Teaching and Educational Methods

Reimagining Teaching Water Issues through Integrative Experiential Learning

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Abstract
This paper highlights an undergraduate experiential learning course on water resources, which was designed and coordinated by the Nepal Study Center (NSC) and offered by the economics department at the University of New Mexico (UNM). The experiential learning course, "Problem-Based Learning," combined learning experience in the classroom with community outreach and international research experience via a study abroad program. The course development closely followed the principles of the "experiential learning theory" (ELT), and the course structure comprised four components: (1) field-based data collection, problem identification, and conceptual framework development, (2) data analysis and development of potential intervention and solutions, (3) study abroad and implementation in the field, and (4) dissemination of findings and community outreach. A noteworthy feature of this learning model included graduate and undergraduate student collaboration. Graduate students aided instructors by serving as mentors for undergraduate students, helping them with empirical analysis and leading discussions in the development of policy tools and solutions implemented in the study abroad program. The broader impacts of these experiential learning courses can be summarized as: (1) student learning experience, (2) community impacts, (3) research experience, and (4) potential for the program to serve as a model for other institutions.

1 Introduction

Water is an essential resource that sustains all forms of life, yet ensuring its quality and availability continues is an increasingly urgent contemporary issue. Water scarcity is an acute issue in many parts of the United States, including Arizona, California, Colorado, Nebraska, and New Mexico, which are all facing considerable strain on their water supplies (Hofste et al. 2019). The problem is even more widespread globally, with more than 40 percent of the world population residing in regions of moderate water stress. Additionally, countries in the Northern African, and Central and Southern Asian regions are facing the issue of groundwater consumption far exceeding the replenishment rate (Food and Agriculture Organization and UN Water 2021). The inevitable consequence of increasing water scarcity is the prevalence of unsafe water practices, which pose significant public health implications (Jury and Vaux 2007). In several regions of Asia and Africa, waterborne diseases like diarrhea and dysentery have inflicted tremendous damage on their respective development (Weli and Ogbonna 2015; Zahid 2018).

To address the multifaceted nature of water, it is crucial that water-related topics be integrated across academic disciplines including social sciences, natural sciences, and humanities (Yarime et al. 2012; Amahmid et al. 2019). However, merely integrating these topics into the classroom is not enough. It is essential for departments to collaborate, co-design, and co-teach water-related topics that provide students with practical, hands-on learning experiences that go beyond traditional classroom lectures. To

this end, undergraduate institutions have started to emphasize the importance of richer learning experiences such as capstone projects, internships, study abroad programs, and undergraduate research (Fink 2013; Barber 2014). These integrative learning programs have the potential to improve students' appreciation and comprehension of topics such as water resources from multiple disciplinary perspectives, which is crucial in tackling water-related challenges in the future.

This article highlights the development of a problem-based experiential learning course to investigate issues that lie at the intersection of environment and health. The course, Econ 369*[1]: "Problem-Based Learning Using Data Analysis," has been recurrently offered by the economics department at the University of New Mexico (UNM) in collaboration with the Nepal Study Center (NSC[2]) at UNM since Fall 2018. This course came into existence following two years of trial runs with two separate courses: Econ 395: "Problem-Based Learning Using Data Analytics: Health and Environment in Urban Nepal," and Econ 451: "Sustainable Development Action Lab" during Fall 2016 and Fall 2017. In Fall 2018, the three courses, Econ 395, Econ 451, and the Econ 369*, all focused on water-related issues in Nepal, but since Fall 2018, the Econ 369*[3] course has investigated other environmental topics such as air pollution and solid waste management. The primary focus of the problem-based learning courses was to provide undergraduate students with an international research experience by taking the classroom to the field. These courses followed a pedagogical approach that encouraged students to engage in problem-driven, policy-relevant work. In these courses, students were exposed to real-world problems through data and research, and had the opportunity to visit the area where their research focused and implement their findings. These courses relied on a primary teaching instructor, with the assistance of a volunteer team of doctoral student mentors.

We discuss in the following the comprehensive overview of the design and implementation of the Econ 369* course along with the Econ 395 and Econ 451 trial courses, highlighting the positive outcomes achieved through this experiential learning approach. Section 2 introduces the theoretical underpinning of the Econ 369* course design, emphasizing the importance of learning by doing through Kolb's (1984) "experiential learning theory" (ELT). Section 3 delves into the pedagogical structure of the course, encompassing both classroom and fieldwork components. Section 4 discusses the broader impacts of the course, alongside the metrics used to evaluate its effectiveness, and finally, section 5 outlines the challenges of implementing similar courses and provides suggestions for the future programs.

2 Theoretical Framework

The problem-based learning[4] course was based on the theoretical foundation of the experiential learning model, which emphasizes the role of experience in the learning process. The experiential learning model has its intellectual origins in the works of prominent twentieth-century scholars such as John Dewey, Kurt Lewin, and Jean Piaget (Kolb 1984). The ELT was proposed in Kolb (1984) as an alternative pedagogical approach to traditional educational methods that focus on theories taught in classroom settings and reflection on these theories through written exams. ELT, on the other hand, views learning

[1] More information on the Econ 369*, Econ 395, and Econ 451 courses is available at https://nepalstudycenter.unm.edu/SustainableResearchLab/UndergraduaterResearchInitiatives.html

[2] NSC is a research center housed in the economics department at UNM. It was established in 2005 with the aim of creating a platform for knowledge transfer where graduate students and scholars could develop, restore, and promote policy-oriented research on issues pertinent to the Himalayan region. Over time, NSC has developed innovative strategies and tools to facilitate knowledge sharing between North America, South Asia, and other regions. One notable example is the "problem-based learning" courses discussed in this paper, which the Economics Department at UNM offers regularly.

[3] This course can be taken for graduate credit too, which is why there is an asterisk (*) in the course number.

[4] We use the terms "problem-based learning" and "experiential learning" interchangeably throughout the paper. Both terms capture the approach to teaching the Econ 369*, Econ 395, and Econ 451 courses.

as a holistic process that aids in the creation of knowledge through the transformation of experiences (Kolb and Kolb 2009).

