9 ENVIRONMENTAL SCIENCE AND POLICY PROGRAM

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9.1 INTRODUCTION

The 2013 Chapman University Environmental Audit gives a broad overview of curriculum at Chapman University. This was the project of the first catalog class of graduating seniors in the new Environmental Science and Policy (ES&P) major. In *A Call to Action*, a paper by the Association for the Advancement of Sustainability in Higher Education, researchers, scholars, and activists note that "colleges and universities can serve as test sites and models for sustainable practices and societies. Where colleges and universities may have the largest impact, however, is with the students they educate" (2013). Chapman University has taken on this idea by supporting the ES&P program since 2009, with a curriculum that creates "scientists who can communicate with policy makers and future policy makers who understand science" (Chapman University). This is a step in the right direction to educate students about sustainable practices and policies, however it applies to a very small subset of students on campus. Environmental Science and Policy students' engagement and involvement on campus can amplify these educational opportunities by adding perspectives and knowledge to programs, discussions, and classes that otherwise would ignore environmental sustainability. However, it is important that the environmental science students are properly educated in addressing topics of sustainability in their curriculum. Possibly more important than the education students receive on campus is how students are affecting change after they graduate. This chapter will explore the possibilities of growth and expansion of the major, as well as how the major is preparing students for post-graduation. Survey data were collected from the Chapman University 2017 Environmental Audit Survey, as well as a separate survey for ES&P alumni.

9.2 HISTORY OF ENVIRONMENTAL SCIENCE & POLICY PROGRAM

9.2.1 Creation of the Major

The first appearance of the B.S. and B.A. in Environmental Science was in the catalog year 1997/1998, but disappeared the following year. In the catalog year 2003/2004 a B.S. and B.A. in Environmental Science was once again available to students. However, they were eliminated shortly thereafter from the catalog possibly due to lack of support and resources from the school to sustain a brand-new science major. In 2009, a B.S. in Environmental Science and Policy (ES&P) appeared in the catalog spearheaded by faculty members Dr. Chris Kim and Dr. David Shafie. Along with the major, an Environmental Science minor and an Earth and Its Environment cluster also appeared. In 2011, an Environmental Studies minor was available to students. Since then, the environmental science program has not experienced any other major catalog expansions.

9.2.2 Faculty and Staff

Under the leadership and support of Dr. Kim and Dr. Shafie, the program began to gain the interest of many other faculty, and is now headed by Dr. Jason Keller. In the Chapman University 2013 Environmental Audit Survey, faculty and staff indicated an interest in teaching and promoting sustainability in higher education institutions. Over 95% of faculty and staff believed that it is either somewhat or very important that this kind of education is taught at Chapman University, and in 2017 that percentage rose to over 97% (**Figure 9.1**). However, that percentage is not reflective of the courses and curriculum that promote and teach sustainability. In the same Environmental Audit survey done in 2013, only 23% of students indicated that they had learned about sustainability in any of their classes. This huge disconnect of theory and practice is an indicator that although there may be interest in sustainability, there are factors that prevent any substantial development, such as support from the school, student interest, student involvement, and the perception of sustainability.

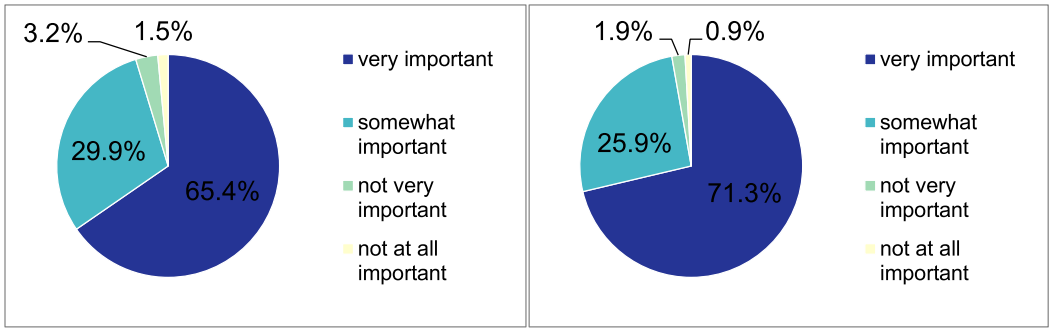

Figure 9.1 - *Faculty and Staff responses in 2013 (left, n=346) and 2017 (right, n=108) to "how important is it that sustainability is taught and promoted in higher education institutions, such as Chapman?"*

9.2.3 On-Campus Leadership

After the creation of the major, more leadership opportunities centered around students and various aspects of sustainability programming began to appear more frequently. Work-study positions such as sustainability interns, habitat restoration coordinators, community garden and community supported agriculture managers, and running the Green Initiative Fund became job opportunities for students. These kinds of positions allow students to have hands-on sustainability experience on University's campus with other Chapman students. Positions like these allow students with sustainability education to spread their knowledge across campus in efforts to engage their fellow students who may not be as well educated in sustainability. This kind of collaboration also allows students to interact with faculty and staff who support promoting and teaching sustainability at Chapman University, when they may not have a class or other platform to incorporate and explore sustainability.

9.3 Current Status of Environmental Science & Policy Program

9.3.1 Overview

Since the first Environmental Audit, Chapman's campus climate has changed substantially, which has had an important impact on Schmid College of Science and Technology. New organizations and opportunities have risen to promote a sustainable and student-centered education. Some of the following are a few examples of these organizations and opportunities. Work-study positions in Chapman's Sustainability Department are now available to students. The Schmid Student Leadership Council was created in 2015 to connect students and faculty in Schmid College where ES&P students are well represented and engaged. Students in the major also began a movement on campus called Fossil Free Chapman, which is a fully run student movement supported by faculty and staff on campus to encourage the school's board of trustees to divest in fossil fuel bonds and stock. These initiatives, among others, are still being well represented and supported in the ES&P program. In terms of numbers, the major has grown since its creation, but there does not seem to be a clear rate of growth or shrinkage (**Figure 9.2**). The larger enrollment of students has a wide array of student interests and involvements, which may not be well reflected in the major's stagnant curriculum requirements.

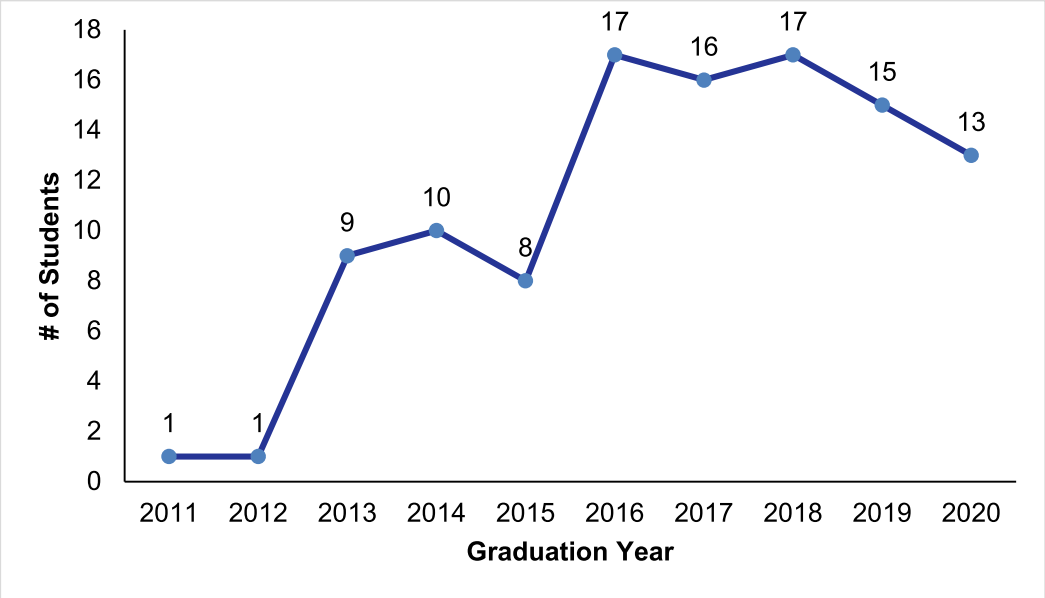

Figure 9.2 - *Graduates and projected graduates of the Environmental Science & Policy program by graduation year.*

9.3.2 Program Structure

Currently, the ES&P program has 15 required core classes, with a requirement of 48-49 credits. Students then choose an emphasis in Earth Systems, Ecology, or Policy which each require 9-12 credits, or about three classes. Students then must take one class in each of the other two areas for a more comprehensive and well-rounded curriculum. Internships and undergraduate research are also eligible to count towards emphases, effectively letting students apply their knowledge to in field experience. Almost all of the required courses in the major are requirements for other majors, allowing students to interact with different colleges and majors

like other hard sciences and political science. The only two classes specifically for ES&P students are the two Environmental Problem Solving classes, Energy and Matter Flow and Senior Capstone and Seminar. Out of the 15 required core classes, 11 are science-based and three are policy-based. The major also includes a seminar class with professionals from different fields speaking about their experiences, and the senior capstone class where they audit the school in different areas and present the research to faculty and staff of the university. Understandably, depending on the track a student chooses, their exposure to policy and science classes change (**Figure 9.3**). When looking at the breakdown of classes in the ecology and earth systems track, those students' curriculums are overwhelmingly science-based, yet they are required to take a few policy classes instead of expanding on more environmental science classes. This has caused some problems with students that have attended graduate school, or currently applying to graduate school. Many students noted that they had not known they wanted to go to graduate school for science, but filled basic requirements from the major. However, in order to be a stronger candidate, a heavier emphasis on science classes is needed. Students commented that more classes like calculus, organic chemistry, and physics would have aided in their application process instead of the policy-based classes.

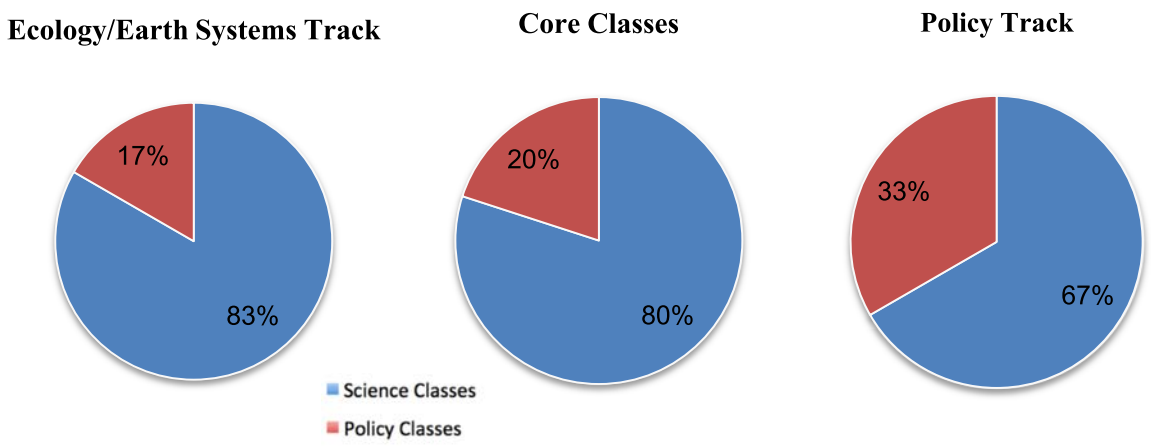

Figure 9.3 - *Percentage of science-based and policy-based classes taken by students in the Environmental Science & Policy major dependent on emphasis.*

Since the creation of the ES&P major in 2009, there has not been a significant change in the core requirements. The only change that has occurred was the addition of ENV 112 Introduction to Hazards and Global and Environmental Change in the 2013/2014 catalog. In regards to emphases, 2016/2017 has the most electives for each emphasis since 2009. Since the creation of the major, new political science, business, chemistry, biological science, and sociology classes have begun to become available to students. Many of these areas are beneficial to the ES&P program by introducing more specific sciences, expanding knowledge of policy, and acknowledging the behaviors of humans. The environmental movement has also gained momentum in recent years, with many developments in different area like environmental justice, policies, and natural disasters – some of which are not reflected in the major at Chapman.

