The Value of Experiential Learning: a Case Study with an Interdisciplinary Study Abroad Course

Tara Prestholdt* Departments of Biology and Environmental Studies

Vail Fletcher Department of Communication Studies

The University of Portland, 5000 N Willamette Blvd., Portland, OR 97203

*Corresponding Author: holdt@up.edu

Abstract

Experiential learning provides students the time and space to participate in the process of learning by engaging in real, modern situations. Via hands on activities and reflection, students are able to assimilate new experiences with previous ones, and it has been repeatedly shown to improve student learning. We assessed how ten days of experiential learning in Tanzania, Africa affected student understanding and retainment of fundamental concepts in evolution, ecology, and ethology. We assessed 25 college students (n = 12 biology majors, n = 13 non-biology majors) with a pre- and post-test. The pre-test was announced to the students and given before travel, and a nearly identical post-test was unannounced and given four weeks after travel. Non-biology majors performed at least ~15-30% higher on their post-exam compared to their pre-exam, and biology majors performed 5-10% higher on their post-exam compared to their pre-exam. The success of our interdisciplinary course can partially be attributed to experiential learning, and our results suggest that experiential learning has a particular value to non-majors.

Keywords: experiential learning, assessment, non-majors, interdisciplinary, study abroad

Introduction

Experiential learning is the type of education that occurs when students actively participate and interact with their surroundings. Originally proposed in the 1930's, the application of experiential learning as part of the higher education process has been growing exponentially since Kolb introduced his Experiential Learning Model in the 1970's (Dewey, 1938; Kolb, 1984; Manolis et al., 2013). Although the details of the experiential learning model (as well as other closely related learning models) continue to be refined in the literature, the fundamentals of all experiential learning theories are the same: in experiential learning students are given the time and space to participate in the process of learning by engaging their senses real, modern situations (Cantor, 1997; Kolb, 1984; Kolb et al., 2001; Kolb & Kolb, 2005; Lewis & Williams, 1994; Manolis et al., 2013; Schwartz, 2013; Wenger, 2009). Student learning takes place via hands on activities, via contextualization of information in real world examples or scenarios, and with reflection, they assimilate new experiences with previous ones. Studies documenting the value of experiential learning are plentiful (especially compared to a "knowledge transfer" based education), and it is a powerful teaching tool across many disciplines (for reviews see Kolb & Kolb, 2006 and Springer et al., 1999).

Like experiential learning, interdisciplinary course offerings are also growing in popularity. Cross-curricular programs allow faculty to weave together timely fields of study and allow students to learn about topics through multiple, and different, faculty lenses (Coops et al., 2015; Jacobs, 1989; Klein, 1997; Kurland et al., 2010; Matthews et al., 2010; Sherchan et al., 2016; Smit & Tremthick, 2013; Weinberg & Harding, 2004). Interdisciplinary courses provide the opportunity to make explicit connections with topics that might otherwise be treated as insular, and this can be especially true in undergraduate programs where departments, divisions, or schools separate academic topics (i.e., a Department of History and a School of Engineering). The value of interdisciplinary coursework can be directly seen in the trend for many colleges and universities having adopted "globalization" or "internationalization" as part of their mission statement or long term plans (Maringe & Foskett, 2012). While overhauling entire programs to be more interdisciplinary is a daunting task, there are smaller, more manageable approaches to helping students become global citizens who interpret the world through multiple lenses. 'Studies Abroad' programs for example, are by definition already global and have an experiential learning component, as students travel to a potentially new and foreign setting. Moreover, they can be relatively easy to make interdisciplinary, as they are often comprised of a small group of students that are taking the same few courses. We began thinking about the value of interdisciplinary coursework in the light of experiential learning in a new study abroad course we developed at The University of Portland, "Ecology, Evolution, and Culture in East Africa". It is a 300-level course with sixteen weeks of classroom time during fall semester, ten days of experiential learning in Tanzania over winter break, and two weekend retreats during spring semester. During the fall semester students are exposed to a unit on environmental communication as well as a unit on the fundamental concepts of ecology, evolution, and ethology. The field component in Tanzania is the hopeful climax of the course as it provides the students with the opportunity to apply and expand their views and understanding of the world around them; ideally they internalize the academic topics covered in the classroom, challenge their previous beliefs, and recognize how their experiences are shaping the way they have come to understand information.