The ELT model posits that effective learning occurs in four phases, namely "concrete experience" (CE), "reflective observation" (RO), "abstract conceptualization" (AC), and "active experimentation" (AE). These phases are illustrated in Figure 1, where the vertical axis depict the knowledge grasping dimension, showing that knowledge can be acquired through apprehension (CE), comprehension (AC), or a combination of both. The horizontal axis represents the knowledge construction or transformation process, which can be achieved through intention (RO) or extension (AE). Kolb emphasized that all four modes of experiencing, reflecting, thinking, and acting are equally important in facilitating the learning process. The course structure of Econ 369* was modeled under the ELT framework and comprised four main components: (1) field-based data collection and problem identification, (2) data analysis and development of potential intervention problems, (3) study abroad and implementation in the field, and

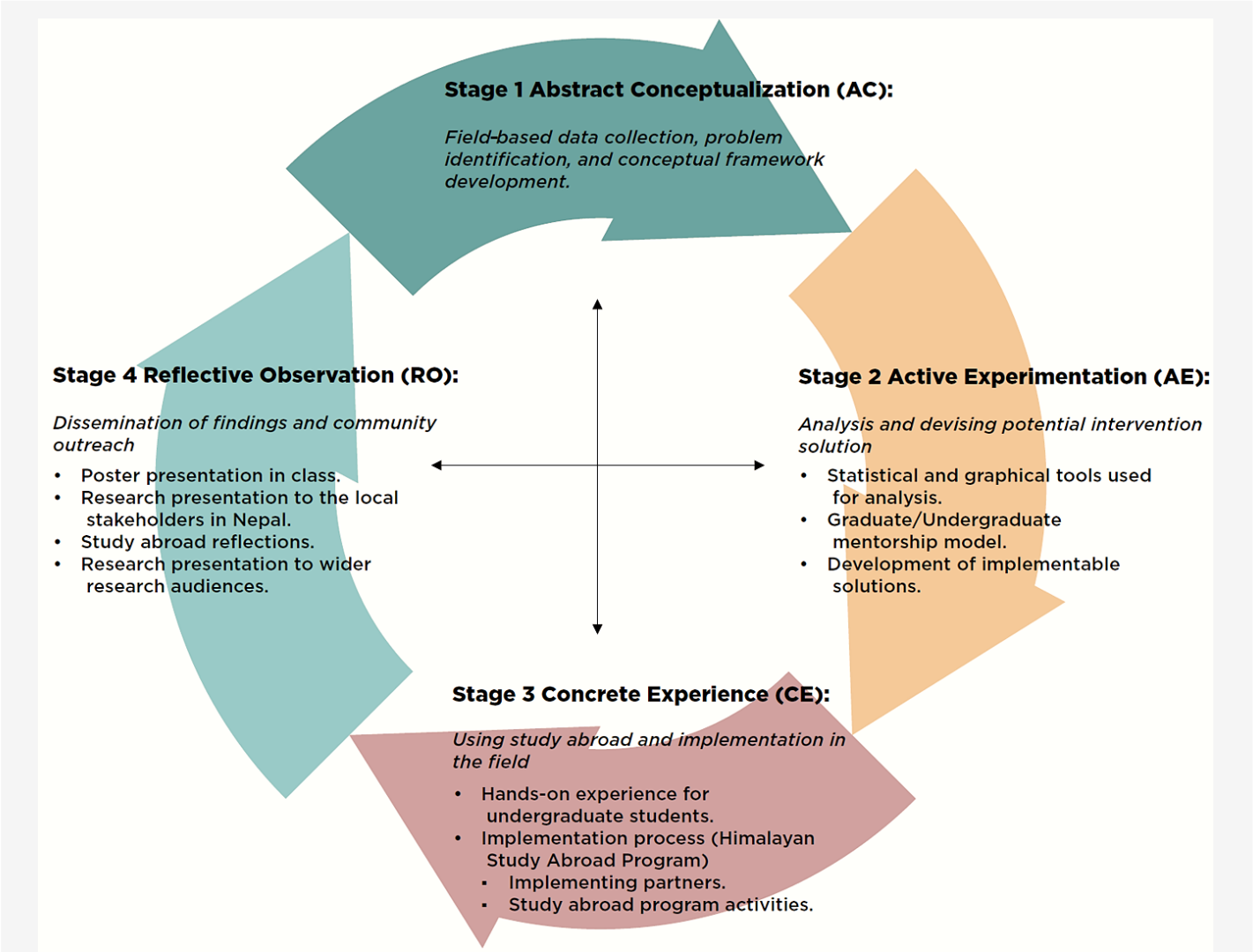

Figure 1: The Four Stages of Learning Construction (CE, RO, AC, AE) in Kolb's Experiential Learning Model Knowledge grasping occurs during the CE and AC phase, while RO and AE represent the knowledge transformation dimension. This figure also illustrates how these four elements of ELT align with the course structure of Econ 369*.

(4) dissemination of findings and community outreach. Figure 1 also displays the structure of the Econ 369* course by mapping it to the ELT framework.

The learning process, according to the ELT model, requires that students first grasp knowledge, either through AC and/or CE, after which a phase of construction, via AE and/or RO, is necessary to complete the learning process (Kolb 2014). The construction allows the grasped knowledge to be transformed into a mental model through the experience of this knowledge. The principles of ELT have been adopted in many courses across various institutions around the world, and the results on the outcome of student learning are largely positive (Healey and Jenkins 2000; Ahn 2008; Abdulwahed and Nagy 2009; Rajasulochana and Ganesh 2019). Supporters of experiential learning believe that it promotes greater interest in the subject material, enhances intrinsic learning satisfaction, increases understanding and retention of course material, develops the desire and ability to be continuous learners, and improves communication, interpersonal, problem solving, analytical thinking, and critical thinking skills in the students (Brickner and Etter 2008).

3 Detailed Course Description

The experiential learning courses were designed to provide undergraduate students with an opportunity to develop, analyze, and execute original research projects on environmental and health issues, and to implement their solutions in the field. These courses, which included Econ 369* and the earlier trial courses (Econ 395 and Econ 451), enrolled 15–18 undergraduate students on a first-come, first-served basis. To encourage students from diverse academic backgrounds to collaborate and develop research ideas, the course did not require an economics prerequisite for enrollment. This allowed for multidisciplinary teams to be created that could leverage each student's skills and expertise to develop executable plans. Students were, however, required to have completed an introductory statistics course for enrollment in the course.

The experiential learning course was first offered as a pilot course in the Fall of 2016. This course, Econ 451, was offered to undergraduate students with a theme of "*moving from classroom to action research.*" This pilot course aimed to create a classroom-based research learning environment where students, graduate mentors, and faculty could collaborate on research projects that could be implemented, monitored, and evaluated. In Fall 2017, Econ 395 was offered as another trial course following the same structure as Econ 451, but with a few extensions. One extension was the inclusion of the Himalayan study abroad program during Winter 2017–2018, which offered interested students an opportunity to take their classroom ideas to the field by engaging in interdisciplinary research in Nepal. Econ 451 and 395 were eventually combined to form a permanent course known as "Problem-Based Learning Using Data Analytics" (Econ 369*), which has been offered since 2018.