9.3.3 Publicity of the Major

Since the ES&P program is a relatively new program on campus, one of the most challenging aspects of the major is the publicity and awareness of the major across campus. With comparatively small enrollment size to the business school and biology majors, the ES&P program must work its way into filling its small niche. **Figure 9.4** shows that majority of the campus is aware that there is an ES&P program on campus, mostly through friends and peers. This shows that students are constantly exposed to the ideas and conversations of ES&P students.

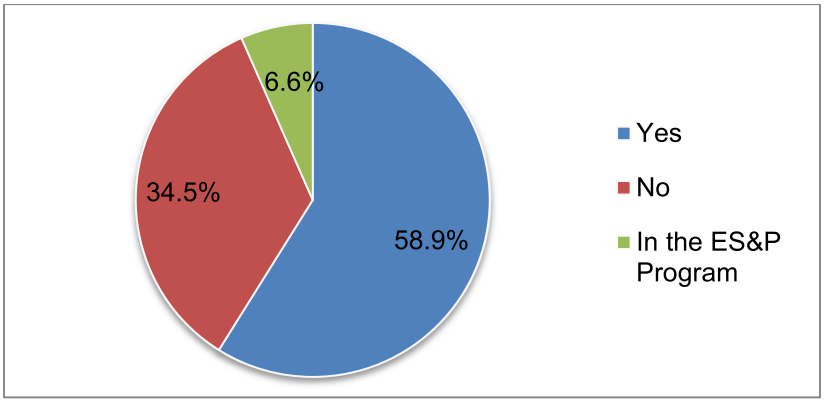

Figure 9.4 - *Responses of students (n=519) to "Are you aware that there is an Environmental Science & Policy program on campus?"*

However, when breaking down awareness into class standing, there are appears to be a trend where students learn about the program as they progress in college with about a 20% increase in awareness from Freshman to Seniors (**Figure 9.5**). This is an understandable trend because students learn about their college more as they become more involved. As students' progress through college, they are exposed to many ES&P students through social and academic events, which likely causes this increase in awareness. In turn, students learn about the ES&P major after starting their college career, and are not necessarily interested in the major. If the

major begins to receive more enrollment, funding, support, and resources from the school will also increase.

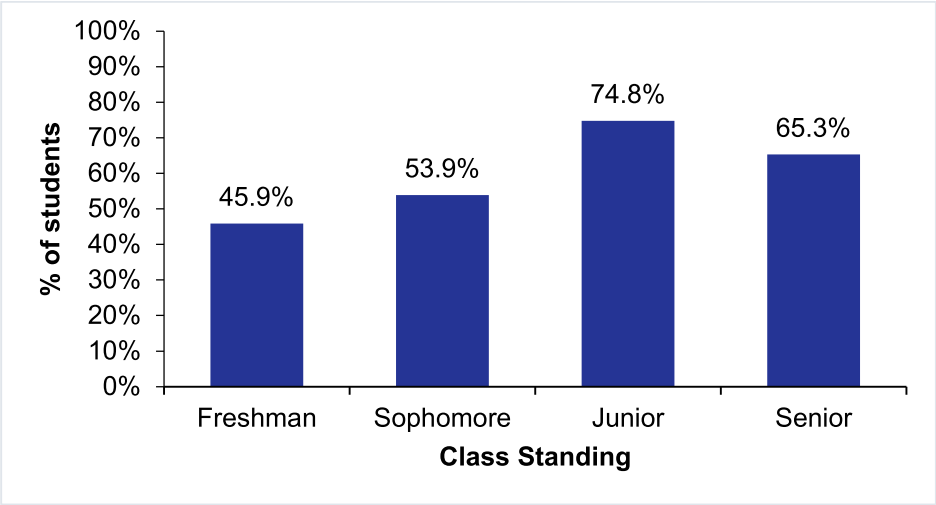

Figure 9.5 - *Percentages of Students that responded "yes" to "are you aware there is an Environmental Science & Policy program on campus" by class standing. Freshman (n=170) Sophomore (n=104) Junior (n=115) Senior (n=124).*

9.3.4 Student Involvement

From the survey, ES&P students are involved in 33 unique organizations including those shown in **Table 9.1.**

Table 9.1 *– The 33 unique organizations Environmental Science and Policy students are involved in at Chapman University (2017).*

Admissions Volunteer	Fossil Free Chapman	Promising Futures Program
Black Student Union	Greek Life	Research Labs
Chapman Ambassadors	Hawaii Club	Rotaract Club
Chapman Democrats	Honors Program	Schmid Student Leadership Council
Chapman Feminists	Honors Societies	Snow Club
Chapman Hillel	I Am That Girl	Sports Teams
Chapman Radio	IV Christian Fellowship	Surf Club
Chapman Veg*ns	Mission Environment	Tri Beta
Circle K International	Nikkei Student Union	Ultimate Frisbee
Civic Engagement	Orientation Leader	University Program Board
Disciples on Campus	Outdoors Club	Watershed Ambassador

This shows a widespread involvement across campus in many kinds of organizations. With so many organizations having ES&P students, the idea of sustainability and environmentalism are apt to come up in these organizations. Many of these organizations are student run, where students have a real voice in what is occurring in their organizations and how they carry on events. Educating ES&P students with the right kind of curriculum will then effect

these organizations. This stresses the importance of providing a well-rounded curriculum to students that are able to interact and promote the idea of sustainability to students from all kinds of backgrounds. Students are able to act as disseminators of sustainability education in organizations and involvements that are not directly related to the subject.

9.3.5 Current Students

Current ES&P students responded to survey questions regarding their favorite classes, classes they think are irrelevant, and if they believe the major is preparing them for their future goals. This information was gathered to help highlight areas of strength and weakness in the major. Overall, current students believe that the major is preparing them for their future goals, with few who strongly disagree (**Figure 9.6**).

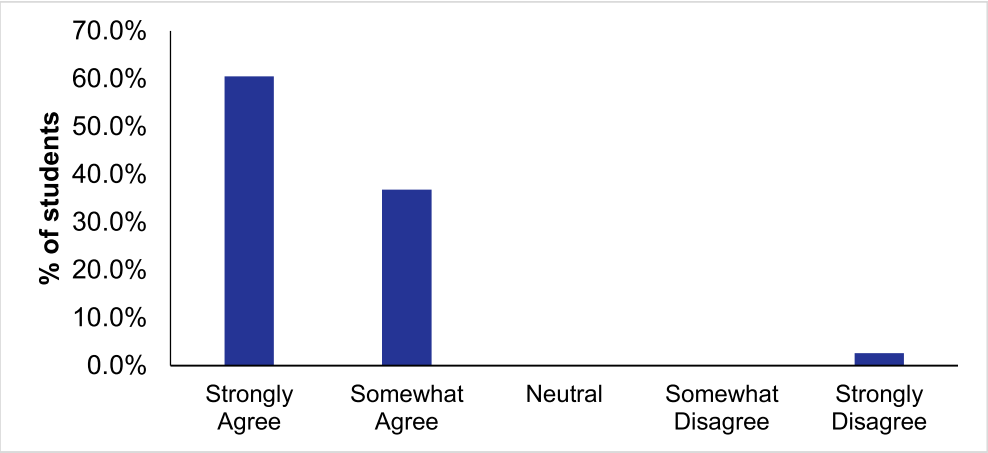

Figure 9.6 - *Environmental Science & Policy students (n=38) responses to "the Environmental Science & Policy program is preparing me for my future goals."*

Students were also asked about their favorite class in the ES&P curriculum. The most favored classes were the seminar series, evolution and diversity of multicellular organisms, introduction to environmental science, introduction to hazards and global and environmental change, and environmental problem solving. For seniors, the most favored classes were Introduction to Environmental Science, Environmental Problem Solving, and Introduction to Hazards and Global Climate Change. Nine of the 38 responses for “what class(es) have you taken in the Environmental Science & Policy major that you feel are not relevant” included General Physics I. Classes that are not being perceived well to the ES&P students should be investigated. The courses that are receiving negative attention could be providing irrelevant information for ES&P because it could be too focused on a different science and not revolved around interdisciplinary science studies. Also, there may not be enough support for the class, such as only taking one semester of physics and calculus, when there are usually two semesters for a full education in the topic. Classes that are favored by the students should also be investigated to discover the important aspects of the class that make it effective. The class should also be investigated to expand to other majors to increase interdisciplinary studies and involvement in sustainability from multiple backgrounds.

9.4 ALUMNI

9.4.1 Overview

Program head, Dr. Jason Keller, described connections with alumni as a challenge to the Environmental Science & Policy program. There are currently 45 alumni, and contact with them does not seem like it would be difficult. However, an effort like a LinkedIn group with ES&P alumni has not been effective. Engagement on LinkedIn is minimal and many alumni are unaware that the group exists. Connections with alumni are extremely valuable because they can start to pave the way for current students to achieve their goals. They are experienced professionals that are able to offer their knowledge and advice to current undergraduates. Having current and accessible connections and conversations with alumni would benefit all students. Since the ES&P program is relatively new, these connections are even more valuable for students as the current alumni are pioneers in turning their education at Chapman into a career.

9.4.2 Post-Graduation

Alumni were asked about their life after graduation and their current job and academic endeavors. Overall, alumni agreed that the ES&P major has prepared them for their future goals (**Figure 9.7**). Although it is expected that students who graduated in the program would agree that it prepared them for their future goals, it is important to confirm this information especially because it is a relatively new program.

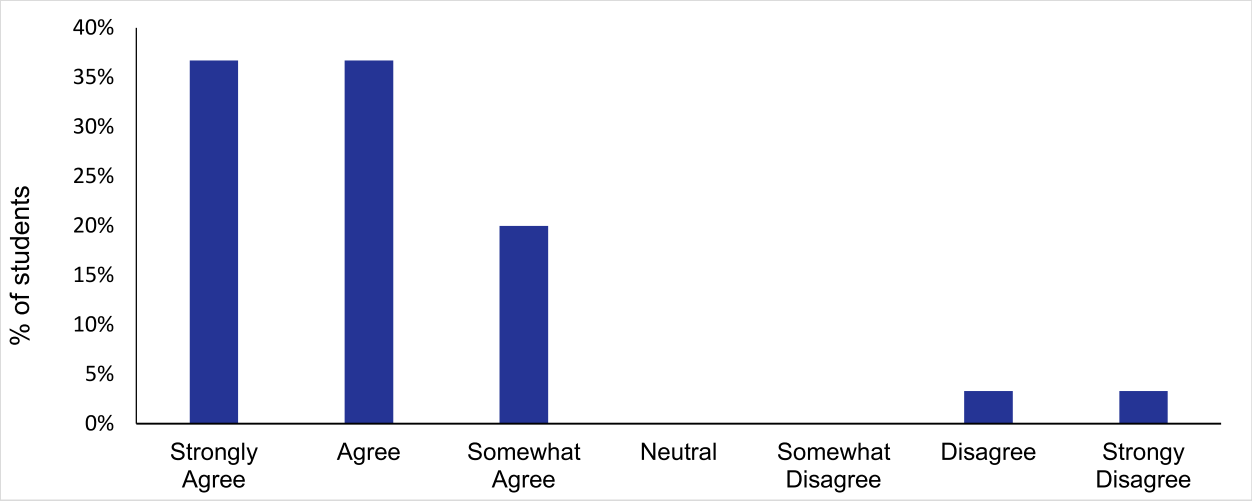

Figure 9.7 - *Alumni responses (n=30) to "the Environmental Science & Policy program has prepared me for my future goals."*

Table 9.2 - *Alumni graduate schools and areas of study from survey.*

Graduate School	**Area of Study**
Columbia University	Sustainability Management
University of San Diego	Entry level masters of nursing
UC Irvine	Urban Planning
University of Melbourne	Master of Environment
University of Michigan	Earth and Environmental Science
University of San Francisco	Environmental management
University of Montana School of Law	Law
Texas A&M University	Master of Agribusiness
Chapman University	Health and Strategic Communications
UC Berkeley	Biogeochemistry - Environmental Science Policy and Management
University of Colorado - Boulder	Renewable and Sustainable Energy
Colorado State University	Conservation Leadership

After graduation, alumni have a wide array of occupations as well as attend a variety of different graduate school programs (**Table 9.2**). This information is important to gather because sometimes it is difficult for students to realize what they can do with the degree that they have earned. A database with this information is useful for students that are applying to graduate programs in order to gather information on how to reach the same or related programs. Students would also be able to track alumni's minors, majors, and involvements that have aided them in completing the requirements for graduate schools. In **Figure 9.8**, the two alumni disagreed that the ES&P program had prepared them for their future goals have both attended graduate school. Current students and alumni both appear to agree that the program provides some difficulties when applying to graduate school programs. This is also reflected in some current students that are applying for graduate programs.