The current learning outcomes of our international and interdisciplinary course are lofty. First, students should be able to demonstrate critical thinking in the social and biological sciences. This includes using concepts and ideas from scholarly sources to enrich personal views about global awareness and cultural consciousness as well as reflecting on what it means to develop international goodwill and appreciating difference. Second, students should be able to demonstrate knowledge of theories and research related to ecology, evolution, and culture of East Africa. This includes analyzing the role of culture in nature and the role of nature in culture as well as explaining how human relationships impact the social and biological environment, locally and globally. Additionally, our course aims to contribute to deeper questions that are part of our University's Core Curriculum: How does the world work and how could the world work better? How do relationships and communities function? What is the value of difference? What is the role of beauty, imagination, and feeling in life? Given such comprehensive learning outcomes, our assessments are a work in progress. Students who take this study abroad course come from diverse backgrounds, and since experiential learning is in part based on previous experiences, we would like to develop ways to tease out the variables that contribute to their ability to achieve our learning outcomes. Eventually we aim to demonstrate if and how their understanding of biology and environmental communication grows over time and some of these assessments are inherently or logistically difficult. However, one piece of assessment that was realistic to capture on our first few iterations of the course was how the experiential learning portion of the course influences student understanding and retainment of biological content. Tanzania is one of the richest sites of human and biological histories in the world, and the examples of flora and fauna there can be used to explain any basic principle in evolution, ecology, and ethology. Thus, we explored if and how the *in situ* travel in Tanzania affected student understanding of core concepts in evolution, ecology, and ethology. We hypothesized that all students would demonstrate an improvement in their ability to explain fundamental theories in biology, and that non-majors would show more of an improvement than biology majors.

Methods

We assessed two cohorts of students who participated in the course, one in 2015 and one in 2017. In total there were 25 students: 12 biology majors and 13 non-biology majors. All students were juniors or seniors, and other majors represented were business, education, communications, German, Spanish, history, and sociology. The first round of assessment was given as an in-class exam prior to travel. It was announced in the syllabus (as an exam) and students expected and prepared for it. Students did not get their exam grades or the paper copy of the graded exam before taking the post-test. A nearly identical assessment (see below) was given four weeks after students returned from Tanzania during our first weekend retreat. The students were given no warning or chance to prepare or study for this second assessment; it functioned like a pop-quiz. Both the pre- and the post-test were proctored by the authors.

The assessment tool (or exam) consisted of four parts: animal identification (30%), evolution (30%), ecology (20%) and ethology (20%). For the animal identification portion, students were given a list of 50 East African animals to be able to identify. These animals were covered in lecture pre-departure, usually as examples of biological concepts. They learned about the animal's life and natural history with a particular focus on its ecological niche and/or its unique adaptations and behaviors. For the exams, thirty pictures (via a PowerPoint presentation) were shown to the students and they had to identify it. There were different pictures and animals on the pre- vs. post-assessment, but all animals presented to the students were included on the original list of the 50 animals. These identification questions were worth one point each and were graded as correct (1 point) or incorrect (0 points). Incomplete or vague answers such as "monkey" or "bird" were counted as incorrect. The second portion of the exam focused on terms, short answers, and examples of evolutionary concepts. Examples of test questions included: *Explain natural selection and provide an example* and *What is Olduvai Gorge and why is it important to studies of human evolution?* The third section was questions about ecology such as *What is a keystone species? Describe with two examples*. The fourth section focused on ethology and included questions such as *What are the fitness costs and benefits of living in a group? Describe with an example* and *Name and describe (using examples) two types of mating systems common in intraspecific competition.*