Nepal was selected as the location of the study abroad program in these courses. This is partly due to NSC's field connections with the country, which provided a natural platform to teach a field-based course on water issues in a developing country context. Nepal is also an ideal case study for water-based courses due to its unique geography and topography. This small country boasts around 6,000 rivers, including rivulets and tributaries, as part of the Indo-Gangetic plain. The Ganges Basin, one of the world's most populated river basins, is heavily reliant on Nepal's rivers, which contribute around 70 percent of the dry season flow and 45 percent of the annual flow in the Ganga River (Upreti and Acharya 2017), making Nepal a unique and effective location for research and education on water-related issues.

During the first three occurrence of these courses (Fall 2016, Fall 2017, and Fall 2018), students learned about environmental and health issues stemming from the Danda River, which falls in the Western region of Nepal. The river flows from the Northern Mountains near Tibet, passes through urban and agricultural districts, and finally crosses the Indian border to join the Ganges River. One of the major concerns with the Danda River stems from unplanned urbanization around the town of Siddharthanagar, which has transformed the once-pristine river into a sewage drainage. The unfortunate result of such

urbanization has been the degradation of the river ecosystem, making it unsuitable for irrigation, spiritual rituals, and recreational activities, which were once the primary benefits derived by the community (Kunwar, Bohara, and Thacher 2020).

The experiential learning courses employed several innovative pedagogical approaches for imparting students with adequate knowledge of critical water-related issues. First, there was an effort to incorporate an interdisciplinary approach to learning, which started from the student background itself. The students enrolled in these courses came from diverse backgrounds in social sciences, natural sciences, and humanities, and brought different perspectives to water-related issues in the classroom. The class also provided opportunities for students to hear and learn from guest lectures affiliated with the Bosque Ecosystem Monitoring Program (BEMP), the Water Resources Program at UNM, the UNM Global Educational Office (GEO), and the doctoral students in the economics program.

Second, the course incorporated a graduate–undergraduate mentorship model, where graduate students served as research mentors to undergraduate students. Under the guidance of graduate students, the undergraduate students developed water-related research projects and identified several interventions, policy tools, and solutions. Third, the Fall semester course offered in the classroom was followed by a three-week winter session study abroad program in Nepal where students implemented some of the solutions they identified, such as collecting water quality data and setting up awareness kiosks. During the study abroad program, students also got the opportunity to interact with local stakeholders in Nepal, including government officials, local students, and the larger community.

The general structure of the experiential learning courses comprised four major components: (1) field-based data collection, problem identification, and conceptual framework development, (2) data analysis and development of potential intervention and solutions, (3) study abroad program and implementation in the field, and (4) dissemination of findings and community outreach, which we discuss as they related to our course development in the following.

3.1 Field Based Data Collection, Problem Identification, and Conceptual Framework Development

The courses were designed using a holistic approach that drew inspiration from real-world problems. The course curriculums had a central focus on the topic of water and aimed to examine the feedback and linkages between water resources and the built environment. This included exploring the impact of households' knowledge, attitude, perceptions, and behaviors on water bodies; understanding the relationships between water-handling behaviors and human health; and assessing the effects of built environment and water resources on various household outcomes. The flowchart presented in Appendix A, Figure A1 provides a comprehensive view of the key factors involved in the conceptual design of the course. Once students gained an understanding of the potential connections between water bodies, environment, human behaviors, and health, they were expected to formulate research questions and hypotheses, which they would then test empirically using primary data.

To aid students in their understanding of real-world problems and to develop potential solutions, the problem-based learning courses focused on providing exposure to actual data from the beginning. The data sets utilized by students in the course were based on actual data collected by UNM economics doctoral students for their dissertation research. NSC has collaborated with PhD students at UNM and local institutional partners in Nepal to design and conduct several primary surveys, including three surveys on water-related issues.[5] These surveys included studies on the management of Bagmati and

[5] In addition to supporting studies on water-related issues, the NSC has also facilitated primary surveys for PhD students at UNM in a range of other areas, including cancer and HPV vaccine-related issues, climate change and natural disasters, solid waste management, and air pollution. The experiential learning classes offered at UNM were made possible in part by NSC's field connection of NSC to the Himalayan region and its capacity for doctoral research. Under the guidance of Professor Alok Bohara (Director of NSC), several economics PhD students at UNM have worked as a NSC research team to design and carry

Danda Rivers in Nepal and the health impacts of groundwater arsenic in the Rupandehi and Nawalparasi districts of Nepal (Katuwal 2012 Kunwar, Bohara, and Thacher 2020). These data collected from the graduate research survey have been extensively used in the problem-based learning courses to enhance real-world data-based learning.

Some examples of research questions that students identified by analyzing the survey data in the course included: How do public awareness initiatives affect the adoption of water filtration measures? What is the impact of environmental knowledge and attitudes on households' behaviors and beliefs regarding the Danda River? How does arsenic contamination in groundwater impact health outcomes among the females? What roles do education and income play in determining preferences (and valuation) for the Danda River ecosystem? And, whether households consider contribution of their time and money as substitutes in their preference for conservation of the river ecosystem. This phase of the course is akin to the AC stage of the ELT.

3.2 Data Analysis and Development of Potential Intervention and Solutions

One area of emphasis in the problem-based learning courses was to develop students' statistical knowledge, and train them on analysis and interpretation of survey data using the Stata software. The learning objectives of the course were organized into several data analytical modules. Some examples of the topics covered in the class include water quality index calculations; public health consequences of poor water quality; and households' knowledge, attitude, and behavior toward drinking water and the Danda River. The data analytical modules started with coverage of basic statistical concepts such as mean, median, *T*-test, and Chi-squared test using variables from the survey data set. For instance, to understand the test of association, students examined the connection between households' distance to the Danda River, water treatment and sanitary behaviors, and the prevalence of waterborne diseases like diarrhea.

As the course progressed, students were introduced to several regression models including ordinary least squares (OLS), logit, probit, negative binomial, and two-stage least squares, which were then utilized using information from the data. As an example, a linear regression and a logit model were employed to investigate the impact of education level on the willingness to pay for Danda River restoration while controlling for confounders such as household wealth and other socioeconomic characteristics. Another area of emphasis in these courses was on the development of a graduate–undergraduate mentorship model. To implement this model, students were divided into small groups of 3–4 undergraduate students, with a graduate student assigned as a mentor to each group. As mentors, the graduate students worked closely with their groups, assisting them in selecting research topics, finding relevant peer-reviewed studies, identifying key variables from the data set related to their topics, and analyzing the data. This mentorship model played a key role in the undergraduates being able to develop interventions, policy tools, and solutions, which would be implemented in the field.

