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Developing Integral Ecologists: Description and Analysis of the State of Environmental Education at Jesuit High Schools in Light of Religious Ecological Commitments and Science Education Research

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DEVELOPING INTEGRAL ECOLOGISTS: DESCRIPTION AND ANALYSIS OF THE STATE OF ENVIRONMENTAL EDUCATION AT JESUIT HIGH SCHOOLS IN LIGHT OF RELIGIOUS ECOLOGICAL COMMITMENTS AND SCIENCE EDUCATION RESEARCH

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Ad Majorem Dei Gloriam

I am well aware that in the areas of politics and philosophy there are those who firmly reject the idea of a Creator, or consider it irrelevant, and consequently dismiss as irrational the rich contribution which religions can make towards an integral ecology and the full development of humanity. Others view religions simply as a subculture to be tolerated. Nonetheless, science and religion, with their distinctive approaches to understanding reality, can enter into an intense dialogue fruitful for both.

—Pope Francis, *Laudato Si'*

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LIST OF ABBREVIATIONS

ACS	American Chemical Society
AP	Advanced Placement
APES	Advanced Placement Environmental Science
DBER	Discipline-Based Education Research
ES	Environmental Science
ICC	Ignatian Carbon Challenge
ISN	Ignatian Solidarity Network
Jesuits	Society of Jesus
JSN	Jesuit Schools Network
JVLA	Jesuit Virtual Learning Academy
K-12	Kindergarten to twelfth grade
NAAEE	North American Association for Environmental Education
n/a	Not applicable
NGSS	Next Generation Science Standards
NRC	National Research Council
POGIL	Process Oriented Guided Inquiry Learning

ABSTRACT

This research responds to numerous calls to focus more immediately and deeply on environmental education in the context of local communities. Jesuit high schools offer a rich network to study this movement, as schools with long histories of scholarly and moral concerns for forming students to think about and act on worldwide problems. The key research question is: How can science education research inform environmental education in these schools? The research methodology includes data collection and analysis of publicly-accessible website data, phone interviews with teachers, and a literature review of science education research. Recommendations are given for vertically aligning the diverse environmental education activities at these schools with coherent standards for student development of specific environmental competencies.

CHAPTER 1

RESEARCH INTRODUCTION AND SIGNIFICANCE

Definition of Key Terms

Several key terms are critical to clarify in order to elucidate their intended meaning throughout the rest of this thesis.

- Environmental education is any activity in a school meant to influence students' content knowledge, skills, attitudes, or behaviors related to environmental topics through classroom content, informal and co-curricular activities, speakers, or the physical parts of the school facilities.
- Competencies are the specific ways students are expected to develop after participating in an activity, including: content knowledge, cognitive skills, affective (or emotional) development, attitudes, or behaviors
- Integral ecology is a term borrowed from Pope Francis' encyclical *Laudato Si'* (2015) that refers to his vision of an ecology that considers: (1) environmental, economic, and social factors, (2) cultural respect, (3) the daily life of each person, (4) the principle of the common good, and (5) justice between the generations.

Subsequent chapters build on these initial definitions and contextualize the terms within this research project.

Motivation and Research Questions

The motivation for this project grew out of parallel movements within science education literature and Catholic Church documents. Particularly, this research responds to numerous calls to focus more immediately and deeply on environmental education to develop students with particular competencies that will help them address current and future environmental issues in their communities and the world. High schools run by the Society of Jesus (or Jesuits) offer a rich context to study the interaction of these movements, as schools with long histories of scholarly and moral concerns for forming students to think about and act on worldwide problems. Three key questions served as the basis of this research.

1. What is the basis for environmental education in science education and Catholic pedagogy literature?
2. In what ways do teachers at Jesuit high schools educate students about environmental issues currently, both in formal classroom curricula and in co-curricular activities or the informal school culture?
3. How might the enacted science curricula at these schools be changed to better align to national standards and research on environmental education?

These questions were explored with a mixed-methods approach as detailed in Chapter 3. Data and analysis are included in Chapter 4, and implications for Jesuit schools are detailed in Chapter 5.

Scope and Significance

This thesis focuses on schools in the Jesuit Schools Network (JSN) throughout the United States and Canada for a few different purposes. First, these schools have rigorous expectations for their classes including Advanced Placement (AP) and dual-enrollment courses for college credit. The teachers at these schools also offer vast experience in teaching with environmental issues. Therefore, they can serve as models of high-caliber environmental education that other schools can emulate. Second, many of these teachers have significant flexibility and autonomy over their classroom curriculum as compared to teachers at many public or private schools with more restricted curriculum. Therefore, teachers at Jesuit schools likely have more immediate freedom to alter their curriculum and test new methods of environmental education. Third, these schools have articulated clear goals to increase environmental awareness and action in their communities, but there has been limited coordinated support for teachers to develop their curriculum around environmental issues. This research builds on the momentum and motivation of these teachers and schools to support them in advancing environmental education more broadly.

Finally, in addition to city schools with significant numbers of students from underrepresented groups, the JSN includes several Cristo Rey schools that use an innovative model of college-preparatory curriculum mixed with professional work experience for students from economically-disadvantaged families living in inner-city areas across the United States. Developing resources that work for teachers and students at the wide variety of schools in the JSN will help make the resources applicable to many different classrooms outside the JSN, especially for schools serving students from traditionally underrepresented groups in the sciences. Therefore, research conclusions are presented within the context of the JSN but could be adapted to a wider variety of classrooms.

The significance of this research for the broader science education field includes providing a detailed description of the variety of efforts at Jesuit schools to educate students about environmental topics. Describing these blended (both formal and informal) educational efforts could help to provide these and other schools with an initial reference point for comprehensively evaluating their environmental education. This work could also lead to a more formal and comprehensive assessment of environmental education by providing some relevant variables to be evaluated.

This project also begins to establish a model for evaluating changes in student attitudes or behaviors as a result of science instruction. Significant research has investigated the change of student attitudes toward science in context-based chemistry classrooms (Cam & Geban, 2011; Neerinck & Palmer, 1979; Onen & Ulusoy, 2014). More work is needed to investigate student behavioral change and the connections between attitude and behavioral change, particularly in science classrooms focused on environmental issues (Daubenmire, van Opstal, Hall, Wunar, & Kowrach, 2017; Guagnano, Stern, & Dietz, 1995; Steg & Vlek, 2009; Vining & Ebreo, 1992). These behavioral changes in students are expected to result in real impacts on their communities during and after their time in the classes. As they connect with their families and communities, the students can have larger impacts as leaders and young educators about the most current environmental knowledge (Daubenmire et al., 2017).