Throughout the exam the terms were worth two points each (2 points for a complete definition, 1 point for an incomplete definition, and 0 points for an incorrect definition) and the open-ended short answer questions were graded on a "points earned" basis. For example, providing two examples of keystone species was worth six points, and students could earn up to three points for each example. An answer of "dung beetle" earned one point, while an answer that elaborated on the specifics of why dung beetles are a keystone species was worth three points. In other words, answers with more details and synthesis earned more points. Ultimately the test was ~45% "right or wrong" and ~55% "points earned". Students were instructed to write something for every answer (even if they didn't know the correct answer), and with only one exception (see Results), all students answered all questions. Paired t-tests were used to compare pre- and post-exam scores. We did not test for differences between cohort 1 and cohort 2 due to sample size (i.e., each cohort individually was not large enough for statistical analyses). Instead, the two cohorts were pooled for all statistical analyses.

Students spent a total of ten days in Tanzania. The company that handles logistics while in East Africa is Thomson Safaris and they have a unique vehicle that seats 16 people; it accommodated all the students, two faculty, and one Tanzanian guide. Thus, unlike many travel safaris, we did not have to separate into small groups of Land Rovers that hold 2-6 people. This helped ensure similar visual experiences for all students (i.e., there were not situations where one group of students go to see something that another group of students did not). We traveled to four different conservation areas, each chosen because of their biological setting. Days 1-3 were spent in Tarangiere National Park. It is a microcosm of rainforest in an otherwise dry landscape, and reinforced topics included biomes, mating, and adaptations in plants. Days 3-5 were spent in Ngorongoro Crater National Park. This 2 million year old caldera is the largest in the world, and reinforced concepts included biogeography, natural selection, male-male competition and female choice, keystone species, and ecological niches. A travel day either to or from Ngoro Ngoro was punctuated with a visit to Oldupai (or Olduvai) Gorge; after a lecture on the history and major discoveries of the area, students explored the museum and interacted with volunteers and docents. The primary reinforced topics were hominid evolution and geologic time. Days 5-8 were spent in Serengeti National Park. As the most famous park in Tanzania, it houses the most species of ungulates anywhere in the world. Reinforced concepts at this park include group living, game theory, migrations, and the arms race between the hunters and the hunted. The final few days were spent in the Eastern Serengeti. This area, outside any national park, is a 12,600-acre conservation area that used to be owned and farmed by Tanzanian Breweries. It was purchased by Thomson Safaris and named "Focus on Tanzanian Communities" (FoTZC) and the focus of the organization's efforts include education, women's empowerment, community development, and clean water. Large carnivores no longer roam the Eastern Serengeti so students were able to explore the area on foot and experience the macro and micro ecological differences between wild and agricultural lands. Students also visited with farmers and a local veterinarian. Finally, because reflection is such a key component of experiential learning (Kolb, 1984; Kolb & Kolb, 2005), we also had nightly discussions around the campfire. While the topics always involved some aspect of Tanzanian flora or fauna, discussions often dovetailed into issues in conservation; this often provided a social context for students to understand fundamental biological concepts.

Results

Non-biology majors performed at least ~15% higher on their post-exam compared to their pre-exam, with their greatest improvements in concepts related to evolution and ethology (~30% improvement for both topics in post-exam scores compared to pre-exam scores, see Table 1). The average pre-test grades for non-biology majors were C, C-, and D and the average post-test grades were B, B+, and A+. For all four learning areas (identification, evolution, ecology, and ethology), as well as the exam overall, there were statistically significant differences between their pre- and post-exams (all $p < 0.01$, see Table 1).