The graduate–undergraduate mentorship model proved to be a mutually beneficial learning opportunity. Graduate students acquired valuable skills in mentoring and working with undergraduate students. Additionally, they learned how to work closely with students from diverse backgrounds and majors, which provided a uniquely enriching experience, since economics graduate students typically only work with undergraduates who are economics majors or minors. Meanwhile, the undergraduate students gained experience in collaborating with peers from different disciplines. Further, they got the

out primary surveys on water-related issues. These data sets were utilized in the problem-based learning courses. For example, Hari Katuwal (2012) conducted a primary survey in Kathmandu, Nepal, to understand the attitude and beliefs toward the Bagmati River; Samrat Kunwar (2019) looked at public preferences for river ecosystem in the Danda River Basin, Bhairahawa; and Mashiur Rahman worked on water and waste management issues in Siddharthanagar, Nepal (Rahman, Bohara, and Vazquez 2021). The undergraduate students enrolled in Econ 369*, Econ 395, and Econ 451 were able to work with actual data collected by graduate students for their dissertations.

opportunity to work closely with graduate students and received insights into how research is conducted and presented at the graduate level. These experiences are likely to be helpful in their future careers, particularly when working alongside peers with diverse backgrounds and skills.

An important element of these courses was also the focus of the development of implementable solutions that students were required to come up with based on their research findings. One such solution was regular monitoring of water quality in the Danda River to track the spatiotemporal changes in water quality. An innovative aspect of this solution was the development of a citizen science protocol to monitor water quality, where our students developed the curriculums and protocols for water quality monitoring in the classroom, and trained students from local schools in Nepal during the study abroad program. The citizen science approach-based water quality monitoring project was later implemented in the field during the Himalayan study abroad program in 2017. Another solution presented was increasing community awareness about water treatment and sanitation through seminars and setting up awareness kiosks, which was proposed based on the students' finding that educational attainment positively correlated with improved sanitation practices and higher willingness to pay for river restoration in the Danda River Basin. These aspects of the course, which included data analysis, discussion and presentations of policy-relevant papers, group collaboration, graduate–undergraduate mentorship, and development of intervention programs, collectively represent the AE stage of learning within the ELT framework.

3.3 Study Abroad Program and Implementation in the Field: Translation of Research into Action

The opportunities afforded to students by these programs to analyze field data, to collaborate on devising interventions and solutions, and to have graduate students as mentors are all effective ways to learn and be introduced to the real-world problems. Nevertheless, this approach can be further enhanced by providing students with a hands-on experience to implement their classroom learnings by visiting the field and interacting with the local community. This concept aligns with the philosophy of experiential learning, which recognizes the importance of experience in the learning process (Kolb 2014). We present in the following the implementation process of the Himalayan study abroad program, which provided a platform for students to translate their research ideas into action. This phase of the course exemplifies the CE phase of the ELT framework.

3.3.1. Study Abroad Program Preparation

The study abroad sessions took place immediately following the end of the fall semesters. During the winter break, students who participated in the Himalayan study abroad program had the opportunity to put their classroom learnings into practice by engaging in a series of hands-on activities in the field. Students embarked on a three-week international research-focused trip[6] to Nepal, which was led by the main instructor and the program's graduate student coordinators. Prior to departing,[7] students worked with the Global Education Office (GEO) at UNM to ensure they completed the necessary requirements. Among other items, this included a detailed preparation guide to inform students of the predeparture expectations and provide them with helpful information on Nepal. Once in Nepal, students participated in various orientation sessions, including a session on understanding Nepalese culture. The study abroad program was carried out with the assistance of a host institution in Nepal, the Lumbini Center for Sustainability (LCS), situated at the Pratiman-Neema Memorial Foundation (PNMF) in Siddharthanagar, Nepal.

[6] Links to the study abroad program flier and the syllabus is presented in Appendix D.

[7] The budget allotted per student was approximately $2,000. Financial assistance of around $10,000 was provided by the UNM administration, which was distributed among the students at a rate of approximately $500 per student. The cost of the travel was borne by the students themselves.

3.3.2 Study Abroad Program Activities

The first phase of the three-week study abroad program was spent in the urban town of Siddharthanagar, Nepal, where UNM students collaborated with local researchers and Nepalese students at the host institution to implement the solutions developed during the semester. Some examples of this included collecting data in the field, installing environmental monitoring equipment, and engaging with community members and local policy makers. Since the first Himalayan study abroad program that took place in 2017, UNM students have worked together with institutional collaborators and eco-club members of local colleges and schools in Nepal to establish ongoing monitoring programs across five primary areas: water quality, air quality, climate, waste management, and biodiversity. During the first study abroad program, UNM students created a citizen science[8] initiative called the "Danda Ecological Monitoring Program" (DEMP), which monitors river water quality and various climate parameters. The DEMP citizen science initiative was modeled after a successful program run by the Bosque School of Albuquerque known as BEMP. Prior to departure for Nepal, students visited BEMP sites to receive guidance and to refine their DEMP protocol.

As part of the DEMP initiative, UNM students trained Nepalese students from local high schools to monitor water quality levels. Together, they collected water samples and placed a pressure transducer along the Danda River to analyze water quality and river flow dynamics. Additionally, they installed a device (The Geotech) to measure groundwater depth to track changes in groundwater level over time. A log of the groundwater level data is provided as an example in Appendix B. Figure C1, in Appendix C, shows example images of some monitoring devices used by students to carry out various tests.

Following a week in Siddharthanagar, students embarked on an ecological and cultural tour of rural villages in the Himalayas. This provided them with a firsthand knowledge of the challenges of sustainable development in a developing country, as well as exposure to grassroots community activities. During the tour, students gained insight into a range of issues faced by these communities, including watershed management, biodiversity, and health and sanitation concerns. Figure 2 shows a map of the route for the study abroad research experience tour.

3.4 Dissemination of Findings and Community Outreach

The fourth segment of the course comprised community outreach programs, research dissemination, and a personal reflection piece for each student, all of which are integral components of the RO phase of the ELT. To date, students have disseminated their research through three major platforms: research presentations to their classmates and to wider research audiences, research presentations to local stakeholders in Nepal, and study abroad reflections.

Before embarking on the study abroad component of the course in Nepal, students were required to complete a group-based research project, to develop implementable solutions based on their research findings, and to prepare a poster presentation as part of their final project for the in-class portion of the course. An example of this was a poster presentation by a student group that examines the linkages between the presence of E. coli in water, sanitation behavior, and the risk of contracting diarrhea. These poster presentations were meant to give students the opportunity to showcase their research and

[8] Citizen science involves the public in the collection of large quantities of data across various habitats and locations over an extended period of time.