Finally, this research attempts to provide a model of a research design appropriate for broad and disparate educational initiatives similar to environmental education at Jesuit schools. Purely quantitative measures like standardized test scores are not appropriate to explore the impacts of educational initiatives across schools with vastly different contexts and approaches to particular content. Other educational researchers might be able to adapt the mixed-methods approach used here to evaluate similarly blended educational initiatives.

CHAPTER 2

LITERATURE BACKGROUND

This chapter focuses on describing the relationships among historic trends in science education practice and Catholic, especially Jesuit, documents as they relate to environmental education. First, the theoretical basis of these approaches to science education is covered. Then, a brief history of the place of environmental education in science education and in Jesuit schools helps elucidate the extent of this content area and its development over time. Then in later chapters, the current place of environmental education at Jesuit high schools is explored along with recent science education research to make recommendations about the future of science education at these schools.

The Learning Theory Basis for Environmental Education

Although relevant to current social and political contexts, environmental education is not simply a response to these current issues. It builds on research-based theories about teaching practices and the way students learn best. The clearest theoretical backing for the type of environmental education proposed in this thesis comes from the theory of situated cognition (Brown, Collins, & Duguid, 1989). This theory presents education as a social endeavor where students learn from teachers in implicit ways like the vocabulary or behaviors a teacher models, in addition to learning from each other and their wider communities. Furthermore, situated cognition suggests that students will learn content more deeply and authentically if it is presented in a way that focuses first on activity and perception rather than conceptualization (Brown, Collins, & Duguid, 1989). In other words, the implicit learning of attitudes and actions is an important consideration alongside the explicit concepts in a variety of subject areas. Because environmentalism is a social issue, it becomes especially important to foster classroom spaces where students learn in more authentic ways, beyond isolated content knowledge.

A second basis for this work is the theory of planned behavior (Ajzen, 1991), which includes the idea that if someone has the intention to do a certain action and if they think others around them will be supportive of that action, they are more likely to carry it out. Research based on this theory studies how attitudes and intentions shape future behaviors (e.g., Rise, Thompson, & Verplanken, 2003). For environmental education, this type of research helps us understand how classroom learning could affect student actions in their current communities and later in life. These two learning theories are embedded in the research and educational initiatives explored throughout the rest of this chapter.

Environmental Education in Science Education Literature

The effort to include environmental education in high school science courses has a long history in the United States, with origins in the environmental movement of the 1960's (Carter & Simmons, 2010). Among chemistry educators, one well-known example of environmental education is the *Chemistry in the Community* text developed and supported by the American Chemical Society (ACS) with funding from the National Science Foundation. The sixth edition of this text was published in 2011 (ACS, 2011). The text was designed for high school students reading below their current grade level and not considering studying science in the future or attending college at all (Sutman & Bruce, 1992). Early evaluations of this text showed promising results, including that these students were more motivated to study science in the future (Sutman & Bruce, 1992). Students also scored higher on standardized ACS final exams compared to students in traditional chemistry courses (Penick & Leonard, 1993). A related text, *Chemistry in Context: Applying Chemistry to Society*, was also developed by ACS for non-science majors at the college level, with the eighth edition published in 2015 (Middlecamp, 2015). Although not exclusively focused on environmental issues, both these texts include substantial and explicit connections to environmental issues such as air pollution, ozone depletion, global climate change, energy sources, water issues, acid rain, nuclear power, food contents and growth, and includes sustainability as a theme across chapters of the text.

Other efforts to include environmental issues in chemistry education can be placed under the broad areas of:

- green chemistry (Anastas & Warner, 1998; Royal Society of Chemistry, 1999; Sharma & Mudhoo, 2011; Ware et al., 1999);
- context-based chemistry (Mahaffy, 1992; Onen & Ulusoy, 2014; Stolk, De Jong, Bulte, & Pilot, 2011; Ültay & Çalik, 2012; Van Driel, Bulte, & Verloop, 2008); and
- citizen science initiatives (Connors, 2013; Ledley, 2015; Lepczyk et al., 2009; Mueller & Tippins, 2015; Saylan, Blumstein, & Blumstein, 2011).

The magnitude of efforts to use environmental issues in chemistry education shows both the energy within the chemistry community and the need for updated and coherent standards for student development during these courses that go beyond traditional content standards for chemistry courses.

Several research studies have suggested the potential impacts of classrooms that use environmental issues. One project suggested that using environmental issues as a context for learning across different classrooms improved student achievement (particularly in language arts) and reduced behavioral issues (Lieberman & Hoody, 1998). A related project found that even limited classroom inclusion of environmental issues as a context for learning science can impact students' real-world actions (Daubenmire et al., 2017). These promising results emphasize the need to test environmental education in more classrooms to verify and explain these results.

Other recent educational developments have also influenced current high school chemistry and environmental education. The Next Generation Science Standards (NGSS) for K-12 classes built upon previous research about the nature and process of science (Project 2061, 1993), recommending specific objectives across three dimensions, including: Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts (NGSS Lead States, 2013; Willard, 2014). The implication for chemistry education is that curricula and assessments should be based on more than simply factual recall for students, professional scientists, or science educators (Cooper, 2013).

One strategy for science classes that attempts to move beyond factual recall is inquiry-based learning where students are encouraged to ask questions and actively investigate concepts in a student-centered environment (Larson & Keiper, 2013; Park Rogers & Abell, 2008). Within chemistry curricula, Process Oriented Guided Inquiry Learning (POGIL) is an extensively studied and adapted instructional approach for both high school and college classrooms (Barthlow & Watson, 2014; Brown, 2010; Daubenmire et al., 2015; Farrell, Moog, & Spencer, 1999; Loo, 2013; Millis, 2010; Moog, 2014). For AP science curricula, the College Board (2016) has updated recommendations to include inquiry approaches in chemistry, biology, physics, and environmental science. The AP Environmental Science (APES) curriculum also had a pilot program in the 2016-2017 school year to include a service component in the course requirements where students devote time to working on local environmental issues (The College Board, 2016). One implication from these developments is that students should develop certain skills and science practices during these courses that have value outside of preparing them to be future scientists (Penick & Leonard, 1993).