Biology majors also showed some improvements in the test overall as well as some of the knowledge areas (identification, evolution, and ecology), but none of these differences were statistically significant. On average, biology majors performed 5-10% higher on their post-exam compared to their pre-exam (see Table 1). The average pre-test grade was a B while the average post-test grade was an A. For the ethology questions, student performance decreased by 2%; students averaged 99% on the pre-test and 97% on the post-test (see Table 1). One biology major did not answer an ethology question worth eight points on the post-test, and analysis of the data without this question in the pre- and post- exam revealed a 3% improvement in majors understanding of ethology (96% average pre-test score, 99% average post-test score, data not shown on Table 1).

	Non-Biology majors (n = 13)				Biology majors (n = 12)			
	average pre-test	average post-test	average % difference	paired t-test results (pre and post test)	average pre-test	average post-test	average % difference	paired t-test results (pre and post test)
Exam Total	71.1%	88.0%	**+ 16.9**	**<.001**	88.0%	91.7%	+ 4.9	.190
Animal I.D.	70.2%	85.2%	**+ 15.0**	**.003**	85.8%	91.3%	+ 5.5	.376
Evolution Questions	60.1%	88.2%	**+ 28.1**	**.003**	79.6%	86.8%	+ 7.2	.126
Ecology Questions	72.9%	86.9%	**+ 14.0**	**.005**	83.3%	93.5%	+ 10.1	.257
Ethology Questions	68.8%	100%	**+ 31.2**	**<.001**	99.2%	97.1%	- 2.1	.408

Table 1. Comparisons of pre- and post-tests for non-biology majors and biology majors. For non-biology majors, students demonstrated a 14-31% improvement in their understanding of fundamental biological concepts, and comparisons between pre- and post-tests revealed statistically significant differences for the exam total as well as each of the four test subject areas (all $p < 0.005$). For biology majors, students demonstrated a -2-10% difference in performance, and none of the differences were statistically significant (all $p > 0.1$), * pre- and post-test comparison.

	average pre-test	average post-test	average % difference	paired t-test results (pre and post test)
Exam Total	78.6%	89.8%	**+ 11.1**	**<.001**
Animal I.D.	77.7%	88.1%	**+ 10.4**	**.008**
Evolution Questions	69.5%	87.5%	**+18.1**	**<.001**
Ecology Questions	77.9%	90.1%	**+ 12.2**	**.012**
Ethology Questions	83.4%	98.6%	**+ 15.2**	**.003**

Table 2. Comparisons of pre- and post-tests for all 25 students revealed significant differences between student pre- and post-test (all $p < 0.05$).

Biology majors performed better than non-majors on all aspects of the pre-test; biology majors averaged an 88% on the pre-test and non-biology majors averaged a 71%. The greatest differences in performance between majors and non-majors on the pre-test were in the evolution and ethology questions; for the evolution questions, biology majors averaged an 88% on the pre-test and non-biology majors averaged a 71%; for the ethology questions, biology majors averaged a 99% on the pre-test and non-biology majors averaged a 69%. However, there was little difference in the performance between the majors and non-majors in the post-test, and in some cases the non-majors out performed the biology majors (see Table 1). For animal identification, majors and non-majors differed by 6%, for evolution questions they differed by 1.4%, for ecology questions they differed by 6.6%, and for ethology questions they differed by 2.9%.

Discussion

Non-biology majors showed a dramatic improvement in their ability to explain fundamental evolutionary, ecological, and ethological concepts. Across the range of topics, non-biology majors showed a ~15-30% improvement in their post-exam scores compared to their pre-exam scores. Since the students were given no warning or chance to prepare or study for the post-test, we believe most or all of the improved performance can be attributed to experiencing the biology themselves in Tanzania. Once they had seen, smelt, and heard the topics and animals firsthand, students were able to transform their previously sophomoric and vague answers into detailed explanations of how the world works on a biological level. Our results are consistent with other research that has demonstrated improved scientific learning from an outdoor experience (Bogner, 1998; Ernst et al., 2014; Falk & Balling, 1982; Jose et al., 2017, Lisowski & Disinger, 1991, Randall 2012; Scarce, 1997).