Figure 2: Map of the Study Abroad Route (Source: Himalayan Study Abroad Program, NSC, UNM, Winter 2017–2018)

receive feedback from their peers, graduate mentors, and the instructor. Additionally, students from these courses were able to participate in various conferences and exhibitions to share their work with wider research audience[9] once they returned from their study abroad trip. This included research presentations by the students in meetings such as the Undergraduate Research Opportunities Conference at UNM, the STEM bridge undergraduate session at the Southwestern Society of Economists, and an undergraduate panel at the Annual Himalayan Policy Research Conference. Overall, these group-based research projects and presentations provided students with valuable opportunities to develop teamwork skills, receive feedback on their work, and present their research to a broader audience.

The research posters that students developed in the classroom were also presented to Nepalese policy makers and distinguished guests, including the mayor of Siddharthanagar municipality and the U.S. ambassador to Nepal, and were displayed in the LCS lab in Nepal. During the study abroad program, students used the findings from their research to engage with the community and raise awareness on water-related issues. Examples of these included informing community members about the presence and implications of E. coli contamination in drinking water and highlighting the importance of sanitation and hygiene practices. Students also engaged in a citizen science initiative that was aimed at tracking the quality of the Danda River.

As part of the citizen science initiative, local students were taught to collect water samples and carry out tests on ten different indicators of water quality, including nitrates, ammonia, turbidity, and phosphates. The resulting scientific data on the river water quality indicators were then sent to NSC, which have been used for various purposes, including student research projects, development of new experiential learning courses, and assisting in policy interventions and awareness-raising efforts in Nepal. Figure C2, in Appendix C, shows a picture of UNM students collecting water samples from the Danda River during the citizen science initiative. Figure C3, in Appendix C, presents one example of a

[9] Two master's students from UNM's College of Fine Arts also presented their environmental art project, which included a floating wetlands model that used natural vegetation to purify river water, to the communities in Albuquerque during a one-month exhibition at the Maxwell Museum of Anthropology.

Danda River conservation plan that was proposed by the students to the Mayor of Siddharthanagar and his environmental assessment team.

The 2017 cohort of the Himalayan study abroad program shared their experiences through an online blog that is publicly available (see Appendix B). The blog provides a detailed account on the day-to-day activities performed by students in the field, along with pictures and short reflections. In addition to the daily updates, students who embarked on the study abroad trip were required to write a 3- to 5-page reflection paper on a water-related issue they witnessed and experienced in Nepal. Specifically, the students were asked to identify and critically assess a problem that they encountered and offer solutions based on their research or best practices discussed in other studies. The reflection essay was an integral part of the final grade of the program.

4 Broader Impacts

The broader impacts of the Econ 369* and earlier trial courses can be categorized into four major fronts: (1) the learning experience for the students, (2) the impact on the community, (3) the research experience gained by the students, and (4) the potential for this program to serve as a model for other institutions.

4.1. Student Learning Experience

The biggest outcome of the experiential learning courses was the learning experience it provided to the students. These courses were developed with the aim of delivering a comprehensive learning environment to aid in developing students' essential research skills while allowing them to put their ideas into practice in a real-world setting. The courses used a combination of classroom-based learning, field experience, and international research to give students a unique hands-on learning experience.

The learning process followed Kolb's ELT, which involved moving from AC to AE, to CE, culminating in RO. During the semester, students worked on completing different modules developed from real-world data previously collected in Siddharthanagar, Nepal. Students were introduced to various econometric methods and were equipped with the skills to analyze and evaluate data and empirical relationships using Stata software. Students also worked in groups to read, discuss, and present relevant literature on different environmental issues found in the data set. The exposure to real-world data, application of different econometric approaches, and discussion and presentations of policy-relevant papers helped empower students to make informed decisions about their research questions and develop solutions that were implemented in the field.

The learning process continued to the field where students had the opportunity to put their ideas into action during the three-week research-focused study abroad trip to Nepal. Students played an active role in increasing awareness and promoting actions on critical water-related issues by engaging with the community and sharing their knowledge with local students in Nepal. Throughout this entire process of the experiential learning course, students also gained valuable life skills in areas such as problem solving, critical thinking, communication, and collaboration, which likely enhanced their academic experience and prepared them for their future careers. Overall, these courses provided a holistic learning experience that began in a classroom setting and concluded in the field.

4.2 Community Impacts

There was a tangible impact on the local community in Nepal, one which made the results of policy work, research, and community outreach visible to students, and validated their research and the class methodology. Students who took the course between 2016 and 2018 were able to create and share their findings with the local community in Nepal. For instance, one group of students created and installed a three-dimensional floating wetland model in the LCS lab to demonstrate the functioning of wetlands in the Danda River ecosystem. Another group created an interactive citizen science curriculum and toolkit to monitor river water quality, and subsequently, trained local high school students to monitor river

water quality and to share the data with NSC. Students also collaborated with local eco-clubs in Nepal to create instructional manuals and educational programs aimed at educating the community on hygiene and sanitation behaviors. The actions students took in terms of community-based education, showcasing environmental artworks and the citizen science initiative, raised awareness among locals about their health and encouraged them to appreciate their local water bodies. Moreover, the scientific data that were generated from the citizen science project were used for ongoing research projects, as well as guiding local policy interventions and awareness.

4.3 Research Experience

The experiential learning courses created an environment that was conducive for undergraduate students to learn about the process of conducting research from start to finish. Students who were enrolled in the course were required to complete an original group-based research project and present their findings to their peers and the local UNM community. Some students from the course also presented their papers to wider audiences, ranging from showcasing their projects to the Albuquerque community to presenting their findings in academic conferences at UNM and beyond. In addition, students who participated in the winter session study abroad programs were encouraged to share their work with the local stakeholders. These students shared their findings to the local community, government representatives, and international delegates in Nepal. Many students who completed these courses also gained personal benefits in terms of graduation, publications, and acceptance to prestigious graduate schools around the country.

4.4 Model Program That Can Be Emulated by Other Institutions

These experiential learning courses emphasize holistic learning, and the program developed at UNM is highly adaptable in terms of investigating water issues within the United States or in different regions of the world. These courses have become increasingly popular in both economics and noneconomics disciplines at UNM. Table 1 displays the number of students that have taken these courses by their major. Table 2 provides metrics on the overall outcome of the experiential learning courses between 2016 and 2018.