Another related area of research can be summarized as project-based or problem-based classrooms, where students are presented with real-world problems to solve using class content knowledge (Vasconcelos, 2012). Research on these classrooms has shown them to help students (a) be more engaged, (b) see the subject as part of their everyday life, and (c) learn the content more completely than other types of classrooms (Conley, 2005; David, 2008; Thomas, 2000). These research-based teaching practices and previous projects indicate substantial promise for using contexts and problems based on local environmental issues to support student development in science classes.

A challenge for these perspectives on educating students is to measure and evaluate student development beyond recall of content knowledge. Competency assessment is a growing area of education research based on the identification and measurement of knowledge, skills, and attitudes needed by experts in a particular discipline (Duarte, Ramos, Rosillo, Alperstedt, & Hazé, 2015). The perspective of competency assessment in science education places less focus on evaluating content knowledge. One argument for this shift in focus is that students have access to a deluge of scientific information so that expecting them to memorize information is less important than their development of specific skills (Lee, 1964).

Competencies in science courses beyond specific content knowledge can include the development of:

- "big ideas" about science, such as the particulate nature of matter (Kennedy, 2014; Talanquer, 2013);
- problem-solving or critical-thinking skills (Shadle, Brown, Towns, & Warner, 2012; Taasoobshirazi & Glynn, 2009);
- laboratory and research techniques (Prades & Espinar, 2010);
- metacognitive awareness and skills (Cooper & Sandi-Urena, 2009; Rickey & Stacy, 2000; Sternberg, 1998; van Opstal & Daubenmire, 2015); and
- positive attitudes about science in society (Çam & Geben, 2011; Dalgety, Coll, & Jones, 2003; Juntenen & Aksela, 2013; Neerinck & Palmer, 1979).

These competencies do not replace content knowledge. In fact, content knowledge is still a critical component of developing these competencies fully (Conley, 2005). However, these competencies do help to reframe how educators build curricula and assess student performance. For example, instead of asking students to write out the definition of the first law of thermodynamics on an exam, a teacher might assess students' content knowledge and critical-thinking skills by asking them to explain how the first law of thermodynamics could be applied to statements like, "aluminum can be recycled infinitely." Using the context of environmental issues in high school science classes has been one way for educators to respond to the educational developments covered in this section, within a growing cultural awareness of and concern for those issues.

Environmental Education in Catholic Pedagogy Literature

The Catholic community, in particular, has recently made several notable calls for increasing environmental awareness and action. One example was Pope Francis' encyclical *Laudato Si'* that emphatically outlined the ethical and moral imperatives to act on climate change and other ecological issues (Pope Francis, 2015). Although this encyclical followed a long tradition in the Catholic Church of environmental awareness and stewardship, a clear message from the encyclical was the urgency of a determined global response to these issues in the near future. As mentioned in Chapter 1, the term "integral ecology" comes directly from Pope Francis' encyclical *Laudato Si'* (2015) that outlines this view of an ecology that considers: (1) environmental, economic, and social factors, (2) cultural respect, (3) the daily life of each person, (4) the principle of the common good, and (5) justice between the generations. An integral ecologist is not necessarily a professional scientist but someone prepared to explore solutions to environmental problems that consider these five dimensions.

The Jesuits, as an international order, have also made clear calls for environmental action in their networks. One document, "Healing a Broken World," details how the various groups within the Jesuits can and should act in more environmentally-conscious ways, including educational initiatives preparing students to solve environmental problems (Alvarez, 2011). Within Jesuit high schools in North America, a group of administrators who oversee secondary education in these areas outlined a document titled "Our Way of Proceeding: Standards & Benchmarks for Jesuit Schools in the 21st Century," including a specific standard to educate "students in issues of ecological stewardship and solidarity with creation" (Provincial Assistants for Secondary and Pre-Secondary Education, 2015). The JSN also maintains a "Profile of the Graduate at Graduation" with detailed goals for every graduate of a Jesuit high school including standards about practicing "a sustainable lifestyle" and engaging in "public dialogue on environmental issues, practices, and solutions," under the broad category of "Committed to Doing Justice" (Jesuit Schools Network, 2015). These recommendations, although clear about the imperative to include environmental issues, are lacking detailed suggestions for how teachers might address the standards in their classrooms or other school activities.

These calls for environmental education build on broader pedagogies within Jesuit schools, such as the Ignatian Pedagogical Paradigm that advocates for teaching students through cycles of experience, reflection, evaluation, and action, emphasizing that knowledge is most valuable when it helps students perform some positive action in the context of the world (Kolvenbach, 2013). Particularly for science education, implementing this paradigm would pose a significant challenge to some models of teaching that are limited to content memorization and do not extend content knowledge to reflection or action. In the area of environmental education, the ideal student would graduate from a Jesuit high school already beginning to think as an integral ecologist by using scientific knowledge, ethical principles, and spiritual awareness to analyze and act on environmental issues.

The confluences of Ignatian educational goals and recent trends in science education research reveal the shared values of action and skills over isolated knowledge. Both movements suggest the need to develop students who can apply scientific reasoning, ethical consideration, cultural awareness, and a just outlook to solve environmental issues in their community as integral ecologists. Additionally, the particular subject area of environmental science seems to be an area of interest for both Jesuit schools and secular science education, as an area of great need in the world and broad applicability to scientific content areas.

Amidst the opportunities being explored for using environmental issues as a context to teach science content, several challenges will need to be addressed. Educators will need to develop and test a rigorous set of competencies for students in these classes. High school teachers might also need to change the inertia of their current high school science curricula that might focus more on content recall to better align to research-based education practices. In order to address these challenges and possibilities more fully, this thesis explores the place of environmental education within Jesuit schools in light of science education research and current standards for high school education.

Environmental Education as a Subset of Discipline-Based Education Research

Discipline-based education research (DBER) describes an approach to science education research that studies educational theories and methods situated within particular disciplines (National Research Council [NRC], 2012). One implication of DBER is that different disciplines bring unique assumptions and content knowledge that may require instructional strategies unique to each discipline. DBER studies have been most extensive in chemistry, physics, engineering, and biology as summarized in the NRC report (2012). The report also identified “geoscience education research” as a unique discipline, noting that “there is no central ‘canon’ of knowledge that is encompassed by the disciplines that study the earth” and that “geoscience content may be taught in a variety of courses, in different departments” (NRC, 2012, p. 49). These observations hint at the state of environmental education at many of the Jesuit high schools and emphasize the lack of DBER for environmental courses or activities. There is a clear need for more research into how students develop competencies in these types of courses and the types of teaching practices that support student development best.