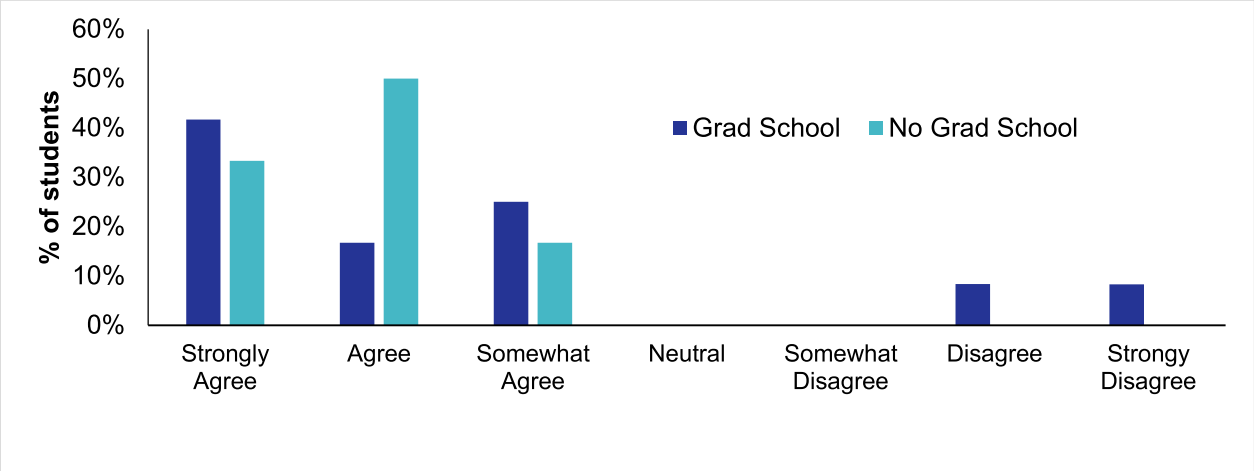

Figure 9.8 - *Alumni responses (n=30) to "the Environmental Science & Policy program has prepared me for my future goals" broken down by whether or not attended graduate school.*

From the same Alumni survey, **Table 9.3** shows which post-graduation jobs were listed.

Table 9.3 *– Post-graduation jobs of Environmental Science and Policy students, surveyed in 2017*

Administrative Assistant	Environmental Educator	Organic Fair Trade Café
Aerospace Wastewater Technician	Environmental Law Clerk	Pharmaceutical Scientist
AmeriCorps	Environmental Nonprofit Communications Coordinator	Real Estate Investment
Asset Coordinator	Environmental Specialist	Research Positions
Bee Keeper	Executive Trainings Operations Assistant	Restaurant Manager
Boarding Assistant	GIS Digitizer	Scientist
Civil Defense Attorney	Green Building Commissioner	Sustainability Business Consulting
Community Supported Agriculture Delivery Programs Coordinator	Lab Manager	Transportation Planner
Energy and Safety Assessor	Natural Treatment System Specialist	USDA Forest Service
Environmental Consultant	Nonprofit Work	Water Use Efficiency Specialist

This database is important in creating foundations and pathways for future students to follow an alumni's previous curriculum and job pathways to end up in the same profession. Having this information available to potential and current ES&P students would allow them to have potential contacts and necessary information to achieve their career goals with a degree from Chapman University. Other schools have this kind of data available to students as well as laying out what students can do with the degree depending on what field they want to go into accompanied with classes that the student should take to be best prepared for their intended professional field.

9.5 Comparisons to Other Institutions

9.5.1 Overview

In order to measure our growth in the Environmental Science & Policy program, the following is a list of aspirational schools for Chapman University: Claremont McKenna College, Gonzaga University, Occidental College, Seattle University, Tufts University, University of Redlands, University of San Francisco. None of these schools have a program quite like

Chapman's ES&P major, but consist of many different variations of the major like environmental management, environmental studies and environmental science. These schools have similar student populations and resources that will allow us to control for some factors. University of California – Berkeley is consistently highly ranked in their Environmental Science program, so looking at their program will provide valuable recommendations as well, even if the university has extremely different funding and resources. All the universities described have had time to establish the program, and have changed significantly since their creation by taking advantage of the growing world of environmental science and different programs within their schools.

9.5.2 Programs at Other Institutions

9.5.2.a Gonzaga University

Private Roman Catholic University, Enrollment: 7,421, Acceptance Rate: 67.5%

Located in Washington, the university has access to a plethora of National Parks, National Forests, and National Recreations Areas. This allows students to have hands-on experiences directly with their communities, highlighting experiential learning. Their curriculum consists of classes that are specifically designed for environmental science, like environmental biology and environmental chemistry. Their core curriculum also includes some of Chapman's elective courses, like environmental ethics and ecology. The school also provides many opportunities for students to be involved in things like environmental programming throughout the year, a committee on divesting the endowment of the school, outdoor adventures, gardening, managing a green fund, and combines the religious aspect of stewardship with their office of sustainability.

9.5.2.b Claremont McKenna College

Private Liberal Arts College, Enrollment: 1,328, Acceptance Rate: 9.4%

The college offers degrees in Environment, Economics, and Politics and an Environmental Analysis Program. The Environment, Economics, and Politics major is similar to Chapman's ES&P major, with the goal of understanding environmental systems like biology, chemistry, economics, and politics to help inform each field in environmental decisions being made. In this degree, students are able to choose from groups of different kinds of sciences as well as political courses, allowing students to customize and choose both their policy and science side of the major. This also requires a strong proficiency in economics, which is important in environmental decision-making. The degree also includes a two-semester senior thesis, where they expand their knowledge to environmental issues that apply to the world. The Environmental Analysis Program has similar requirements, but focuses on preparing students for environmental education and community environmental action. It includes concentrations in science or policy with a wide array of classes offered like environmental leadership, soils and society, herpetology, natural resource management, environmental justice, protecting nature, etc.

9.5.2.c Occidental College

Private Liberal Arts College, Enrollment: 2,062, Acceptance Rate: 44.9%

This college offers Urban & Environmental Policy and Environmental Science concentration in a biology and geology major. The concentration under the biology and geology

major allow students to have a more science-focused program that requires classes that aide in applying to graduate programs. Some of the classes in the environmental concentration are economics, geographic information systems, earth's climate, and environmental economics. The Urban and Environmental Policy program engage students in applying research and analysis to organizing and leading to help bring about change in policy. This college appears to break Chapman's major into two different areas, allowing for a deeper concentration and connection to either policy or science. The college also encourages experiential learning by allowing students to take a semester to participate in a political campaign, research, and study abroad programs. They also require intensive seminar classes to allow students to gain critical thinking skills that can be applied to policies.

9.5.2.d Seattle University

Jesuit Catholic University, Enrollment: 7,405, Acceptance Rate: 73%

This university offers an environmental studies major with multiple concentrations in fields like urban sustainability, environmental education and communication, ecological systems, and politics, policy, and justice. This allows students to create a highly-specialized education with available resources in Seattle, which is a hub for sustainability initiatives. The major also focuses on connecting Jesuit-Catholic traditions to help recognize the sacredness of creation. This is a unique aspect because religion and environmental science appears to be separate in many cases, but this program uses religion to help emphasize the spirituality that nature can provide.

9.5.2.e Tufts University

Private Research University, Enrollment: 10,872, Acceptance Rate: 14%

This university offers an environmental studies major that requires the completion of five core courses, five courses in a selected track, and an internship. The tracks include environmental science, sustainability, policy, and equity, environmental communication, food systems, nutrition and the environment, environmental humanities, or a self-designed track. The goal of this major is to establish knowledge in basic scientific principles, explore the relationship between nature and technology, and give a framework for policies. The program also has extensive support from faculty, providing students with 20 different advisors that help in designing one's curriculum and paving pathways to professions.

9.5.2.f University of California – Berkeley

Public Research University, Enrollment: 40,173, Acceptance Rate: 17.5%

This public university is constantly rated as one of the top universities for their environmental science program. The university has a lot of faculty resources with brilliant professors because of their emphasis on research. Much of this success comes from their dedicated classes to environmental science, with in depth knowledge of common sciences revolved around the environment. The institution also has extensive research opportunities for students to get involved in many different areas of sciences, as well as expanding that into policies, urban planning, law, health, etc. Their senior research seminar is a yearlong, allowing full development and culmination of their college career to create and design their own experiments and research to present orally and written. One of the most useful resources that the

program provides is information on job pathways and alumni statistics. They have information on what specific classes a student should take to gain the right knowledge for their intended career. This is information that has been easily collected and distributed to students, allowing for students to be able to follow a set class of courses as opposed to figuring it out themselves. They also have statistics on alumni, like their average income, graduate programs, and employment, which offers valuable information to students interested in the program.

9.6 Recommendations

9.6.1 Low Cost and/or Effort

Some low effort recommendations for Chapman's campus include giving all students a comprehensive database of on campus opportunities. Currently, there are a lot of different mediums that various kinds of events and opportunities are presented. It can be confusing at times because of the different categories of events only appearing on certain mediums. A comprehensive list would allow students to know all of their opportunities to expand on their interests and aspirations to help use these opportunities supported within class curriculum. In regard to ES&P students, there are many different interests that students have that cannot be accumulated into one singular major, so a resource that shows leadership opportunities in fields of interest will allow students to expand on their education.

Another low effort recommendation is to create a comprehensive network of alumni of the environmental science & policy program. Using these kinds of connections and resources will allow students to know what they can do with the major and see if it properly aligns with their future goals. Alumni also benefit from a strong alumni connection because they are still able to find connections across the world as well as continue professional development and collaboration.

- Create alumni database of jobs and education after obtaining their undergraduate degree in Environmental Science & Policy.
- Create database of on-campus opportunities for current ES&P students to expand on their education through influential leadership roles.
- Create a more resourceful website with links to current and past students' involvements, the companies students work with, research done by students, and more that show the broad reach of ES&P students.
- Publicity of the satisfaction survey sent out to students each year about the program.
- Increase cross-listed classes with other departments.

9.6.2 Medium Cost and/or Effort

An effort that will need some more planning and resources would be increasing the awareness of the program. The first step would be expanding and publicizing the parts of the program that make it unique to Chapman. The location of the school is attractive because of the ability to interact with big corporations and organizations while also being in close proximity to

a variety of ecosystems. The size of the major is also an crucial factor to highlight because of the fact that class sizes are small, offering individualized and personalized connections with professors, faculty, and other students in the major. Finally, the capstone experience is a unique aspect of the major that garners a lot of interest because of its impact and application.

To minimize the gap of knowledge of freshmen awareness to the program, more outreach to local high schools could be done. For example, Orange High School is right across the street and representatives from the major could present to science classes to tell them about the program. Current students can also be funded to visit their old high schools to give similar presentations. Increasing interest and enrollment in the program will increase resources and funding. These resources and funding will help expand the program to include more unique programs and opportunities, especially with the new Center of Science and Technology building.

- Increase awareness of the program to local high schools
- Outreach to aspirational schools to learn about how they made their programs strong, as well as ask for comments on the ES&P program at Chapman.
- Create pathways and roadmaps for intended careers.

9.6.3 High Cost and/or Effort

Although the Environmental Science & Policy program is unique in the fact that it incorporates both science and policy, which is important when the goal of the major is to create scientists that can communicate to policy makers, there are many students that are more interested in the science side of the program. Also, the policy side of the program appears to be a little light because of the three related classes. There is only one lower division, and two upper division classes, which are very similar. Developing different majors and restructuring some of the major requirements can expand upon the science and policy aspects of the major.