As shown in Table 1, students enrolled in these courses tended to major in various fields, including international studies, biochemistry, mathematics, political science, biology, engineering, statistics, business administration, and water resources, to name a few. There was a total of 19 majors represented among the students who took these courses, with economics major representing only half of the total enrolled students. Table 2 provides additional metrics that quantitatively examine the overall impact of the problem-based learning courses. Five students from the course continued to work on their research projects and were able to convert their projects to their undergraduate and master's theses. In addition to the theses, one student from the course was able to publish their paper in a peer-reviewed journal, while other students were able to complete two working papers. Similarly, several students attended national-level research conferences to present their research findings. The total number of students enrolled in the course between 2016 and 2018 was 88, of which 18 students participated in the Himalayan study abroad[10] program in Nepal. The success of these courses is more evident when we consider the metrics from Table 2 with other conventional economics courses offered at UNM. For example, in upper-level courses[11] such as Eco 343 (Environmental Economics) or Eco 409 (Econometrics) at UNM, it is rare for students to convert their class papers to honors theses, present their papers at conferences, or to publish peer-reviewed articles.

[10] The study abroad component of the course has not been offered since 2019 due to COVID-19 concerns.
[11] We chose Eco 343 and Eco 409 as example courses since both courses are taught by the co-authors of this paper.

Table 1: Number of Students in Problem-Based Learning Courses by Major

Major	Frequency
Anthropology	1
Biochemistry	3
Biology	3
Business Administration	1
Economics	46
Health, Medicine, and Human Values	1
International Studies	4
Mathematics	4
Nondegree	3
Political Science	2
Pre-Business Administration	3
Pre-Civil Engineering	1
Pre-Computer Science	1
Pre-Economics	4
Pre-Population Health	1
Psychology	1
Sociology	3
Statistics	1
Water Resources	4
Total	88

Table 2: Metrics Used to Quantitatively Examine the Overall Impact of the Problem-Based Learning Courses

Metrics	Number/Facts
Number of honors and master's theses	5 (3 undergraduate and 2 master's)
Number of peer-reviewed research papers	3 (1 published and 2 working papers)
Number of students that attended and presented in research conferences	14 students
Total students enrolled in these courses	88 (Econ 369–37, Econ 395/595–34, Econ 451–17)
Total students that went to the Himalayan study abroad program in Nepal	18 students

An interesting feature of the experiential learning course is that it was designed with flexibility in mind and can be extended to cover other water-related issues, such as drought, flooding, extreme climate events, urban water crisis, waterborne diseases, and their mitigation strategies. Moreover, the study abroad sequence of the course can be expanded to include investigations in the United States or other parts of the world. Although Nepal was selected as the study abroad site for the courses discussed in this article, a similar outcome could have been achieved locally, thereby avoiding the high cost associated with study abroad programs. The main objective of the course was to provide students with

hands-on learning experience to supplement the theoretical knowledge gained in a classroom environment. The study abroad component was not the primary focus but rather a means of enabling students to immerse themselves in a different cultural and environmental context to learn about water-related challenges and solutions.

The UNM economics department now regularly offers the Econ 369* course, which is a result of two years of trial runs with the Econ 395 and Econ 451 courses, providing a valuable collection of data and relevant pedagogical materials. Appendix B includes some of the curricula, syllabus, and modules used in the course. More information is available on the NSC website, and other materials are available upon request to any interested institutions.

5 Challenges, Opportunities, and Way Forward

Study abroad programs, while highly beneficial and popular, will require careful effort to design and execute. It is even more difficult to design study abroad programs that incorporate experiential learning aspects like the courses discussed in this paper. Their successful completion requires lengthy planning and competent support teams both in the United State and in the host country. One major hurdle we faced was maintaining regular communication with local institutional collaborators in Nepal to coordinate program details. This required scheduling virtual meetings and phone calls outside of normal working hours. The study abroad coordinating team conducted multiple orientation sessions to brief the participating students on program objectives, logistics, and expectations. In addition, the team had to ensure that the environmental monitoring equipment functioned properly in the field before leaving for Nepal, which required significant research and trial testing.

Another set of challenges that we faced was coordinating with the UNM GEO to ensure that the program requirements and expectations for the study abroad programs were met, such as vaccination, travel orientation, and course learning objectives. Many students had limited knowledge about preparing for international travel, particularly to South Asia, and encountered cultural and language barriers in Nepal. It is important to ensure that study abroad programs like the ones discussed in this article are sustainable and allow for maximum participation. However, sustaining such a program is challenging due to various factors including innovation, scalability, finances, and support from the university. These challenges were further exacerbated by the COVID-19 pandemic, which made travel more difficult, expensive, and unpredictable.

Going forward, several steps can be taken to sustain the program and enhance its features. First, to provide an interdisciplinary perspective, instructors from multiple disciplines could co-teach the class. Additionally, to create a more immersive learning experience on community- focused projects, a “semester abroad program” could be developed, where students could go to Nepal (or a different location) to work on their projects in collaboration with local partners. The first half of the semester would be taught in the United States, and the second half would be taught by local faculties in Nepal. Another option could be to organize a summer camp to train students and faculties on water-related topics. The courses discussed in this article were developed and executed with the help of graduate students who served as volunteers. However, moving forward, arrangements to provide graduate students with credit as co-instructors or co-organizer can help make similar programs more successful and sustainable.

To ensure the longevity of the program, it is also crucial to secure grants that can cover the high costs. These funds can be utilized for various purposes, such as providing stipends to graduate students and coordinators, purchasing scientific equipment, and subsidizing travel expenses. To make such programs more inclusive, targeting minority students who may have limited opportunities to participate in study abroad programs due to financial constraints should also be considered.

The NSC facilitated UNM in signing a Memorandum of Understanding (MOU) with the Himalayan University Consortium (HUC) of the International Center for Integrated Mountain Development

(ICIMOD). ICIMOD is an international nongovernmental organization based in Nepal that coordinates and conducts research in the Hindukush region spanning eight countries. Through HUC's consortium of over sixty universities, NSC has been able to connect with the Himalayan community, enabling U.S.-based students to gain a broader understanding of the region. Participating students are made aware of specific water-related issues in the climate change-prone Himalayan belt, such as water resiliency along the Tibet/China/Nepal border. There is also the possibility of organizing multiuniversity study abroad programs to enhance the students' learning experiences.

Finally, it should be noted that while the experiential learning courses in this paper were focused on Nepal for the study abroad component, similar environmental issues are a concern for many communities within the United States. There are many water-related issues in different U.S. states that students could investigate and visit as part of their field trip, which would provide similar learning opportunities. For instance, communities in Flint, Michigan, have been struggling with lead contamination in their water supply for years (Hanna-Attisha et al. 2016). The Navajo Nation in Arizona and New Mexico has been dealing with the aftermath of abandoned uranium mines, which has led to contaminated drinking water (Rock and Ingram 2020). Likewise, sea-level rise could severely impact freshwater resources in Florida (Williams et al. 1999).