Several other groups have recently taken a DBER approach to develop standards and competencies focused on environmental education or including significant environmental content. Table 1 gives a summary of organizations that have developed curriculum or standards for environmental education.

Table 1. Organizations with Curriculum or Standards for Environmental Education

Curriculum or Standard Title	**Associate Organization(s)**
Next Generation Science Standards (NGSS)	The National Research Council (NRC), the National Science Teachers Association, the American Association for the Advancement of Science, and Achieve
Guidelines for Excellence: K-12 Learning	North American Association for Environmental Education (NAAEE)
Closing the Achievement Gap: Using the Environment as an Integrating Context for Learning	California’s State Education and Environment Roundtable
Advanced Placement Environmental Science (APES)	The College Board
Social Justice, Peace, and Environmental Education: Transformative Standards	American Education Research Association

The NGSS include significant environmental content across the Performance Expectations and Disciplinary Core Ideas in different topic areas (NGSS Lead States, 2013). The North American Association for Environmental Education (NAAEE) has developed detailed guidelines for K-12 environmental education (2010), aligned with national standards for other content areas, including the science standards that preceded the NGSS (Project 2061, 2009). In California, the State Education and Environment Roundtable has worked on creating professional development and curriculum resources including “the environment as an integrating context” across academic departments (Lieberman, 2013; Lieberman & Hoody, 1998). The APES curriculum details mostly content knowledge expectations, as well as some lab and field work skills (The College Board, 2013). One group of scholars associated with the American Education Research Association developed a set of “transformative standards” for “Social Justice, Peace, and Environmental Education” that emphasized the importance of adapting these standards to local contexts (Andrzejewski, Baltodano, & Symcox, 2009). These sets of standards provide a detailed basis for Jesuit high school teachers to continue building a structure for environmental education at their schools.

The educational theories, trends, and pedagogies surveyed in this chapter help to portray the context in which environmental education is growing in Jesuit high schools. Both science education research and Catholic pedagogy documents have called for a focus on environmental issues in classrooms. Implementing environmental education can also fulfill movements to focus on building competencies beyond only recall of content knowledge. Chapter 3 explains how this research studied the current state of environmental education at Jesuit high schools in light of this literature background.

CHAPTER 3

METHODS AND SCOPE

Analysis of Environmental Education at Jesuit High Schools

The key questions for this segment of research were: (1) In what ways do teachers at Jesuit high schools educate students about environmental issues currently, both in formal classroom curricula and in the informal school culture or co-curricular activities? (2) What activities exemplify the ways these schools help students develop the relevant environmental competencies?

This project considered only schools in the JSN that work with high school aged students–a total of 62 schools. See Appendix A for the full list of schools and their respective data. Informal phone conversations with 15 teachers from some of these schools helped to illuminate the range of environmental education at their schools and influenced the variables chosen in the first segment of research. The public websites of these schools were then used to gather data about the following variables:

- student population size,
- student genders,
- Cristo Rey affiliation,
- availability of an APES course and associated grade level,

- availability of other science courses that might include significant coverage of environmental topics and a description of that course (outside of traditional chemistry, biology, and physics), and
- the existence and names of student clubs or activities related to environmental issues.

Another factor considered was the school's participation in the Ignatian Carbon Challenge (ICC) at the individual or institutional level (Ignatian Solidarity Network, 2016). This project is run through the Ignatian Solidarity Network (ISN) with monthly challenges related to environmental topics. For the 2016-2017 school year, more than 20 schools (including schools outside the JSN) and 3000 individuals participated in the challenge each month. The participation information was found on the ISN website and supplemented based on individual school websites, as additional schools claimed to be involved on their own website.

Website data were accessed from January to February of 2017 and may be outdated or might not reflect what actually goes on in the school day to day, but these data at least provide points of comparison for what different schools claim to do around environmental education. Often current school population was difficult to find and older data or non-official school websites were used instead. Each school's data were also shared via email with at least one faculty member from that school to increase the accuracy of these variables. Replies were received from 33 teachers, and updates to the data were made as needed.

Finally, a series of formal phone interviews were conducted with seven of these teachers about their experiences with environmental education. Two experts from Jesuit universities were also interviewed by phone or in person for their perspective on standards and environmental education at Jesuit high schools to compare with the perspectives of the high school teachers. Representative quotes are included throughout this thesis to add qualitative depth to the descriptions included here. IRB approval was obtained from Loyola University Chicago before conducting any interviews (application #4621), and all participants signed consent forms where they could choose to participate anonymously or with their name included with their quotes.

Environmental Competencies Comparisons

The main questions for this segment of research include: What are the expert competencies (including professional skills, content knowledge, or affective development) students are expected to achieve (or make progress in achieving) after instruction in environmental science, ecology, or context-based chemistry? What competencies typify an integral ecologist?

To address these questions, research articles were compiled that seemed to give recommendations about competencies that students should develop in courses that include environmental applications of chemistry content (Bennett, Lubben, & Hogarth, 2007; Cam & Geban, 2011; Coenders, Terlouw, Dijkstra, Pieters, & Pieter, 2010; Habraken et al., 2001; Jackson, 1998; Neerinck & Palmer, 1979; Onen & Ulusoy, 2014; Overton, Byers, & Seery, 2009; Stieff & Wilensky, 2003; Ultay & Calik, 2012; Vasconcelos, 2012; Zollen, Tsaparlis, Fatsow, & Lubezky, 1997). A team of four undergraduate researchers and the author conducted a consensus coding process to identify and describe the competencies discussed in these articles, with at least two researchers reading each article. Next these competencies and several of the environmental standards lists were cross-compared to find areas of overlap or significant gaps. The NAAEE guidelines (2012) for grade 12 students were used as an outline for this comparison because of their clarity and comprehensiveness.

Based on this alignment process, the author and an undergraduate researcher constructed a spreadsheet with these competencies cross-aligned with each other. This spreadsheet will be shared with teachers to help them incorporate environmental competencies into their current curriculum more easily and in comprehensive, structured ways among the variety of activities and courses at their school. See Appendix B for a summary of this spreadsheet. Initial alignment with the traditional courses of biology, chemistry, and physics as well as other courses or activities were also proposed as a model for teachers to adapt to their own schools.