- Outreach to high schools beyond Orange County through alumni presentations and distributing information about the program.
- Increase full-time faculty of the ES&P program.
- Increase classes related specifically to the environment (i.e. environmental chemistry & biology)
- Develop new emphases for the major such as environmental justice, education, urban planning, corporate sustainability, communications, nutrition, etc.
- Expand the ES&P program by dividing the majors into Environmental Science, Environmental Studies, and Environmental Policy, or some other kind of variations.
- Development of sustainability and environmental departments on campus to increase programming and awareness.
- Develop the capstone class to two semesters to allow ample time for research and data collection.

9.6.4 Future Areas of Research

There is an enormous potential for growth of the ES&P program at Chapman University because of the projected growth of the school itself. The development of the Center for Science and Technology will develop the science departments on campus, especially with the intention of creating an engineering program. Researching potential ways to incorporate the new college with ES&P with the program contributing to the new college, or the new college contributing to the ES&P program.

Other colleges and schools at Chapman University should also be investigated in regard to incorporating interdisciplinary studies, and researching how sustainability fits in to that area. If there are any ways that sustainability can help a major reach or improve its course outcomes, there should be knowledge of that potential, so that all schools can benefit.

There have been many experimental courses for the ES&P major, however some only persist for one semester or are very rare. There should be research into these experimental courses to find out how to ensure stability and longevity of the interesting topics that could be taught as part of the major.

Finally, reaching out to alumni from any major that have a job related to environmental science would result in interesting data. Observing how other majors are succeeding in environmental science, or lacking, can show the ES&P program how and where to grow, especially with a highly interdisciplinary subject.

9.7 Contacts

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Christopher Kim, Associate Dean of Academic Programs (cskim@chapman.edu)

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10 SCIENCE COLLEGES LOOKING AHEAD: INTERDISCIPLINARY AND SUSTAINABILITY CURRICULUM IN THE SCHMID COLLEGE OF SCIENCE AND TECHNOLOGY

Elizabeth W. Flowers

10.1 INTRODUCTION

Figure 10.1 *– Shimahara Illustration of Chapman University's new Schmid College of Science and Technology building. Illustration dated: 8-15-16 (CST-PDF).*

Chapman University's Environmental Science and Policy majors complete an environmental audit of the university during the spring semester of their senior year. This year, eleven students chose to audit Chapman's curriculum. Each focused on a different aspect of curriculum in the university and wrote individual research papers. This article focuses on the advantages of interdisciplinary curriculum in college education, incorporating sustainability and environmental science into other science majors at the Schmid College of Science and Technology, expanding Schmid College's interdisciplinary curriculum, and creating a framework to assess and add interdisciplinary courses for colleges.

10.1.1 Contribution to the Field

While this study was conducted by a Chapman student on Chapman University, the framework that was created for evaluating a school's incorporation of sustainability and interdisciplinary science curriculum, and for making recommendations, has been designed to be applicable for other forward thinking universities.

10.1.1.a Research Questions

- Does an interdisciplinary curriculum and/or a curriculum that incorporates sustainability benefit students in their professional lives?

- If so, how can the Schmid College of Science at Chapman University create an interdisciplinary curriculum between environmental science majors and the other majors within Schmid College?
- How has the Schmid curriculum evolved over time?
- What recommendations are backed by the data from surveys, interviews, and manually collected curriculum data?
- Is Chapman receptive to curriculum changes? Is their curriculum well defined?

10.2 History of Interdisciplinary and Sustainability Curriculum

10.2.1 The History of Interdisciplinary Curriculum Overall

There has been limited research exploring the correlation between an interdisciplinary bachelor's degree and income. Many colleges and universities have implemented aspects of an interdisciplinary curriculum under the assumption that it better prepares graduates for jobs. While there is significant discussion in literature about how interdisciplinary curriculum can increase graduates' ability to think creatively, solve problems, and be more innovative, research showed that there is no current framework for assessing or implementing interdisciplinary curriculum easily within a college (Jones, 2010).

10.2.2 The History of Interdisciplinary Curriculum at Schmid College

The Schmid College of Science and Technology at Chapman University has historically been flexible in its courses, and therefore there have been opportunities to incorporate interdisciplinary courses. Chapman allows listing of experimental courses during interterm and occasionally they are made part of the curriculum permanently. For example, in 2015 a course listed as 'ENV 329 Experimental Course' became part of the environmental science curriculum as 'ENV 440 Remote Sensing of the Environment'. Additionally, student-faculty research, independent internships, individual study, capstone, and senior projects are counted as courses in most Schmid majors, allowing for incorporation of interdisciplinary research into a student's repertoire while still providing course credit so they may graduate on time. These opportunities are often poorly advertised and students must design their research to be interdisciplinary and find a professor who is interdisciplinary minded enough to oversee their research. While these flexible courses, a few of which are show in **Table 10.1,** are opportunities for interdisciplinary coursework, they fluctuate. Therefore, it is important that the official courses in each department are assessed to determine if Schmid is becoming interdisciplinary over time. The interdisciplinary curriculum within Schmid College is discussed and analyzed thoroughly in the 'Current Status' section of this chapter from the 2006/2007 catalog year through the present catalog year of 2016/2017.

Table 10.1 *– Flexible Schmid College courses across all 10 departments from the 2016/2017 course catalog. *Note: capstone courses and senior projects are not always listed as a course.*

Department	**Course Acronym**	**"Experimental Course No."**	**"Student-Faculty Research"**	**"Independent Internship"**	**"Individual Study"**	**"Capstone" or "Senior Project"**
Biochemistry	BCHM	329	291, 491	490	499	None listed*
Biology	BIOL	329	491	490	199, 499	494, 498
Chemistry	CHEM	129, 229, 329, 429	491	490	499	None listed*
Computer Science	CPSC	229, 329	291, 491	290, 490	299, 399, 499	440, 498
Environmental Science and Policy	ENV	229, 329,	291, 491	490	199, 299, 499	498
Food Science	FSN	429	None listed	490	499	None listed*
Mathematics	MATH	229	291, 491	290, 490	199, 299, 399, 499	None listed*
Physics	PHYS	229, 429	491	None listed	499	498
Science	SCI	329	None listed	None listed	None listed	None listed*
Software Engineering	SE	329	None listed	None listed	None listed	498

10.2.3 The Chapman University 2013 Environmental Audit of Curriculum

In 2013, a few of the Environmental Science and Policy seniors conducted an audit of Chapman's sustainability curriculum across all its colleges. The 2013 Audit provided an excellent approach to analyzing Chapman's curriculum through keyword searches of the course catalog descriptions. This chapter is an extension of their work.

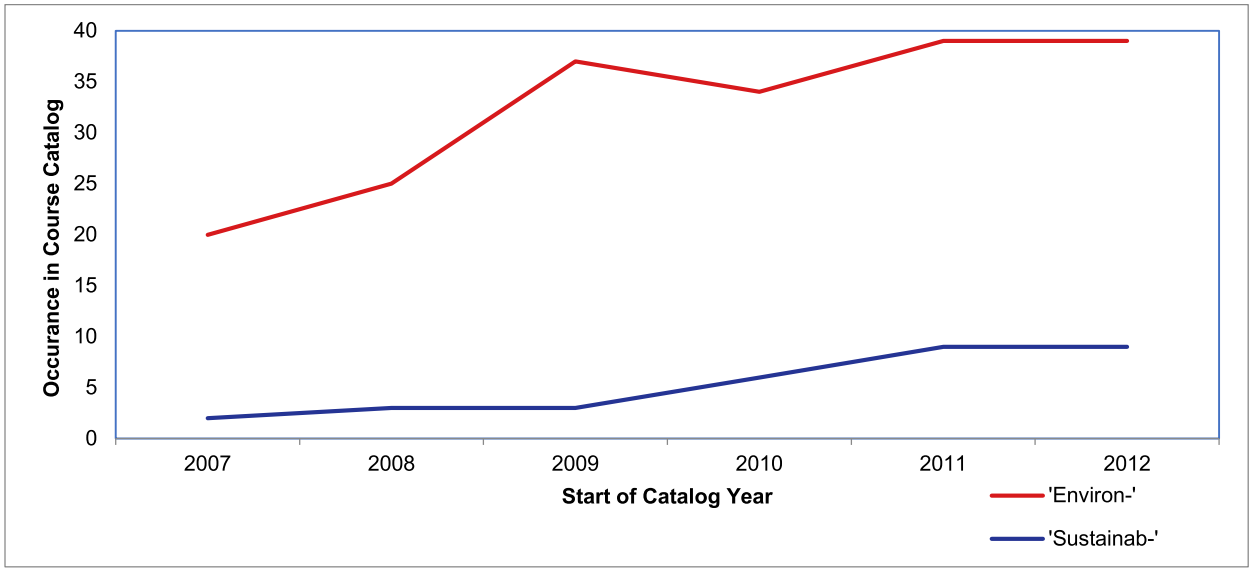

Figure 10.2 - *The frequency of the terms 'Sustainab-' and 'Environ-' in the course names or descriptions from Fall 2007 through Spring 2013* (Chapter 2 – Curriculum).

The course catalogs from the Fall 2007 semester through the Spring 2013 semester were searched for keywords that contained 'environ-' and 'sustainab' (**Figure 10.2)** (Chapter 2 – Curriculum). The results exhibited an overall increasing trend of both keywords across the college, however did not look at individual colleges or departments, or normalize by the overall number of courses. Due to the absence of normalization, the results may indicate a false trend for the overall direction of Chapman's curriculum, and would be better represented by the fraction of courses that contained these keywords, which is discussed in detail in the 'Current Status' section of this chapter.

10.3 CURRENT STATUS OF SCHMID'S CURRICULUM

10.3.1 Methods of Assessment – Summary

Data was collected from individuals by releasing one survey to the public, a second survey to students and faculty at Chapman, and through interviews with professors. Curriculum data was compiled manually for Schmid College from the 2006-2007 catalog through the 2016-2017 catalog using a 25-keyword search across 6 departments.

10.3.2 Methods of Assessment – Public Survey

The public survey released was for individuals with a bachelor's degree or higher. The survey included a variety of broad questions such as age, gender, and income, as well as more specific questions about education, interdisciplinary research in college and jobs, and how aware they were about sustainability and environmental science topics. This survey is ongoing. A full list of survey questions, data, and the survey link can be made available through a request to the contacts listed at the end of this chapter.

10.3.3 Methods of Assessment – Chapman Survey to Students, Staff and Faculty

The Chapman survey questions were compiled for the entire graduating course's research and released as one survey. Eleven individuals had curriculum based questions. A full list of survey questions and data can be made available through a request to the contacts listed at the end of this chapter.

10.3.4 Methods of Assessment – Interviewing Professors

Interviewing professors was originally intended to include a minimum of two professors from each department for 30 minutes each. The goal of this qualitative approach was not only to collect information but also to build relationships and a bridge between the environmental science department and other departments. Open dialogue creates a better flow of information and enthusiasm than online surveys. The interviews were designed to be an opportunity to set the curriculum in motion and gain supporters. However, due to limited responses to emails, it was determined that it would be more beneficial for future audits if the professors were not pursued further. Two interviews were conducted using open ended survey questions, one online and one through a printed version. One interview was conducted in person.

10.3.5 Methods of Assessment – Manually Compiling Data from the Schmid Course Catalog

Departments included were Environmental Science and Policy, Food Science and Nutrition, Mathematics, Physics, Biology and Chemistry. Keywords included 'environ-', 'future', 'ecology-', sustainab-', 'pollut-', 'nature', 'food', 'ethic-', 'resource-', 'biochem-', 'bio-' (not including 'biochem-'), 'chemi-', 'math', 'science' (not including 'non-science', 'politic-', 'ocean', 'land' (including island), 'disaster', 'geo-' (not including 'geom' terms, including '-logy', '-logical', '-biogeochem-'), 'hydro-', 'water-', 'research', 'inter-' (when referring to 'interdisciplinary' or 'interactions' between majors/fields), 'energy-' (referring to energy consumption/production/impacts for commercial/home use not biologically related 'energ-' terms), and 'physics'.