Interestingly, when we combined all 25 students for data analyses, there were statistically significant differences between student pre- and post-test. However, given the results when we analyzed the data by students' major, it is clear that non-biology majors are driving the differences of the group as a whole. That is, any conclusion about an improved performance of the entire group of 25 students would be misleading, as majors and non-majors did not benefit equally from the experiential learning portion of the course. If we had not specifically compared majors to non-majors, we would not have found this exciting difference in the value of experiential learning to non-majors compared to majors. East Africa is an exciting place for anyone to visit, and our data suggest that it has a disproportionate, and hopefully life long effect, on teaching science to non-scientists. This result is consistent with other studies that have demonstrated the value of experiential learning specifically to non-majors (Arwood, 2004; Packer, 2009; Wolfe et al., 2005).

There are three other noteworthy comments about our results. First, we were struck by the lack of detail in non-major pre-tests compared to the level of detail provided in their post-tests. The best examples were in the questions about Oldupai Gorge (i.e., What is Oldupai Gorge and why is it important to studies of human evolution?). No (non-major) student used a scientific name in the pre-test, yet in the post-test almost all the students provided the Latin name of at least one (if not all three) species discovered at Oldupai Gorge (*Homo habilis, H. erectus,* or *Paranthropus boisei*). Similarly, many students applied dates, years, or researcher names in their post-test answers. Second, we did not expect the biology majors to show a statistically insignificant improvement in their biological knowledge. While the students did perform 3-10% better on the post-test compared to the pre-test, we expected both biology majors and non-biology majors to significantly benefit from the field experience. We plan on developing future assessments that might elucidate if and how biology majors academically grow after their experiences in Tanzania. And third, it is interesting that students showed the biggest improvement in topics of ethology. The sights and sounds of birds singing or big horn sheep butting heads are nothing new to our students, as pictorials of these behaviors are often in commercials or billboards. We believe the changes in their understanding of ethology are from the thrill and excitement of being so close to the large, colorful, and active animals of East Africa. Students got woken up by the sound of male impalas fighting and the sounds of the rainbow colored lilac breasted roller singing just a few feet from their tent; these experiences allowed them to internalize how animal phenotypes represent their intense struggle for a chance at offspring. Their original understanding of the ornaments and armaments of the Serengeti transformed from something "cool" to concrete examples of the products of sexual selection.

One of the most unexpected dimensions of our experience in the field was the peer-to-peer learning that took place among the students. As previously mentioned, all students were in the same vehicle, meaning we were physically together during most of the day. At night, we camped in isolated campgrounds where, for safety reasons, our tents had to be within a few feet of each other. So while the group was physically together for all day and night activities, there were inevitably moments where a few students in the back of the truck would be having a different conversation than those students in the front. For example, upon seeing an elephant poached for its ivory tusks, a German major wanted to know why park rangers don't remove the body. As we all watched the venue of Lappet faced vultures feeding on the carcass, a biology major explained the basics and significance of nutrient cycling and food webs (something we had not extensively covered in the classroom pre-departure). As another example, the night after an impromptu visit to a local market, students engaged in a healthy debate over the cultural significance of our presence there, and how our behaviors were and weren't appropriate. It was incredibly exciting for us faculty to see our students share their knowledge and positionality with each other; our students were smart enough to provide facts within their disciplines as well as confident and open enough to discuss them. While we have no formal assessment data on this, we believe the extraordinary level and intensity of interactions that took place among the students broadened their perspective. The organic nature of how students interacted with each other also highlights the value of having the field component of the course be 100% outdoors with no technology or cell phones as distractions. In the future we plan on being much more intentional and deliberate in facilitating peer-to-peer learning (as shown in Boud et al., 2014;

Goldschmid & Goldschmid, 1976; Secomb, 2008; Whitman, 1988), and we suggest that any interdisciplinary approach develop assignments and assessments that specifically address interactions among students.