There are opportunities to further explore aspects of environmental justice issues as well. For instance, there is potential to investigate the impact of drought on water availability and quality from an environmental justice perspective in areas like California and Colorado (Abboud et al. 2022; Simpson et al. 2023). Agricultural production in California's Central Valley is heavily reliant on the water from aquifers, which has caused the land to sink and contaminated the drinking water sources (Pannu 2012; Nelson and Burchfield 2017). The burden could disproportionately affect low-income communities of color, who are more likely to live near contaminated sites and have limited access to clean drinking water (Lee 2002). To summarize, while the study abroad program in Nepal provides a valuable opportunity for students to learn about water-related issues in a developing country context, similar environmental challenges can also be found closer to home. By conducting field trips locally, students will gain a deeper understanding of the environmental issues faced by communities in the United States and learn about the actions being taken to address them.

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Appendix A: Conceptual Framework

The following flow chart illustrates the connection between human behaviors, environment, health, and wealth. Additionally, the chart also shows how built environment, attitude, and education components could relate to the topics. This is an example of the conceptual framework development for the problem-based learning courses

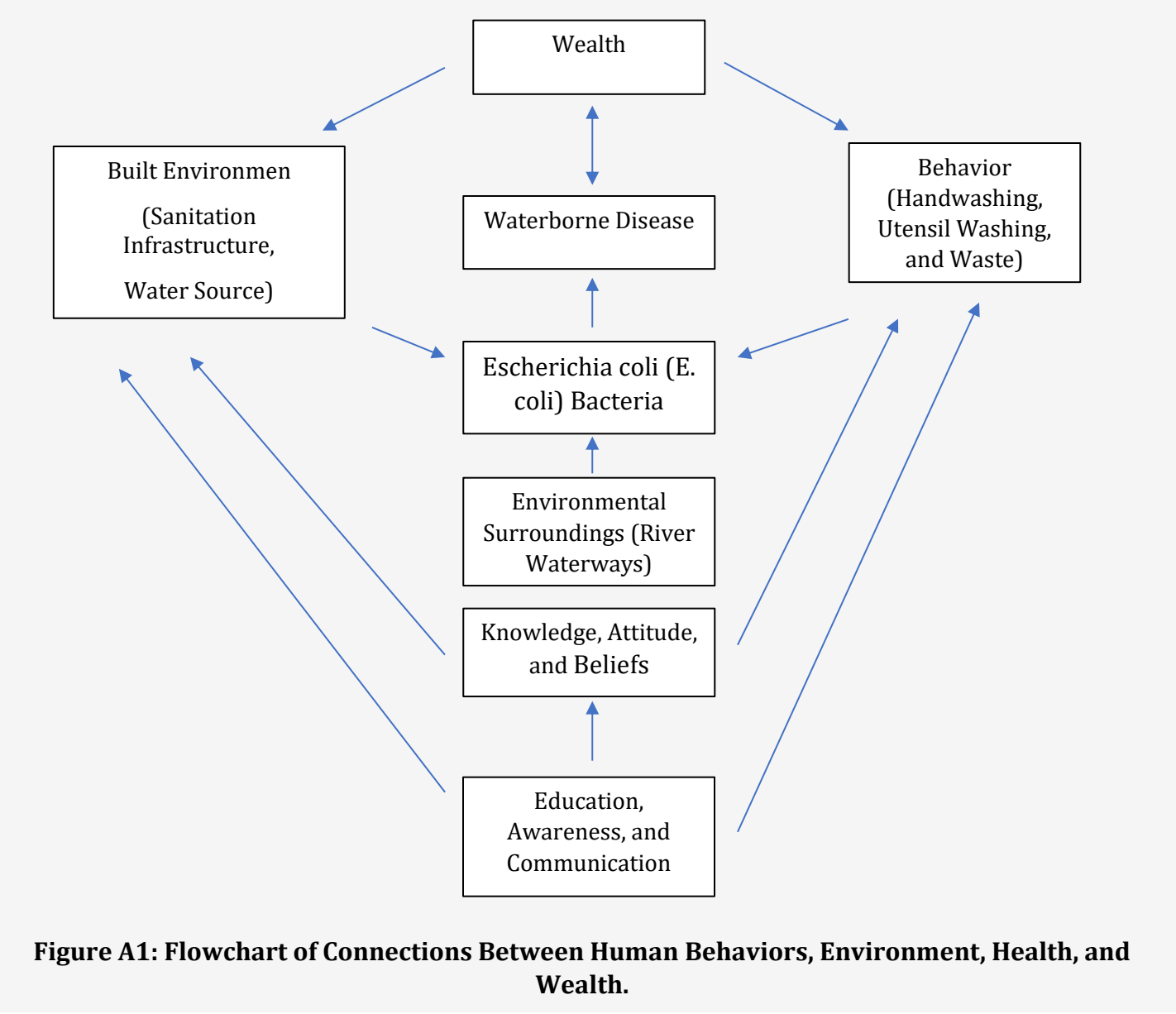


Figure A1: Flowchart of Connections Between Human Behaviors, Environment, Health, and Wealth.

Appendix B: Course Materials and Outputs

1. Nepal Study Center and other local collaborating partners
    - http://nepalstudycenter.unm.edu/index.htm
    - https://pnfoundation.org.np

2. Thesis and undergraduate/graduate research
    - http://nepalstudycenter.unm.edu/SustainableResearchLab/WRP_Corinne%20Fox_July2018.pdf
    - https://www.tandfonline.com/doi/abs/10.1080/21606544.2021.1903560
    - https://digitalrepository.unm.edu/econ_etds/103/

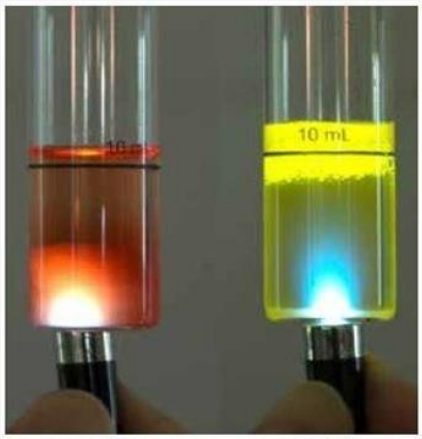
3. Econ 369 course materials
    - Course flyer http://nepalstudycenter.unm.edu/SustainableResearchLab/Econ%20395_595%20Fall%202019Flyer.pdf
    - Course syllabus http://nepalstudycenter.unm.edu/SustainableResearchLab/Econ%20369%20Syllabus_Fall2018Ver10PDF.pdf
    - Sustainable Development Action Lab, NSC overall page http://nepalstudycenter.unm.edu/SustainableResearchLab/UndergraduaterResearchInitiatives.html