10.3.6 Methods of Assessment – Evaluation of Chapman's Attitude towards Curriculum and Curriculum Changes

Determining Chapman's attitude towards curriculum and curriculum changes was essential to determining the appropriate recommendations. This was accomplished by manually exploring the curriculum, reading the general and college specific mission statements, researching the graduation requirements, and speaking with professors.

10.3.7 Results and Discussion – Summary of Method Success

Executing the methods was overall successful, with 112 completed responses from individuals with bachelor's degrees and 600 completed responses from the survey to Chapman's faculty, staff, and students.

10.3.8 Results and Discussion – Public Survey

The public survey released was for individuals with a bachelor's degree or higher. The survey included a variety of broad questions such as age, gender, and income, as well as more specific questions about education, interdisciplinary research in college and jobs, and how aware they were about sustainability and environmental science topics.

10.3.8.a Public Survey Responses Metadata

112 people gave completed survey data. 9 of them were environmental science or sustainability related majors (or similar). Environmental science and policy majors (ENV majors): average age is 35 years, 67% of respondents were female, they included 3 bachelor's degrees with an average annual income of $5,000 a year, 4 master's degrees with an average annual income of $54,000, and 2 PhD degrees with an average annual income of $88,000. Out of all respondents, 51% of people had up to a bachelor's degree, 36% had up to a master's degree, and 13% went through to a PhD.

10.3.8.b Public Survey Results

The goal of this survey was to explore how interdisciplinary knowledge, sustainability knowledge and sustainability related degrees affect qualitatively measurable aspects of individual's lives. While the 112 respondents is not large enough of a sample size to represent the population that hold bachelor's degrees, it is a framework for exploration of correlation between sustainability and interdisciplinary bachelor's degrees with income, type of job research

etc. It was determined that displaying the data from this survey, despite the small sample size, would be an effective way to model what a larger sample size could potentially accomplish (**Figure 10.3).**

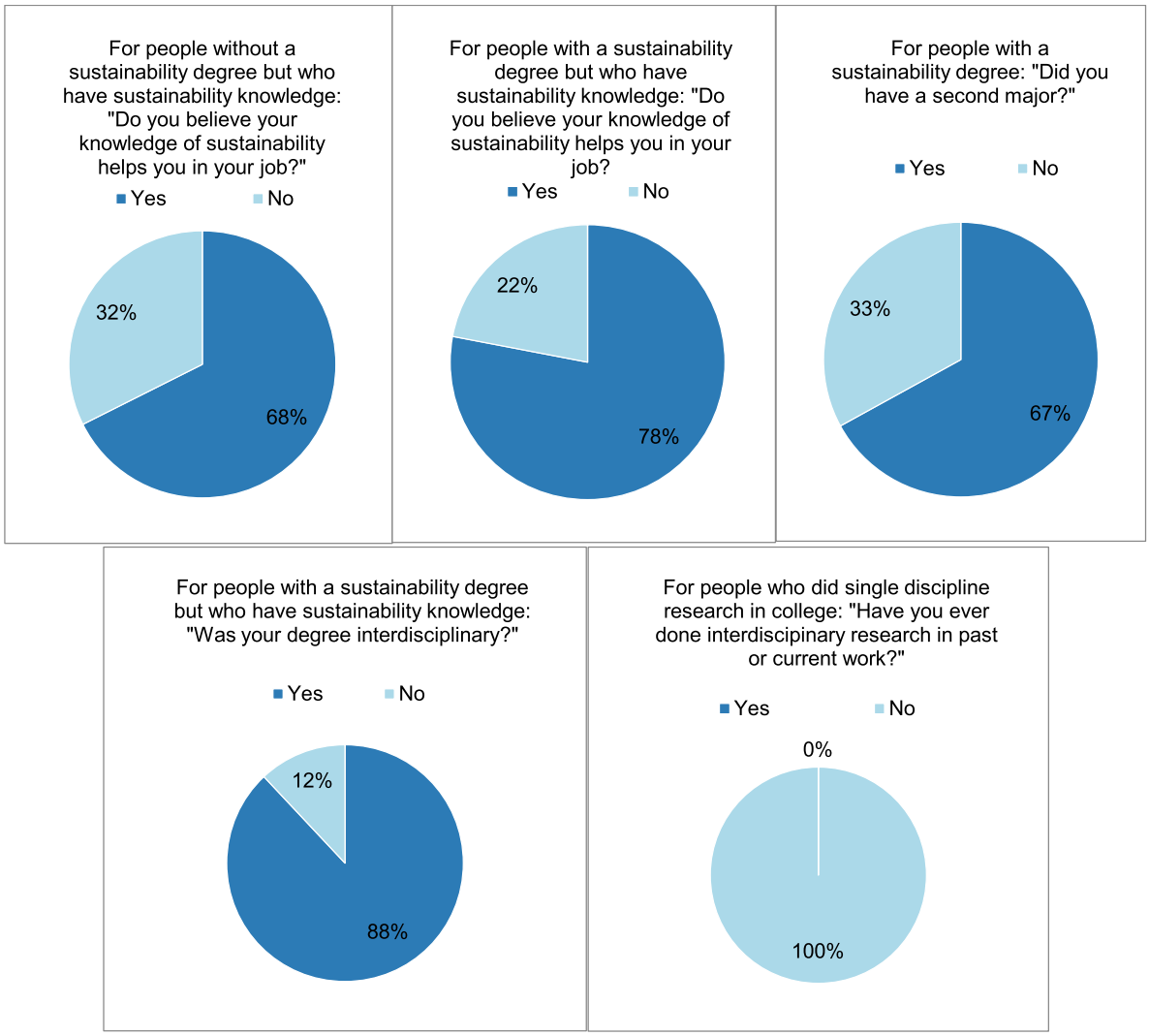

***Figure 10.3** – Data from the 112 Public Survey respondents with bachelor's degrees or higher. Displayed to assist with research questions in further research and as an example of what further research using this model could accomplish.*

The average income of 112 survey respondents is $58,000 and the average sustainability focused job income was $66,000 (out of 7 people). Out of the people who did interdisciplinary research in their degrees the average income was $75,832.8, and out of the people who did not do interdisciplinary research in their degrees, the average income was 68,928.1. Out of people who did interdisciplinary as part of their work, their average income was $68,408.6, out of people who do research that is single disciplinary their average income was $67,221.8 (**Figure 10.4).** Out of 112 random people with bachelor's degrees, those that had an interdisciplinary college education made 9% more than single discipline college education regardless of whether they worked in an interdisciplinary field. This data poses the question for future research: is

interdisciplinary college coursework increasing the average income for graduates regardless of whether they are working on single or multidiscipline projects?

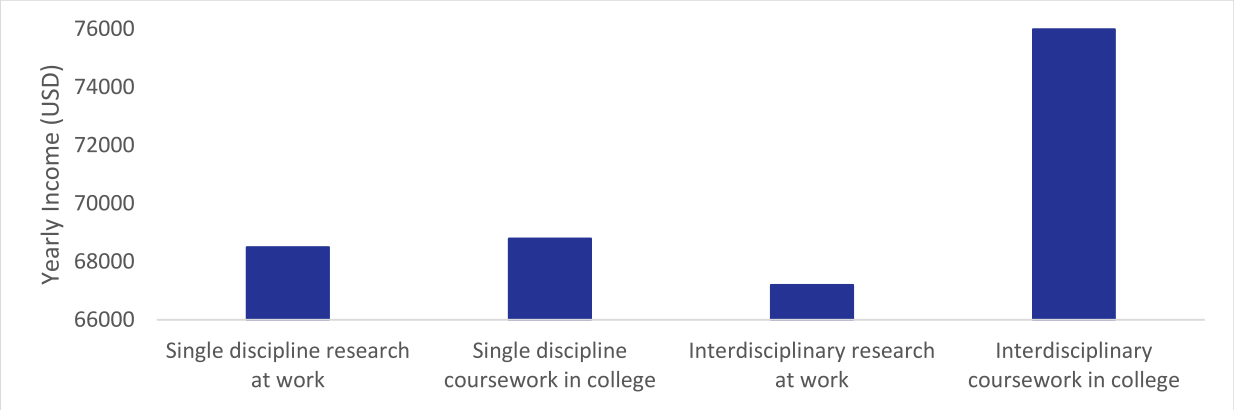

Figure 10.4 - *Interdisciplinary vs. single discipline education and work was compared with income for 112 individuals in the general public. *Note: this data indicates a trend that should be further investigated when more data is collected. The survey is ongoing.*

10.3.9 **Results and Discussion – Chapman Survey to Students, Staff and Faculty**

The survey to students, staff, and faculty has historically been part of the Environmental Audits at Chapman, however for the purposes of this chapter this method was not required to be used as thoroughly. While surveys of individuals at a university can be an effective way to measure attitudes and potentially strengthen a petition for changing aspects of the curriculum, it was determined that the curriculum analysis should take precedence and occur before assessing attitude towards implementing a Schmid interdisciplinary and sustainability curriculum. Other chapters in this audit did measure opinion on sustainability curriculum in other colleges and can be referred to for this method.

As shown in **Figure 10.5**, approximately the same percentage of students in the Argyros, Schmid, Wilkinson, and Performing Arts colleges know of sustainability courses in their college. This could be for a variety of reasons, including but not limited to; there are many sustainability courses in these colleges, 'sustainability' definitions vary among students as they did among the professors interviewed **(Figure 10.6)**, Schmid has more sustainability related courses due to its Environmental Science and Policy major but they are poorly advertised. The interdisciplinary keyword methods shed some light on the fluctuation of courses, partially as a result of low enrollment.

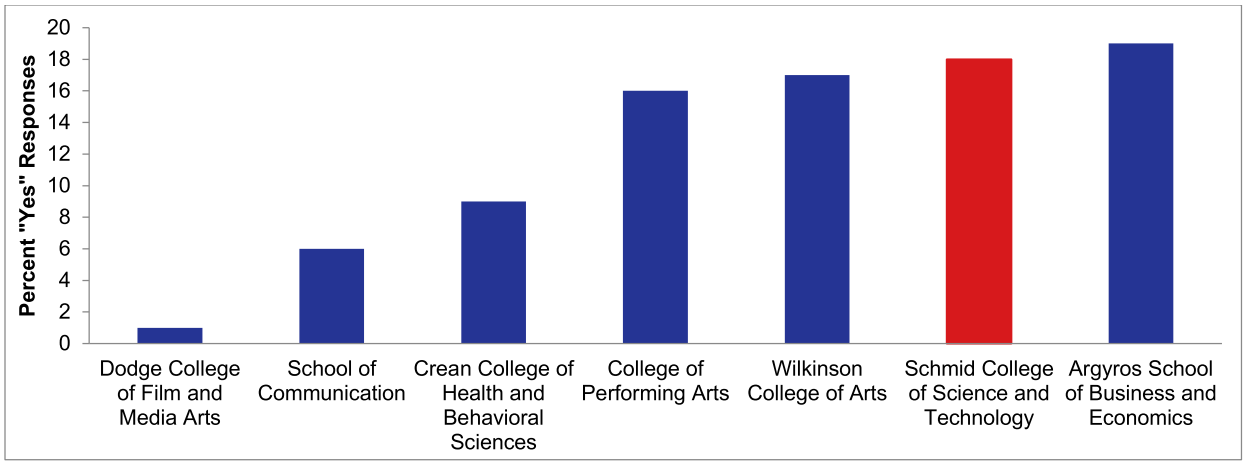

Figure 10.5 - *Students were asked if they knew of any courses in their college that discussed sustainability. Data is from the Chapman University 2017 Environmental Audit Survey. Sample size was 600 students. *Note: School of Pharmacy and School of Educational Studies had 0 Yes responses.*

10.3.10 Results and Discussion – Interviewing Professors

While this audit set out to incorporate sustainability and environmental science in other majors in a more interdisciplinary Schmid curriculum, and the data collected can assist with this long-term goal, there are issues that were revealed throughout the research process that were not anticipated. Many of these were revealed in the process of finding professors to interview and interviewing them. For example, professors expressed having overly full schedules and therefore were not open to the incentives suggested for taking a self-led course about sustainability. Additionally, using the term 'sustainability' and 'environmental science' interchangeably was a recurring issue and affected efficiency and clarity in communication and definitions of 'sustainability' and 'environmental science' varied.

