learn skills like writing and drawing.
- How courses of the same length compare since the two courses in our class occurred over different time periods.
- How gathering qualitative data from both the field study and traditional classroom groups affects results.
- How a quantitative design accounting for the possible presence of response shift bias changes results (Sibthorp et al., 2007). Primarily, the use of retrospective re-test design, where before-and-after questions are asked simultaneously on a post-test, could prove helpful in determining the actual impact of such learning experiences (Coulter, 2012).

While limitations of sample size constrained the depth of quantitative findings from this study, the mixed-methods approach still highlighted a number of important insights. This study provides a starting point for future research on the unique impacts of fieldwork-based learning experiences.

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