Limitations

Several challenges needed to be addressed in the course of conducting this research. First was recognizing and accounting for differences among these 62 schools. Any proposals for a one-size-fits-all approach to environmental education at these schools would be ineffective to support lasting change in their environmental education, because the resources available to teachers and the needs of students can vary widely. Second was seeking input from a representative sample of teachers from the 62 schools. It is likely that the teachers most-invested in environmental education were the most willing to coordinate interviews, and, therefore, the data from those interviews would be biased toward the experiences of these highly-invested teachers. Finally, many of the ways environmental education is expressed in these schools were difficult to quantify and track. These reports attempted to collect a variety of data with both qualitative and quantitative methods to help explore these activities to an appropriate depth, but there are inherent limitations to tracking these data in any comprehensive way. This work should not be construed in any way as a formal evaluation or rating of these schools, although it could contribute to the development of a more formal evaluation of the impacts of environmental education for their students and communities.

This research might also have limited applicability to other school communities for several reasons. First, schools outside the JSN might have different motivations or amounts of freedom to include environmental education in their curriculum, and implementing these changes might look different in these schools. The interview data and many of the conclusions also include the perspective of highly-committed and experienced teachers who have been the driving force for environmental education at many of these schools. Teachers at other schools might not have the same levels of motivation, support, or experience to implement these curriculum changes. This disparity emphasizes the need for support and sharing of resources between schools. Finally, any effort to shift the traditional structure of high school science curriculum will require redirecting the academic inertia of these schools and will likely be more difficult at certain schools with stakeholders who are more resistant to changing the existing structure.

CHAPTER 4

DATA RESULTS AND ANALYSIS

A focus for this project was to provide a detailed description of the state of environmental education at Jesuit high schools. This chapter begins to provide those details by summarizing the data collected from school websites and through formal interviews as well as the alignment of environmental competencies. Brief conclusions are provided, with further recommendations and implications included in Chapter 5.

School Website Data

The context of these schools' local communities is an important factor that can impact the extent of environmental education. Most of the schools included in this study are in large urban areas. The majority of these schools are officially run by the Jesuits, although a few are technically "endorsed" by the Jesuits and might not be included in other lists of Jesuit schools. Three of the schools included are in Canada, with the rest throughout the United States.

Table 2 presents a summary of the other school-level data collected from school websites with deeper descriptions below. Of the 62 schools, eleven are Cristo Rey schools, and the rest are considered here to be "traditional" Jesuit schools. Considering only high school students, the list includes 17 "small" schools with under about 500 students, 22 "medium" schools with between about 500-1000 students, and 23 "large" schools with more than 1000 students. The students are all male at 34 of the schools,

Table 2. School Descriptive Variables

Data Category (N=62 for each)	**Data Summaries**		
Cristo Rey	11 Yes	51 No	
Size (Grades 9-12)	16 Small (less than 500 students)	22 Medium (500-1000 students)	23 Large (1000-2000+ students)
Genders	34 all-male	27 coed	1 co-divisional[a]
Availability of AP Environmental Science (APES)	23 Yes	39 None listed[b]	
Other Environmental Science Options	33 Yes	6 Potential	23 None listed
Environmental Clubs	33 Yes	16 Experiential	13 None listed
Ignatian Carbon Challenge (ICC) Participation	8 at institutional level only	13 at individual level only	12 at both levels

[a] Includes separate boy's and girl's divisions on the same campus
[b] At least two of these schools allow students to take APES online through the Jesuit Virtual Learning Academy (JVLA)
[c] 29 schools were not listed as participating in the ICC.

coed at 27 of the schools, and co-divisional for one school, where separate boy's and girl's divisions are on the same campus. Among other factors, these initial descriptive measures help to show the variability in these schools that might impact how they educate students about environmental issues.

One of the most structured ways students at these schools might learn about environmental issues is through the APES course (The College Board, 2013). According to the school websites, 23 schools offered APES during the 2016-2017 school year. This class was almost exclusively offered as an elective for students in grades 11 or 12. At least two other schools allowed students to take an online version of APES through the Jesuit Virtual Learning Academy (JVLA), through which students from different Jesuit schools have access to courses not available at their own school. Additionally, students at schools without a formal APES class might still choose to take the APES exam by studying on their own or supplementing another environmental science course, although tracking these additional data is more difficult. Although students may differ in how and why they choose to take APES, the availability of this course provides a highly-structured form of environmental education at some of the Jesuit high schools.

Many schools offer some other type of environmental science class, besides APES. There are 33 schools that offer a course with a clear focus on environmental topics. Some of the titles of these courses are: Global Science, Earth Science, Environmental Science, Geology, Oceans and Atmosphere, Zoology, Botany, Marine Science, Science and the Environment, and Oceanography. A full list is available in Table A2 of Appendix A. There are 6 schools that had courses such as Green Chemistry, Engineering Science, and Physical Science that potentially include significant coverage of environmental topics, depending on how they are taught. The other 23 schools do not have a course listed that seems to directly address environmental issues.

These distinctions are somewhat arbitrary, and, in fact, the coverage of environmental topics in these courses depends heavily on the school culture and the teachers of each individual course. For example, the St. Bonaventure's college website notes that they have an interdisciplinary focus on eco-literacy across the curriculum but does not list any single course explicitly focused on environmental issues (St. Bonaventure' College, 2017). It would be inappropriate to evaluate a school's commitment to environmental education solely on the basis of their listed class titles. Although some schools like St. Bonaventure's are integrating environmental topics through a more traditional science course sequence, the course titles included above and in Table A2 reveal an additional avenue that students might take to learn about environmental topics in a focused and sustained way at other schools. It is significant to note that many of these courses are upper-level elective classes. Some introductory classes like Earth Science or Global Science are required for grade 9 students at a few schools, but the vast majority of the schools do not have required courses that predominantly cover environmental topics.

Apart from formal classroom environments, students have opportunities at many of these schools to learn about or act on environmental issues through informal environments like clubs or co-curricular activities. There are 33 schools with clubs or activities that directly relate to environmental content, with names like: Environmental Club, Recycling Club, Green Team, Students Against Violating the Earth, Pro-Earth, Student Environmental Action Society, and more. Additionally, 16 schools had clubs or service programs that allow students to experience the environment but do not necessarily include explicit environmental content, such as several outdoor clubs, fishing clubs, gardening clubs, and service programs that have environmental options. The other 13 schools did not have a club or activity listed online that appeared to connect directly to environmental topics. These types of informal spaces and experiences serve to supplement classroom learning and allow students to opt-in to more ways of learning about their local environment (Kirchhoff, 2016), notably at any grade level.