Fields of expertise of professors interviewed included ecosystem ecology, organic chemistry, environmental chemistry, atmospheric chemistry, air-sea exchange, kinetics, environmental science and environmental chemistry and the time at Chapman as a professor ranged from under 10 years to over 20 years. Their responses are shown in **Table 10.2** and supported that improvements need to be made on the current curriculum and work loads of professors before implementing a training program for professors in sustainability or interdisciplinary education.

***Table 10.2** – Professor's responses to interview questions. *Note: columns do not represent individuals.*

What does the word 'sustainability' mean to you?	'Poorly defined and used too generally. Broad definition environmental social economic pieces, those things are available for future definitions.'	'That life on the planet can continue with quality of life without depleting resources and destroying the habitat of other animals on earth. Humans have procreated to unsustainable levels in my opinion… back in the 70s a big topic was how to slow down human population growth. This topic has pretty much disappeared from the discipline of environmental science. '	'Functioning/living in a way that doesn't change earth as it is today in an irreversible way.'
Are you interested in learning more about sustainability?	Yes	Somewhat	No
Do you feel confident enough that with some research you could incorporate sustainability into some of your classes?	Yes	Somewhat	No
To learn more about sustainability how likely are you to take a self-led discussion course at Chapman? The courses would be free, the books are up to $60 but may be funded by the school.	No – Paraphrased comments: the school would have to pay for books and providing free food would likely be a good incentive.	No – 'Time matters, time needs to be created, tenure track could help that, put the [self-led] course in place of something else that takes up time.	Unlikely – ''The problem is time - I don't have time to take a course. Releasing time from teaching other courses to take the course would be an incentive.'
Do you think sustainability fits into the majors or departments at Chapman?	'It might not but it could. There are sociological, economic, philosophical, and sustainable development aspects of sustainability. Currently, it doesn't fit well into other Schmid majors. Other majors in Schmid don't have room for sustainability. The focus needs to be on environmental science.'	'Sustainability fits into some majors. You can talk about the environment side in Schmid majors, but can't talk about other aspects of sustainability (not the social pieces).'	Yes – Paraphrased comments: A track for earth system science in computer science program could be added. Additionally, a well-rounded sustainability course should be added to the environmental science and policy major. The new Freshman Foundation Course called the 'Grand Challenge Initiatives' incorporates challenges that will gravitate towards the sustainability issue. It is intended to be interdisciplinary.
Do you think students benefit personally from sustainability and environmental science knowledge?	Yes, people who want to learn how to do it.	Possibly	Yes
Do you think students benefit professionally from sustainability knowledge in your field?	If they want to go into a field that includes it then yes.	Possibly	A little
Are there any sustainability related courses you think should be incorporated? What material would they cover?	'Yes, a well-rounded course in sustainability that covers the environmental science, economic, and social aspects of sustainability. Where do we put these classes? We can roll more classes out but if they are inherently interdisciplinary… [in which department] do we put it? …In order to make a truly interdisciplinary course you have to make all the pieces roughly equal amounts…. You have to get four different departmental chairs to sign off on it and it will need to fulfill the major outcomes. It could be considered a resume builder…'	Not sure	No
Are there any courses that you believe should be brought back that were sustainability related?	No.	No.	No. There are some environmental science courses that could be brought back.

10.3.11 Results and Discussion – Manually Compiling Data from the Schmid Course Catalog

In the 2013 Audit, as mentioned in the 'History' section of this chapter, displayed manually collected keyword data from Chapman's College's course descriptions from the 2006/2007 to the 2012/2013 course catalog year. In 2013, the curriculum portion of the audit was conducted by only one individual, while in this audit, 11 people conducted the curriculum audit. This permitted for a much more in depth analysis of individual colleges using the keyword methodology from the 2013 Audit. A 'cntrl+f' search was used for a more in depth analysis of the Schmid College course descriptions using 25 keywords for 6 Schmid majors over the past 10 years (2006/2007 catalog year to 2016/2017 catalog year).

10.3.11.a Sustainability and Environmental Science Keywords

The 2013 Audit stated that the occurrence of the 'environ-' and 'sustainab-' keywords had increased over their period of study. However, the student body increased and the number of courses had increased over this period. This could potentially cause an increase in the keywords 'environ-' and 'sustainab-' over time even if the fraction of courses with these keywords is decreasing. Additionally, these two keywords may not be as complete of sustainability curriculum and a more inclusive keyword list. To remedy this, the number of keywords for sustainability related curriculum was increased to 12 (**Figure 10.6)** and then normalized by the number of courses available (**Figure 10.7).**

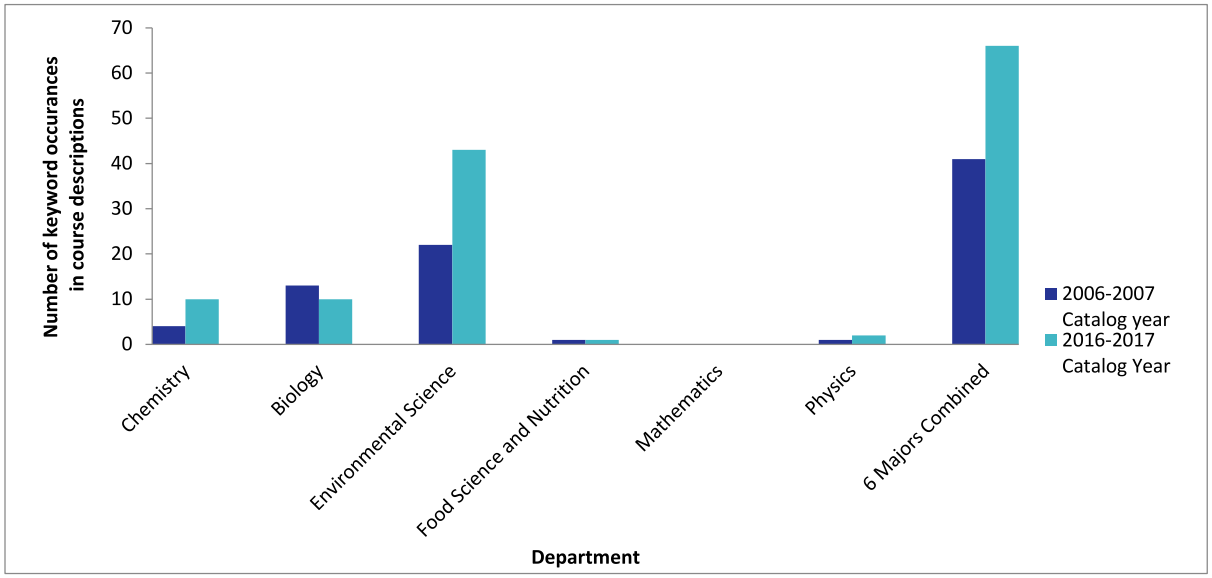

Figure 10.6 - *The number of different environmental science and sustainability keywords in course descriptions from 2006 - 2007 to 2016 - 2017 across 6 majors. Course keywords included 'environ-', 'future', 'ecolog-', 'sustainab', 'pollut-', 'ethic-', 'resource-', 'ocean', 'land', 'hydro-', 'water', and 'energy-'. *Note: courses that contained the same keyword multiple times were counted once, courses that contained multiple keywords were included as multiples.*

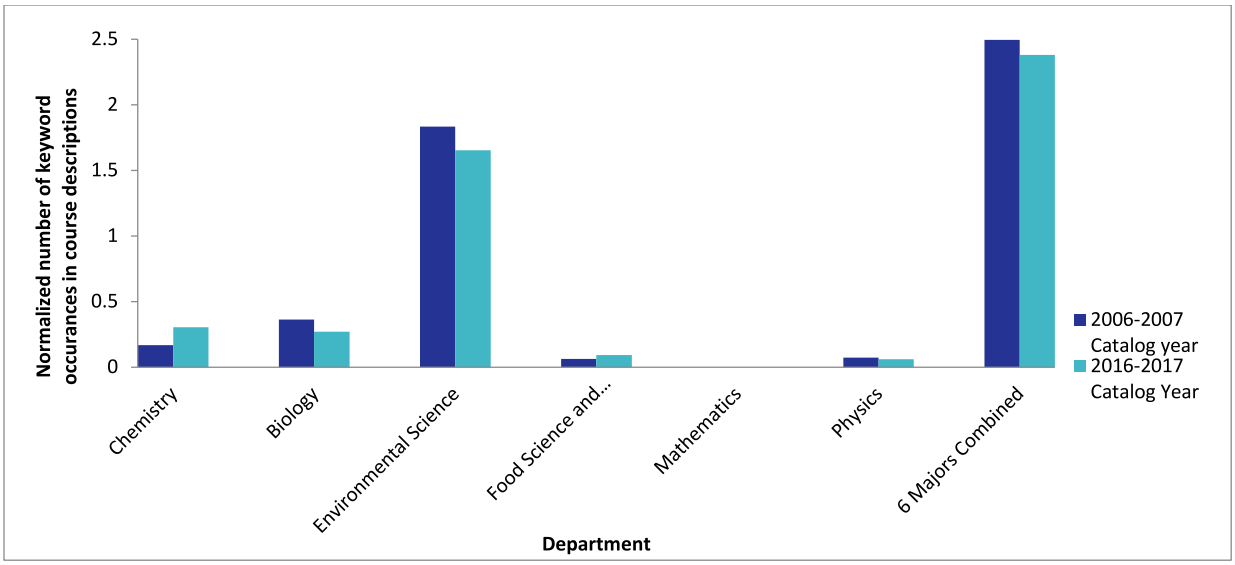

Figure 10.7 - *The average number of different environmental science keywords per class for the 2006 - 2007 and 2016 - 2017 course descriptions across 6 majors. Course keywords included 'environ-', 'future', 'ecolog-', 'sustainab-', 'pollut-', 'ethic-', 'resource-', 'ocean', 'land', 'hydro-', 'water', and 'energy'. *Note: courses that contained the same keyword multiple times were counted once, courses that contained multiple keywords were included as multiples.*

10.3.11.b Interdisciplinary Keywords

The curriculum of 6 majors were assessed using 'ctrl+f' keyword searches from the 2006-2007 catalog to the 2016-2017 catalog, as there is no way to search course descriptions in the 'My Chapman' course search that is currently supplied to students. 'My Chapman' only search for keywords within course titles. **Figure 10.8** shows how the number of keywords that may indicate interdisciplinary classes have fluctuated over time. A spike in keywords can be seen in all 6 majors for the 2009-2010 catalog year. This is due to the incorporation of course objectives as a numbered list in the course descriptions. While this does not indicate more interdisciplinary classes this year, it does indicate that there are more interdisciplinary classes than those found in the other years due to shorter course descriptions with less keywords. This indicates that including course objectives into course descriptions and creating a keyword search in 'My Chapman' will return higher results for students looking for classes in these Schmid departments.