In conclusion, our assessments suggest that experiential learning in the realm of biology has particular value to non-biology majors. With the incredibly bio-diverse birthplace of much human and ecological history as their field site, our students culminated with a deeply important and powerful first-hand understanding of the interdependent and dynamic connections between animals and their environment. We think the success of the course can be attributed to the heavy participation of both the faculty and the students while in Tanzania, as well as peer-to-peer learning and the pre-trip classroom preparations. We believe there was a depth to the course experience made possible only by physically being in the location they are learning about, where any disconnect between fact and feeling was completely abolished; there was no barrier between student learning and engagement, just as there was no fence between ourselves and the wildlife

Literature Cited

ARWOOD, L. 2004. Teaching Cell Biology to Nonscience Majors Through Forensics, or How to Design a Killer Course.
Cell Biol Educ. 3(2): 131–138.

BOGNER, F. 1998. The influence of short-term outdoor ecology education on long-term variables of environmental perspective.
J Environ Edu. 29(4): 17–29.

BOUD, D., COHEN, R., AND J. SAMPSON (EDS.). 2014. Peer learning in higher education: Learning from and with each other. Routledge, London, England.

CANTOR, J.A. 1997. Experiential Learning in Higher Education: Linking Classroom and Community. ERIC Digest.

COOPS, N.C., MARCUS, J. CONSTRUT, I., FRANK, E., KELLETT, R., MAZZI, E., AND A. SCHULTZ. 2015. How an entry-level, interdisciplinary sustainability course revealed the benefits and challenges of a university-wide initiative for sustainability education. Int J Sust Higher Ed. 16(5): 729-747.

DEWEY, J. 1938. Experience and education. Collier Books, New York, New York.

ERNST, C.M., BUDDLE, C.M., AND L. SOLUK. 2014. The value of introducing natural history field research into undergraduate curricula: A case study. Bioscience Education. Advance online publication. doi:10.11120/beej.2014.00023

FALK, J.H., AND J.D. BALLING. 1982. The field trip milieu: Learning and behavior as a function of contextual events. J Educ Res. 76(1): 22–28.

GOLDSCHMID, B. AND M.L. GOLDSCHMID. 1976. Peer teaching in higher education: a review. Higher Education. 5(1): 9-33.

JACOBS, H.H. 1989. Interdisciplinary curriculum: Design and implementation. Association for Supervision and Curriculum Development, Alexandria, VA.

JOSE, S. PATRICK, P.G., AND C. MOSELEY. 2017. Experiential learning theory: the importance of outdoor classrooms in environmental education.
Int J Sci Educ. B: 1-16.

KOLB, D.A. 1984. Experiential learning: Experience as the source of learning and development. Prentice-Hall, New Jersey.

KOLB, D.A., BOYATZIS, R.E., AND C. MAINEMELIS. 2001. Experiential learning theory: Previous research and new directions. Perspectives on thinking, learning, and cognitive styles. 1(8): 227-247.

KOLB, A.Y. AND D.A. KOLB. 2005. Learning styles and learning spaces: Enhancing experiential learning in higher education. Acad Manage Learn & Edu. 4(2): 193-212.

KOLB, A.Y. AND D.A. KOLB. 2006. Learning styles and learning spaces: A review of the multidisciplinary application of experiential learning theory in higher education. In R. R. Sims, & S. J. Sims (Eds.), Learning styles and learning: A key to meeting the accountability demands in education. Nova Science Publishers, New York, New York. pp 45-92.

KLEIN, J.T. AND W.H. NEWELL. 1997. Advancing interdisciplinary studies. Handbook of the undergraduate curriculum: A comprehensive guide to purposes, structures, practices, and change. pp. 393-415.