One other metric of these schools' efforts to provide environmental education is their participation in the ICC organized for the 2016-2017 school year by ISN. There are two separate ways for schools to participate in the challenge. First is at an institutional level where schools are challenged to make far-reaching changes in their institutions. Second is at an individual level where students, faculty, parents, or alumni can sign up as individuals or groups to be challenged each month with smaller tasks, such as going for a hike or tweeting a picture of a reusable water bottle. Of the 62 schools, 12 are listed as participating at both levels; 8 participated only on the institutional level; and 13 participated only at the individual level. The participation of these schools shows some of the social energy among teachers, students, and other community members around environmental issues.

Finally, there are other ways that schools educate students about environmental issues throughout school spaces and programs, such as the presence of recycling or composting, the existence of a sustainability committee, required events such as environmental presentations or outdoor service projects, or through school announcements or other media. These activities are harder to quantify but might offer significant differences in the ways students learn about environmental topics.

Interview Data and Discussion

The interviews with teachers and education experts helped to add depth to the website data and to reveal additional themes about how these schools educate students about environmental topics. One clear theme was that environmental education seems to be offered as an option for students or as part of other courses, rather than a separate class requirement within the traditional sequence of biology, chemistry, and physics. At schools with only one APES class each year, a limited number of students ever encounter the scientific content of environmental topics in a sustained and focused way through the curricula. For example, one science teacher who asked to remain anonymous noted that his school got rid of another environmental science class in favor of an APES option for seniors but that he “would love to see more classes focus on environmental science and do some cross-curricular work” (phone interview, May 5, 2017).

However, there are indications that some schools support a wider culture of environmental awareness. At Red Cloud High School in South Dakota, the culture within the local community already teaches students about environmental awareness. Anne Conover, one of the science teachers from Red Cloud who also works with their greenhouse on campus, elaborated on this point, saying, “there’s a general culture around here of caring for the Earth and being cognizant of the effect that your actions have on it” (phone interview, May 4, 2017). The social energy and informal environments of these schools can potentially provide a more general environmental education to a wider group of students, although the science content coverage might vary widely (Kirchhoff, 2016).

The experiential opportunities, in particular, contrast with typical classroom learning and help cultivate different skills and attitudes in students. Marcia Pecot, a science teacher from Cristo Rey High School in Atlanta, Georgia, explained how teachers would use their outdoor garden space in certain classes, adding that:

> Students started to use it during lunch. They started to use it after school for study space and group meetings. So the garden kind of grew... like a familiar

> space for the kids, but it actually grew and became a safe space for a lot of them. (phone interview, May 5, 2017)

This affective development and affinity for outdoor spaces could be one type of competency addressed by experiential activities more than typical classroom spaces.

The interviews with teachers and experts emphasized that Jesuit schools have a mission-based motivation to focus on environmental education. Dr. Lorraine Ozar, a curriculum expert at Loyola University Chicago who has worked on standards for Catholic and Jesuit schools, explained her view that, "This is part of a fundamental Catholic stance that you would be having responsible stewardship for the Earth, as part of God's creation" (personal interview, April 27, 2017). She elaborated that:

> I think environmental stewardship ought to be best practice… There are a lot of good economic and curriculum-based reasons for doing it. But I think what is different in Catholic schools and in Jesuit schools is the mandate or commitment or motivation to do this is not just pragmatic, it also relates to the deep values of finding God in all things, care for creation, transforming the world so that resources are available for everybody… In a sense, I think Catholic schools, by their mission, have a greater charge to go ahead and do this–indeed, to be educational leaders in this area. (L. Ozar, personal interview, April 27, 2017)

One education expert from another Jesuit university in the United States who chose to remain anonymous, explained similarly:

> The mission [of Jesuit schools] might be helpful to remind faculty and staff how necessary it is to work with these principles [of environmental education]. We talk about the education of the whole person. We talk about being men and women for others, setting the world on fire. Well, all those concepts are related to this… The future of humankind depends on understanding the fragility of the environment, and depends on understanding that unless we begin creating this critical consciousness, the whole world is in danger." (phone interview, May 18, 2017)

The teachers themselves echoed this school-wide motivation to improve the ways they educate students about environmental topics. Marcia Pecot, gave one example, saying:

> Every year we get a hundred percent of the school involved in the Green Apple day of service, whether they're making bulletins or posters, or encouraging parents to practice no-idling in the parking lot. We plan a whole day of service, and we get one hundred percent student involvement. (phone interview, May 5, 2017)

Activities like this day of service at many of the Jesuit schools demonstrate the school-wide motivation to address environmental issues in tangible ways.

Other teachers expressed a desire to include environmental education in their classrooms but note the lack of resources and space in the curriculum to do so. Kirstyn Dutton, a science teacher in the boy's division of Regis High School in Colorado, explained:

> With the added theology courses and things like service projects and the other stuff that goes into making a Jesuit school a Jesuit school, it sometimes takes flexibility out of the curriculum of other classes that kids can take... We want them to know about environmental issues, but if they only have room for this many science classes, is it more important to make sure they have exposure to the big three sciences of physics, biology, and chemistry, or do we let them have some wiggle-room to explore the different issues? (phone interview, May 19, 2017)

Along with motivation to include these topics comes unique challenges for these Jesuit schools to fit this additional information into their curriculum.

Another theme that emerged from the phone interviews with teachers is the extent of misconceptions about environmental science as a course topic. One set of misconceptions is that environmental science is an easier alternative compared to other science classes. Even the APES course is sometimes viewed by students as a back-up to courses like AP Chemistry, Biology, or Physics. Martha Parent, an APES teacher at Bellarmine Prep in Washington, noted that some of her students "are taking the class because they are truly interested in environmental topics," while others are taking APES "because it's an Advanced Placement class and maybe doesn't include as much math as

AP Chem or AP Physics" (phone interview, May 10, 2017). Unfortunately, these misconceptions have been reinforced in some schools where students scoring lower on math exams are placed into a course using *Chemistry in the Community* (American Chemical Society, 2011) or similar curricula, or at some schools where students can test into higher level courses that do not include significant environmental content.