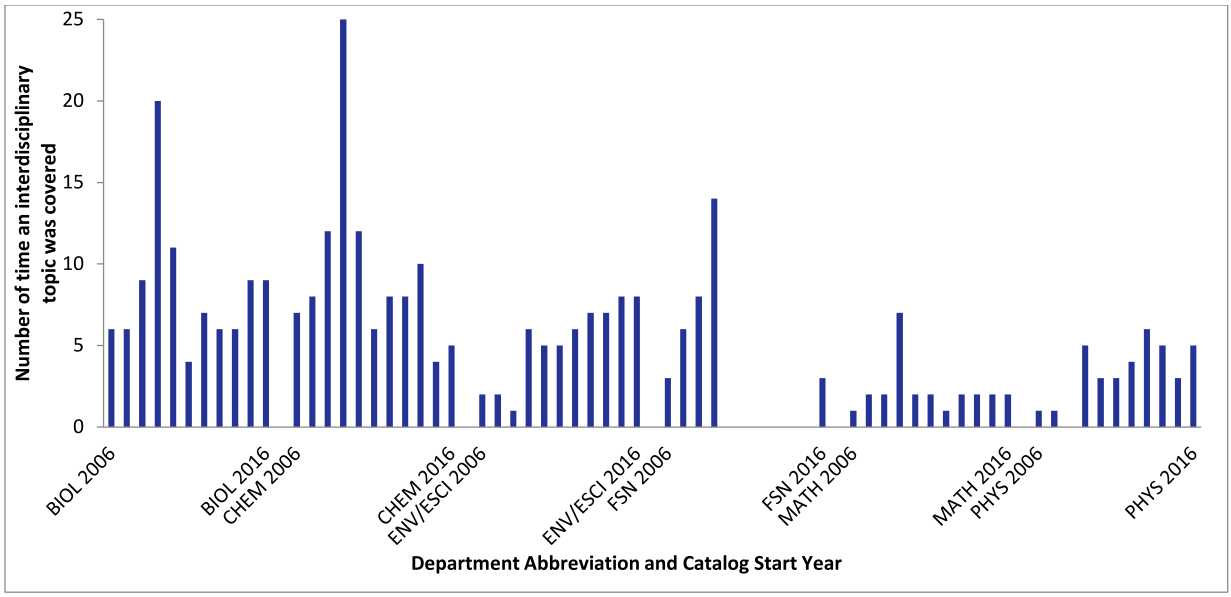

Figure 10.8 *- The number of courses that contained the main keyword from each other major were added together, namely 'Chemi-', 'Bio-', 'Environ-', 'Food', 'Math', 'Physics'. *Note: courses that contained the same keyword multiple times were counted once, courses that contained multiple keywords were included as multiples.*

10.3.12 Results and Discussion – Evaluation of Chapman's Attitude towards Curriculum and Curriculum Changes

Support for an Interdisciplinary Curriculum as Written in Chapman's Graduation Requirements

Chapman University requires that all graduates have two lecture classes in a 'Global Citizen' cluster, a requirement that has been left undefined. A 'Natural Science Inquiry' lecture course and an 'Ethical Inquiry' lecture course are also required. These three requirements are a minimum of 12 credits total and therefore almost fill a semester. While well intentioned, due to the lack of strategic reevaluation of degree requirements, and a lack of incorporation of sustainability and environmental science in the curriculum, the goals of these requirements are not being met. Understanding the changes that the globe is undergoing is an essential part of having a basic level of understanding of natural science, ethics, and what it means to be a global citizen. Sustainability is a topic that fits into everyone's personal and professional lives, and is particularly important for the professional lives of students of science.

Chapman's Vision

Chapman's vision states 'The mission of Chapman University is to provide personalized education of distinction that leads to inquiring, ethical and productive lives as global citizens.' There are two portions of this mission that support an interdisciplinary curriculum between environmental science and other majors at Schmid; the 'ethical' lives portion and the 'global citizen' portion. Ethics are inexorably tied to sustainability. Unfortunately, many sociologists

and environmental scientists do not give the connection enough credit, possibly to the detriment of accomplishing their goals.

Ethics are Inexorably Tied to Sustainability

John Cairns, a distinguished professor of environmental biology and Virginia Polytechnic Institute believes that our lack of sustainability on this planet raises 'some serious ethical issues' (Cairns, 2005). He wrote of eight major ethical issues that arise from our 'ecological overshoot'. A few of these included; (1) 'What is the justification for ruining posterity's opportunity of inheriting a habitable planet?' (3) There is a significant disparity in resource use, where some individuals live in abject poverty and others are extremely wealthy and consume much more of our planet's resources. (6) That while we are overusing the resources on the planet, and therefore come across figures that describe how long we have before we run out of certain resources, this does not include any consideration for the fast that some countries are using drastically more resources than others. Values from the Global Footprint Network show that Australia, Brazil, and Gabon are underusing their biocapacity, while other countries like Belgium/Luxembourg, Israel, Japan, Kuwait, Netherlands, Portugal, Spain, Switzerland, United Arab Emirates, United Kingdom, and the United States are significantly overusing their biocapacity. If Chapman is to follow through with its commitment to teaching its students to be ethically minded, Chapman must provide a more rigorous curriculum for sustainability for all its students.

'Values and Ethics -- One of the most distinguishing aspects of a Chapman education is the ethical emphasis that underscores all academic and student life programs. Students are challenged to think, examine their values and prepare for their future considering how the world might be a better place and how they might contribute to the world.'

Being a Global Citizen Includes Caring for the Globe

The definition of 'global citizens' is missing from Chapman's mission statement. One can imagine what this term means, given the definitions of the two words are common knowledge: global, or worldwide, and citizens, a person who is a member of a formally recognized geographic area with rights that are regulated by a governmental body of some kind. While there is no formal governing body of the world, being a global citizen entails participating in the care of the world, including other human citizens and the earth itself. For Chapman to follow its mission statement, an environmental science or sustainability component must be added as an integral part of every Chapman students' curriculum, not just in Schmid majors.

Chapman's Flexibility in Courses

Chapman is flexible in their curriculum in that they allow many different classes to be chosen for various requirements instead of requiring specific classes for each graduation requirement. This flexibility is what makes it possible to create interdisciplinary classes without restructuring majors. All that is needed is the addition of classes to some of the choices for core class requirements. In many cases, these core classes only need an interdisciplinary component added to their syllabus, which would suffice instead of adding new course. In the case of environmental science interdisciplinary classes, components of chemistry already exist in the

class 'Environmental Problem Solving' for ENV majors. However, few chemistry classes incorporate sustainability intentionally in their classes. A list of interdisciplinary courses was established while keyword data was being manually collected. While the list in **Table 10.3** is not all inclusive, it will assist in further research. The professors of some of the classes below that were considered to be sustainability related by Environmental Science and Policy students did not believe their courses were sustainability related. This may be the result of inconsistencies in definitions and the breadth of definitions of 'sustainability'.

***Table 10.3** – Courses that were collected during manual keyword data collection.*

Course	Course Name	Description	Notes	Interdisciplinary topic
BIOL 235	Impact on Society: Biotechnology	A lecture/discussion course designed to involve students in addressing the numerous issues regarding how the biotechnology revolution of the past three decades has changed many aspects of our lives both as individuals and as a society. Extensive consideration and discussion is given to ethical and social issues related to how this information is used especially relating to medical genetics. (Offered spring semester, alternate years.) 3 credits.		Sociology or Ethics requirement
BIOL 437	BioMedical Informatics	(Same as CPSC 435.) Prerequisite, CPSC 230. Students are introduced to contemporary research topics in medical informatics, including computational techniques for the collection, management, retrieval, and analysis of biomedical data. (Offered as needed.) 3 credits.	Interdisciplinary: same course as CPSC 435	Computer Science
MATH 251	Discrete Mathematics II	Prerequisite, MATH 250. This course covers binary relations with applications to ordered sets, graphs, trees and sorting, followed by topics on Boolean algebras, basic digital circuits, formal languages, and finite state automata. It provides the background and computational tools needed for handling discrete mathematical structures that are used in many applications such as artificial intelligence, bioinformatics, and data mining. (Offered as needed.) 3 credits.	Interdisciplinary: incorporates bioinformatics	Biology - bioinformatics
MATH 403	Statistics for Applied Science	Prerequisite, MATH 203 or equivalent. A second course in applied statistics for research and development in the applied sciences and clinical practice. Beginning with the basic notions of linear regression and the analysis of variance, the course progresses to the principles of experimental design, survey methods, and the elements of observational studies, emphasizing modeling and interpretation of data analyses that arise from research in the applied sciences and the social sciences. (Offered as needed.) 3 credits.	Interdisciplinary: stats for applied sciences	Applied sciences -
CHEM 105	Chemistry of Environmental Issues	Designed for the non-science major. Lectures cover the basics of chemistry as applied to environmental issues, such as air pollution, global warming, ozone depletion, and alternative energy. Lecture, laboratory. (Offered spring semester.) 4 credits.		Environmental Science - sustainability
CHEM 234	Drugs Rx Us	For non-science majors. Drugs Rx Us is an introduction to drugs which have a large social impact on society. This course provides basic information about drug sources, history, and politics, but mostly drug actions in the body, side effects, medical uses, toxic effects, and abuse potential. (Offered interterm, alternate years.) 3 credits.	Interdisciplinary outside of Schmid (with sociology): covers the ethics behind prescription drugs and their impact on society	Sociology or Ethics requirement
CHEM 327	Environmental Geochemistry	Prerequisites, CHEM 331, 340. The field of environmental geochemistry involves the study of the sources, reactions, transport, effects, and fates of chemical species in the near-surface, low-temperature environment. Students will study a wide range of interactions between minerals, rocks, and water at the earths surface that have implications on a number of environmental issues including acid mine drainage, groundwater and surface water contamination,	Interdisciplinary: a great combination between environmental science and Chemistry	Environmental Science or Geology

		hazardous waste management, and natural resource exploration/use. Lecture. (Offered spring semester, alternate years.) 3 credits.		
CHEM 425	Atmospheric Chemistry	Prerequisites, CHEM 411, 441, or consent of instructor. This course will cover the important atmospheric chemistry of both the troposphere and stratosphere. Students will be introduced to the atmosphere, its structure, physical properties and the principles that govern its chemistry before moving on to look at more detailed chemistry, both heterogeneous and homogeneous, of the troposphere and stratosphere. The relationships between atmospheric chemistry and physical climate will be examined. (Offered fall, alternate years.) 3 credits.	Interdisciplinary: discusses air pollution, anthropogenic releases of catalysts and other impacts of emissions on the planet	Environmental Science
CHEM 426	Aquatic Chemistry	Prerequisites, CHEM 411, 441 or consent of instructor. The study of natural water chemistry: a foundation in general principles and selected advanced topics. Special emphasis is given to chemical thermodynamics, redox processes, photochemistry, heterogeneous interactions and kinetics. (Offered alternate years.) 3 credits.	Potential for being interdisciplinary with environmental science and/or biology by looking at anthropogenic water pollution	Environmental Science
CHEM 428	Advanced Topics in Environmental Chemistry	Prerequisites, CHEM 150, 330. Natural and anthropogenic chemical contaminants impacting air, soil, and water are discussed. Topics may include smog formation; ozone depletion; chemicals released into air, soil, and surface ground water, and the fate and transport of contaminant chemicals. Emphasis is placed on chemical reactions and mechanisms. Lecture. (Offered spring semester, alternate years.) 3 credits.	Was also known as ESCI 428 in 2006-2007 catalog	Environmental Science
ENV 310 + L	Geographic Information Systems	Corequisite, ENV 310L. Structure, concepts, and application of geographic information systems (GIS): computer–based systems designed to process large spatial databases. Productive use of GIS in physical and social sciences, environmental management, and regional planning is investigated through applied exercises and problems. Lecture. (Offered spring semester.) 3 credits.		Potentially with Computer Science, Chemistry, Biology, Sociology and others
ENV 320	Earth System Science	investigate short- and long-term changes in earth systems using a variety of seismological, meteorological and environmental monitoring networks using both quantitative and qualitative approaches to better understand geophysics and earth processes. Lecture. (Offered fall semester, alternate years.) 3 credits.		
ENV 440	Remote Sensing of the Environment	Prerequisites, ENV 111, 111L, or 112. Students are introduced how to utilize remotely sensed data to its full potential and how to extract useful information from satellite data. The main emphasis of this course is to shed the light on the physical principals of remote sensing and how to apply to different application topics like remote sensing of vegetation, water, soils, minerals, geomorphology and urban landscaping. Image processing techniques and data manipulation will be also introduced to this class. (Offered fall semester, alternate years.) 3 credits.		Potentially with Computer Science, Chemistry, and Biology
ESCI 428	Advanced Topics in Environmental Chemistry	Prerequisites, CHEM 150, 330. Natural and anthropogenic chemical contaminants impacting air, soil, and water are discussed. Topics may include smog formation; ozone depletion; chemicals released into air, soil, and surface ground water, and the fate and transport of contaminant chemicals. Emphasis is placed on chemical reactions and mechanisms. Lecture. (Offered spring semester, alternate years.) 3 credits.	Was also known as CHEMI 428	Environmental Science
ENV 498	Environmental Problem Solving: Senior Capstone and Seminar	Prerequisites, ENV 310, 330, 374. Interdisciplinary exploration of the scientific, social and economic issues associated with a specific local environmental problem. Students from the three areas of study (Ecology, Earth Systems and Policy) will identify a local environmental issue and work together to produce a proposed solution by the end of the semester. (Offered spring semester.) 3 credits.	Designed to be interdisciplinary, currently this class is being used to conduct audits of	Can be designed to be interdisciplinary with other Schmid majors.