4. Himalayan study abroad program materials
    - Program flyer http://nepalstudycenter.unm.edu/SustainableResearchLab/Himalayan%20Study%20Abroad%20FlyerVer6bPDF.pdf
    - Program syllabus http://nepalstudycenter.unm.edu/SustainableResearchLab/HimalayanStudyAbroadSyllabusOutline2018V4PDF.pdf
    - Himalayan Study Abroad Program Online Blog (created by student Corrine Fox) https://foxc01.wixsite.com/yogdan/projects?pgid=jbn3ux4b-cd4f5313-5c55-4428-b92e-9005d7ba6890

5. DEMP website and data collection
    https://pnfoundation.org.np/home

6. Groundwater log
    http://nepalstudycenter.unm.edu/SustainableResearchLab/Groundwater%20Level%20Log.pdf

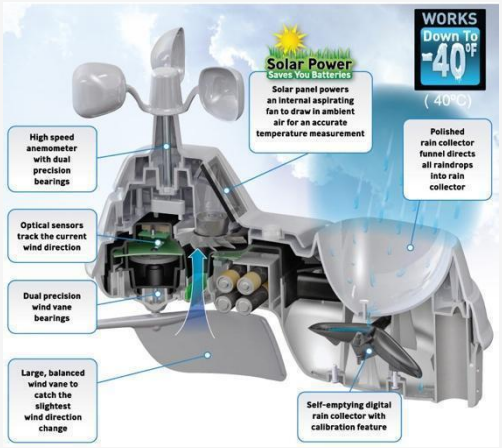
Appendix C: Monitoring Equipment, Citizen Science Initiative, and River Conservation Plan



E. coli bacteria testing procedure

LaMotte water testing kits

Solinist Levelogger



AcuRite 5-in-1 Weather Sensor

Figure C1: Water Testing Kits and Monitoring Devices

Figure C2: UNM Students Collecting Water Samples from Danda River, Nepal

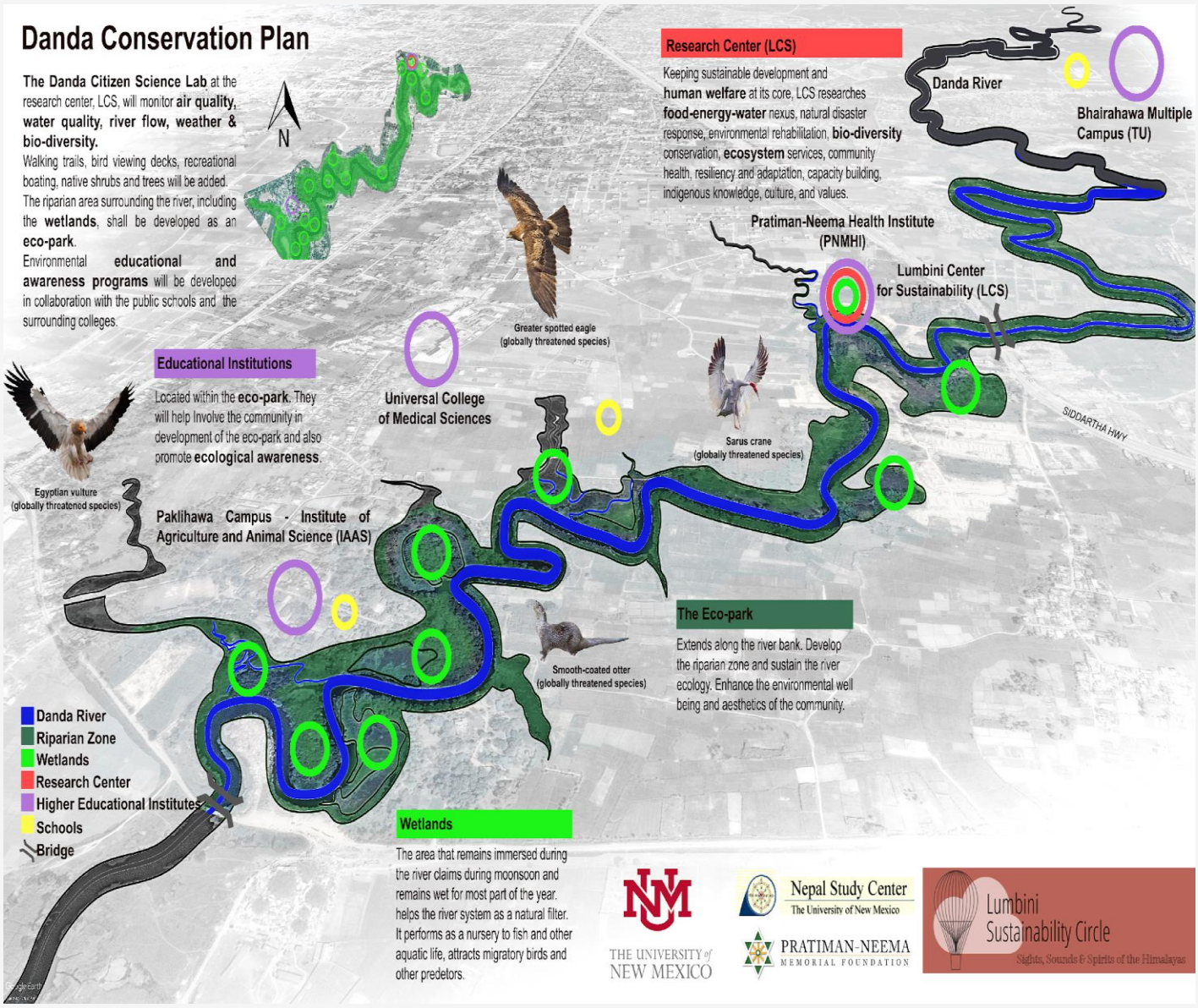


Figure C3: Danda River Conservation Plan (Source: Himalayan Study Abroad Program, NSC, UNM, Winter 2018–2019)

Appendix D: Links for Course Syllabi

Link to Course Syllabus – Econ 369*
(http://nepalstudycenter.unm.edu/SustainableResearchLab/Econ%20369%20Syllabus_Fall2018Ver10PDF.pdf)

Link to Study Abroad Program Syllabus
http://nepalstudycenter.unm.edu/SustainableResearchLab/HimalayanStudyAbroadSyllabusOutline2018V4PDF.pdf)

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