Contrary to this view, many teachers expressed their view that environmental science is one of the more difficult science courses because it combines many other areas of science and applies the content to real world problems. Stanmore Hinds, a science teacher at the Cristo Rey high school in Atlanta, explained, "Taking an AP Chem class does not mean you are smarter than anyone, because it requires way more brain cells to interpret and analyze and come up with solutions to environmental problems than it does just to solve a simple chemistry problem" (phone interview, May 9, 2017). Kirstyn Dutton, a science teacher in the boy's division of Regis High School in Colorado, noted how environmental classes contrast with more traditional classes, explaining:

> When I was in high school, I felt like it was just the traditional disciplines of: you liked bio, you liked chem, or you liked physics. Or you didn't like science at all. But [taking environmental courses in college] showed me that you could integrate and that there were sciences where you were using multiple different components together. (phone interview, May 19, 2017)

Other teachers made similar claims about the difficulty of APES or environmental content generally.

Another misconception is environmental science should be taught in a completely apolitical way. The education expert who asked to remain anonymous noted:

> It doesn't matter how much we teach them if we don't also teach them what happens when the government doesn't care about this... Education is political... This is probably where teachers at Catholic schools might need the most support:

> how to craft lessons that talk about environmental concerns and presenting the sides of the concerns… It's political. But if we are going to be talking about environment, it is going to be political. (phone interview, May 18, 2017)

The idea that environmental topics are too political can unfortunately be reinforced at schools where environmental issues are only discussed as social or institutional issues and not as a discrete content area. These and other misconceptions pose serious barriers to expanding the use of environmental issues in these schools as teachers attempt to gain the support of administrators, other teachers, parents, and students.

Finally, a more general challenge for high school science curriculum is to apply science content and skills to students' current lives and not just their lives as future scientists or citizens (Penick & Leonard, 1993). Shaneka Woods, a science teacher at Verbum Dei Cristo Rey High School in California, explained her school's approach to teaching science classes, noting:

> With the implementation of the Next Generation Science Standards, there's a big push on ensuring that our students are not just learning chemistry, or physics, or learning physical science in isolation, but that they're learning about the long-term and immediate impact of… that particular science. (phone interview, May 9, 2017)

For her chemistry classes, that means applying traditional topics like balancing equations to environmental content like the carbon cycle and climate change "so that [students] can be scientifically literate and make decisions about the world around them." This type of problem-based learning is a promising shift toward providing an environmental perspective on traditional course content. Yet even these approaches can sometimes use far-reaching issues that might not be accessible or applicable to all students, especially those who do not continue to study the sciences beyond high school. Finding and updating applications of science content to problems that are relevant and interesting to students will continue to be a challenge for teachers because environmental information changes more quickly than other disciplines and since local contexts might vary widely between schools.

Conclusions on Current Environmental Education at Jesuit High Schools

One of the most notable features of the opportunities students have available to learn about environmental topics at these schools is that they must predominantly opt-in to the activities. Ultimately the range of activities in these schools that connect students with information about environmental topics indicates a large potential for students to encounter these issues. But the disparate coverage of environmental topics also poses one of the most significant challenges to this research and to schools' efforts to improve or assess their environmental education in any comprehensive way. If different classes, teachers, or activities are all meant to teach students about the environment, there is a higher risk that that these activities are not supporting each other as they would as part of a single course. One alternative would be to implement a required environmental science course for all students. However, the teachers more often expressed a desire to weave environmental content into other courses rather than to create a new environmental science course. Any attempt to improve environmental education at these schools in general will likely need to deal with the current variety of environmental education activities and incorporate environmental topics into the existing course structure to accommodate that preference from teachers.

There are clear calls to continue developing environmental education from both science education research and Catholic pedagogy (Chapter 2). In spite of numerous challenges, there is also energy and interest from teachers at the Jesuit high schools to try to improve the state of environmental education at their schools. If these schools are serious about living up to the environmental expectations embedded in Jesuit documents and recent science education trends, they will need to make significant changes to address the structural challenges that teachers encounter when trying to implement environmental education. The next section explores science education literature for research-based practices and structural recommendations for these teachers and schools to help them form integral ecologists.

Competency Comparison Results

This section applies a DBER perspective to environmental education to explore connections between environmental education competencies from the NAAEE and in the NGSS as compared to science education research. The focus is on context-based chemistry work in particular as one extensively studied area that blends environmental education into a traditional course (Bennett, Lubben, & Hogarth, 2007; Mahaffy, 1992; Onen & Ulusoy, 2014; Overton, Byers, & Seery, 2009; Stolk, De Jong, Bulte, & Pilot, 2011; Ültay & Çalık, 2012; Van Driel, Bulte, & Verloop, 2008). This type of blending is expected to be the most relevant to the teachers at Jesuit high schools who expressed a desire to integrate environmental topics into their existing course structures.

The NAAEE guidelines (2010) include four "Strands" of environmental education standards: (1) Questioning, Analysis, and Interpretation Skills (2) Knowledge of Environmental Processes and Systems (3) Skills for Understanding and Addressing Environmental Issues (4) Personal and Civic Responsibility. These standards have significant overlap with the NGSS, which is unsurprising since both built from similar documents like *Benchmarks for Science Literacy* (Project 2061, 1993).

NAAEE Strand 1 connects most directly with the NGSS Science and Engineering Practices, requiring students to apply these practices to environmental research or phenomena. For example, NAAEE Guideline 1.B: "Designing investigations" applies several parts of the NGSS practice of "Planning and Carrying out Investigations" to "answer particular questions about the environment." These practices are also woven into many of the context-based chemistry articles, emphasizing that these competencies are applicable and should be included in a variety of high school science classes.

The science content of NAAEE Strand 2 includes many of the NGSS Disciplinary Core Ideas, especially in NAAEE Sub-Strands 2.1: "The Earth as a Physical System" and 2.2: "The Living Environment." This content spans Earth systems, structures and cycling of matter, energy, heredity and evolution, and other biological concepts like biodiversity and population dynamics. NAAEE Sub-Strand 2.4 focuses on the interactions between "Environment and Society," including the effects that human activity has on the planet, an idea woven across several topic areas of the NGSS. The knowledge competencies in NAAEE Strand 2 are more directly related to particular course content in biology, chemistry, and physics. School curricula likely cover many of these competencies already and would only need to be modified slightly to include environmental connections. For example, NAAEE Guideline 2.1.B: "Changes in matter" includes content typically covered in a chemistry course such as chemical reactions and rates. To include environmental content, the chemical reactions involved in burning fuels or photosynthesis could serve as a context for students to learn the chemistry concepts.