			Chapman University.	
PHYS 405	Seminar in Multidisciplinary Perspectives	Prerequisites, junior standing, PHYS 202 (with a grade of C or higher). Students examine a current issue in physics from a variety of different disciplinary perspectives. (Offered fall semester.) 3 credits.		
PHYS 498	Senior Capstone Research and Seminar	Prerequisites, PHYS 320, 421. Interdisciplinary exploration of physics and computational science. Students will identify an issue and work together to produce a proposed solution by the end of the semester. (Offered spring semester.) 3 credits.	Designed to be interdisciplinary	Can be designed to be interdisciplinary with other Schmid majors
FSN 201	International Nutrition: The World Food Crisis	Contemporary nutritional issues affecting the world. Social, cultural, political, economic, and scientific aspects of world food problems are examined. Nutritional deficiencies affecting various world regions and the role of international agencies are covered. Students learn about food production and food supplementation programs, and examine possible solutions for the future. Lecture. (Offered every year.) 3 credits.	Discusses sustainability issues and ethics issue	Environmental Science, Ethics requirement, Sociology
SCI 400	Applying to Graduate Programs	This 1-credit seminar is intended for students who intend to apply to research-based Ph.D. graduate programs in the natural or applied sciences during the fall semester. It will cover best practices and include targeted assignments to help students craft their graduate school and fellowship applications for maximum success, including: - Identifying your desired subfield - Narrowing down your search - Contacting potential Ph.D. mentors - Drafting personal statements - Seeking letters of recommendation - Making your final decision (Offered fall semester.) 1 credit.		All Schmid majors

Chapman's Dedication to Expanding Schmid's Reach

Chapman has shown massive support for its Schmid College of Science and Technology by investing over $130 million into building a new science building, which will be finished in 2018. From Sheri Ledbetter's article "Chapman to break ground for new Center for Science and Technology:

> "'I consider the groundbreaking for the Center for Science and technology one of the most significant events in my 25 years as president and an exciting capstone to the leadership I have given Chapman,' said James L. Doti, president of Chapman University. 'This Center for Science and Technology will strengthen Chapman's position in key areas of science so critical to the future of Southern California, as well as stimulate the growth of a new, interdisciplinary learning ecosystem,' he continued."

It is now Chapman's next task to help Schmid College modify the current curriculum so that it can grow in quality and quantity and fill this beautiful new science building.

Figure 10.9 *– Shimahara Illustration of Chapman University's new Schmid College of Science and Technology building. Illustration dated: 8-15-16 (CST-PDF).*

10.4 Concluding Assessments about Interdisciplinary and Sustainability Curriculum at Schmid

10.4.1 Students

Students – Students do not have an accurate keyword search engine for finding courses, this needs to be addressed before adding new courses.

Curriculum – Schmid College has an interdisciplinary curriculum but there is room to grow both in terms of the curriculum content and the size of the curriculum and faculty, thanks to the new science building!

10.4.2 Faculty

Faculty are open to learning more about sustainability but need to have a lower work load in order to do so. New courses should not be added until the existing course issues are rectified. Bringing in new courses that suffer from low enrollment but take time and energy for faculty to create can lead to frustration and even complacency with adding new courses in the future.

10.4.3 Curriculum

Chapman's curriculum has interdisciplinary and sustainability courses, however they need to be easier to search for and better advertised before adding new courses.

Additionally, Chapman's graduation requirements of 'global citizen', 'ethics', and 'natural science inquiry' need to be better defined.

10.5 Recommendations for Remedying Roadblocks to Interdisciplinary and/or Sustainability Curriculum

10.5.1 Low Cost and/or Effort

10.5.1.a Make courses searchable for students

- Send an email to students teaching them how to search using 'ctrl+f' search in the course catalog. Alternatively, the first day of class of next semester, students could be shown this by their professors to make sure that all students are reached.
- Make students aware that 'My Chapman' does not search for keywords within the course description, and therefore should only be used for enrolling after they choose their course using the 'ctrl+f' method in the course descriptions on Chapman's website.
- Add a list of keywords to each course in the course catalog, these can be added at the end of each course relatively easily and is much easier that rewriting the course descriptions. Course objectives could also be added as they were in the 2009/2010 course catalog.

10.5.1.b Advertise courses to students

- Advertise ENV courses to other Schmid majors. Increasing advertisement will likely lead to an increase in interest and enrollment in ENV department courses, which will make a strong financial case to improve and expand the ENV department curriculum. **Figure 10.10** shows an example of a sign that will increase awareness of ENV courses.

***Figure 10.10** – Suggested simple sign for advertising of Environmental Science and Policy courses*

- Advertise new courses in Schmid to all majors. Many new courses have been cancelled due to low interest or enrollment and advertising can help with this.
- Send out new and/or elective course options in emails and decrease email noise. Chapman students receive an excessive amount of emails each day, and before adding new emails the number of emails must be decreased significantly. While many students are aware of the list of courses that must be taken for their major, elective courses, new courses, experimental courses and research courses often are not advertised and are difficult to search in 'My

Chapman'. Therefore, it should be a priority of the Schmid College to advertise these courses to students until 'My Chapman' searches the course descriptions.

10.5.1.c Make it easier for students to design their curriculum to meet their needs

- More of an emphasis needs to be placed on advising Schmid students. Without constant communication with students, program advisors will be unable to help students incorporate the relatively rapidly changing courses in Schmid College.
- Make sustainability courses count for the natural science inquiry, ethics and global citizen requirements. This allows more flexibility in students' coursework and there is a compelling argument that these should already be included in the list of courses allowed for these requirements.

10.5.1.d Include definitions in the course catalog

- Sustainability vs. Environmental Science
    - At Chapman University, there has been a growing effort to prepare students for global changes that are occurring because of anthropogenic activities. Our climate, clean water, clean air, reliable non-GMO organic food sources, and the intrinsic value of the flora, fauna, and landscape of Earth are at risk due to excessive, rapid use of natural resources.
    - The words 'sustainability' and 'environmental science' are often used interchangeably, including at Chapman in its course catalog and on its website. While definitions vary from person to person and institution to institution, at Chapman University we believe that the two are inexorably tied and therefore are interchangeable in many circumstances. Sustainability, in terms of our earth, is when we do not use or damage anything faster than it can be replenished. In the idealistic version of sustainability, a version to strive for, sustainability means that we decrease damage and use enough for the resource to return to as close to its natural state (a state uninfluenced by anthropogenic activities). These resources include anything that is naturally occurring, or that is derived from something naturally occurring, which includes everything.
    - 'Environmental science' is the process through with sustainability, or lack thereof, is measured. In many cases, 'environmental science' refers to assessing impacts on the natural environment directly, such as done through water sampling for pollution. However, assessing a corporation's energy use through their energy company is also using the scientific method to collect data on resource use, and therefore this is also 'environmental science', despite that is may more commonly be called a 'Sustainability Audit'. It is important that faculty, students, and staff understand the interchangeability and interconnectivity of the terms 'sustainability' and 'environmental science', and see both in the bigger picture of assessing anthropogenic impacts on earth. Environmental science is the method with which sustainability can be measured. However often activities involving sustainability have more of a focus on behavior changes to decrease anthropogenic impacts, while environmental science refers to only the assessment of the state of the natural resource and/or the impacts overuse of the resource has had.

- Global Citizen recommended definition – An individual who is recognized not only as a citizen of their country, but also as a member of a world without territory boundaries. A global citizen is someone who understands how their own actions and the actions of their country impact people and places around the world. A global citizen acts to protect humans, animals and ecosystems around the world in their personal and professional lives.
    - Requirements for the Global Citizen cluster – Students can make a case for a course of their choosing to help them understand their own impact and others' impacts on people, animals, and ecosystems. The course must have a component that fosters changes in behavior by examining the student's personal choices. Students can make a case for other courses from Schmid College and may substitute courses at the discretion of the department head of the course they are requesting to count for the inquiry (signature required on add/drop form with a note "GCC").
- Ethics recommended description – Throughout college students' moral values evolve, and the ethics course requirements are designed as a flexible system to help nurture students' development and evolution of personal beliefs.
    - Requirements for the Ethics cluster – Students can make a case for a course of their choosing to help them develop their own personal values as well as expose themselves to differing values of other students and faculty. Ethics courses may include, but are not limited to: socioeconomic disparities, resource use and access disparities, ethical treatment of humans or animals, ethics in rhetoric, ethical issues that result from destruction of resources, habitats, access to clean water and food, and ethics behind industries such as the pharmaceutical industry. Students can make a case for other courses from Schmid College and may substitute courses at the discretion of the department head of the course they are requesting to count for the inquiry (signature required on add/drop form with a note "EC").
- Natural Science Inquiry recommended definition – The Natural Science Inquiry is designed for students to gain knowledge about the natural sciences and scientific method so they can read science related articles, critically think about natural science related topics such as those discussed in the media, and use their knowledge to make educated personal decisions about things like sustainability and food choices. This inquiry can help students explore a natural science that interests them.
    - Requirements for the Natural Science inquiry – The Natural Science inquiry can include any course in chemistry, physics, environmental science, biology, geology, or biochemistry. Students can make a case for other courses from Schmid College and may substitute courses at the discretion of the department head of the course they are requesting to count for the inquiry (signature required on add/drop form with a note "NSI").

10.5.2 Medium Cost and/or Effort

10.5.2.a Make courses searchable for students

- Create a keyword database for courses that can be searched through 'My Chapman'.

- Set the keyword search to search within the keyword database, course objectives and/or the course descriptions of each course. Another program could also be used if 'My Chapman' does not allow for this volume of text within each course.

10.5.2.b Limit work burden on faculty

- Increase the number of student assistants for faculty
- Have department heads teach only 0-1 courses per semester, let them use time they spent on courses to focus on designing and implementing curriculum ideas as recommended by students and faculty.

10.5.2.c Educate faculty on sustainability and environmental science topics

- Offer self-led courses from the Northwest Earth Institute for faculty and students. This should only be expected to be successful if advertised well, books are covered by the university, and if faculty have had time given back to them in the form of a lower work/course load. While a few professors may find the time even if their course load is not decreased, it is unreasonable to expect current faculty to fill their schedules further.

The courses favored by faculty were:

  - Reconnecting with Earth – understand how ecosystems sustain our lives
  - Change Is Our Choice: increase resilience and mitigate the impacts of climate change

The most popular courses according to NWEI's website are:

  - Choices for Sustainable Living – explore sustainability more deeply and learn what sustainability means on a personal level and a global level
  - Menu for the Future – examine the many cultural, social and ecological implications of food consumption, and learn how to make healthier choice for you and the planet.
  - Voluntary Simplicity – examine how consumer culture impacts you and your relationships

10.5.3 High Cost and/or Effort

- Hire faculty specifically to design and grow Schmid's curriculum
- Apply for grants for interdisciplinary and sustainability curriculums. While writing proposals can be extremely time consuming, by combining the minds of individuals who have expertise in visualizing data within the college, and training them using the widely recognized Grantsmanship program, grants could be well worth the initial time and monetary investment.
- Create a work load policy: professors should only teach 2 classes/semester
- Hire additional Schmid faculty for each major to take some of the burden off of existing faculty.
  - Determine which classes need to be assigned to new professors and what expertise are required

10.5.4 Future Areas of Research

Manually Compiling Data from the Schmid Course Catalog - Include a keyword search for 'multidisciplinary' in the interdisciplinary chart, and for the environmental science and sustainability keyword charts, they should be normalized by the number of courses in each course catalog year for each department.

The Public Survey – Keep the survey open and re-evaluate the statistics with a significantly larger sample size. New research question: "Is interdisciplinary college coursework increasing the average income for graduates regardless of whether they are working on single or multidiscipline projects?"

Faculty interviews – Interview significantly more faculty, ideally all the full time faculty. Before interviewing, definitions of environmental science and sustainability should be determined and agree upon for the purposes of clarity.

10.6 CONTACTS …..

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