NAAEE Strand 3: "Skills for Understanding and Addressing Environmental Issues" includes requirements for students to analyze environmental issues, evaluate actions and alternatives, and take action. The standards in this strand parallel some of the engineering standards of the NGSS, exemplifying the idea that science content knowledge should be applied to real problems in the world as part of the learning process. Many of the chemistry in context articles include competencies similar to NAAEE Strand 3 guidelines, showing promise that these guidelines could be incorporated into a traditional chemistry course with some modifications. For example, guideline 3.1.C includes students "identifying and evaluating alternative solutions and courses of action." A traditional chemistry class could have students apply their content knowledge about solubility and acid-base chemistry to evaluate actions to mitigate ocean acidification. The significant overlap of these guidelines and course content helps emphasize the possibility of weaving environmental issues into several courses to fulfill the same standard requirements with an applied perspective. Environmental applications also serve as a natural extension of the movement of the NGSS toward emphasizing transferable skills and behaviors along with content knowledge in science classes.

However, there are other parts of the NAAEE guidelines that differ significantly from the NGSS. NAAEE Sub-Strand 2.3: "Humans and Their Societies" includes content outside the NGSS that might be covered more regularly in social studies classrooms or through informal activities. One example from NAAEE Guideline 2.3.B requires students to "Recognize diverse cultural views about humans and the environment. Anticipate ways in which people from different cultural perspectives and frames of reference might interpret data, events, or policy proposals." Although more closely related to humanities curriculum, these types of cultural or interpretational considerations could also be included as the context of issues in chemistry classrooms (Jackson, 1998). For example, teachers might ask students to consider how different cultures might allocate scarce water resources based on their cultural values. Would some cultures prioritize the weakest in their community? Would some cultures allocate water solely through a free market system? Or would other cultures use different methods? In this way, students would need to draw on their scientific understandings of the availability of water while also considering cultural priorities or distribution infrastructure to make policy decisions.

Additionally, NAAEE Strand 4: "Personal and Civic Responsibility" includes requirements for students to evaluate and explain how a societal context and their personal role in society might impact the effectiveness of environmental actions. This contextualization of science content in a society is not as clear in the NGSS but builds on broader pedagogies such as citizen science (Ledley, 2015; Connors, 2013; Mueller & Tippins 2015; Lepczyk et al., 2009) and situated cognition (Brown, Collins, & Duguid, 1989). Teachers might address NAAEE Guideline 4.D: "Accepting personal responsibility" by beginning a unit on food with a classroom discussion about how individual choices about what food to purchase can affect the world including growth, processing, or transportation impacts. They could ask students to make a list of what information and criteria they would need to consider to decide which foods to purchase and to make a claim about how they would act based on that information. Engaging student's personal values and choices would help to integrate their science knowledge with their sense of personal responsibility.

Overall, the NAAEE guidelines help to define a structure for environmental education that has support from the NGSS and context-based chemistry research. These guidelines are a promising template to incorporate environmental connections into high school curriculum.

CHAPTER 5

IMPLICATIONS FOR ADVANCING ENVIRONMENTAL EDUCATION AT JESUIT HIGH SCHOOLS

Now that the current state of environmental education at Jesuit high schools has been described and some broader trends in science education have been explored, it is time to anticipate the future of environmental education at these schools and make recommendations for improving the way these schools develop students as integral ecologists. The main questions for this chapter are: How can this research be applied to Jesuit high schools, and what future research needs to be done to support the development of students as integral ecologists? To answer the calls for environmental awareness from science education research and Catholic documents (Chapter 2), the competencies and standards should be applied to the current state of environmental education at Jesuit schools (Chapter 4) in several critical ways. As mentioned previously, the context and needs of each school community might require adapting these recommendations significantly. However, this thesis can provide a basis for teachers, administrators, and other stakeholders to determine how best to form their students into integral ecologists.

Several objectives should be prioritized to implement the results of this research and to advance the role of environmental education at Jesuit high schools.

- A certain level of environmental content knowledge and decision-making should be required from all students rather than presenting environmental information mostly in an optional class.
- Environmental education should be presented as a cross-curricular way of applying content, rather than a back-up to "harder" or more math-intensive classes.
- Potential political connections of science content should be addressed, rather than avoided in science classrooms or informal activities.
- Science content should be connected to student's actions in their communities, while avoiding an unreflective environmentalism.
- The ethical and spiritual dimensions of science such as students' beliefs and values should be explored in a structured and open way through science classes.
- Environmental education activities in and outside of classrooms should be aligned with appropriate standards to ensure that students develop the appropriate competencies throughout their time at Jesuit high schools.
- Teachers who are attempting to improve environmental education at these schools should be provided with structured support such as connections to teachers at other schools, focused time to restructure their curriculum, and encouragement and other resources from school administrators.

These recommendations are not meant to provide a comprehensive guide for schools to follow but some points for teachers to consider as they continue improving their environmental education. Further details are explained below.

Perhaps the clearest recommendation is that environmental content and applications should be integrated into the science curriculum generally, and not solely in elective classes for a limited number of students. At some schools, a required class on environmental science might fit best into the curriculum, while others might choose to integrate environmental content across several grade levels and courses, even outside the science department. The goal of these courses would be to integrate environmental topics into the existing course sequences to teach the same scope of content but in more grounded, engaging, and impactful ways that are related to real issues in the school communities and people's lives. In this way, the context of environmental issues would serve as both a framework for teaching science content and an avenue for students to apply content as active citizens in their current communities. A wider inclusion of environmental topics in the curriculum would also mean that every student at these schools has some exposure to these topics.

Because climate change and other environmental issues can be highly-charged political topics for people in the United States, it is important to clarify that the focus in these classrooms should not be to indoctrinate students or to convince them to think in one way about these issues. Rather, the focus should include developing their abilities to recognize and evaluate how their values and other people's values affect their actions in the world, beyond isolated scientific facts. The National Science Teachers Association affirmed a similar idea in a position statement on Environmental Education (2003), writing, "Central to environmental literacy is the ability of students to master critical-thinking skills that will prepare them to evaluate issues and make informed decisions regarding stewardship of the planet." Developing lessons and classroom assessment tools that consider students' beliefs and values in deep ways would be an influential next step of this research. Without validated classroom materials to consider students in this way, teachers might either ignore potentially contentious issues or they might teach in a way that seems (or is, in fact) indoctrinating to students, other teachers, or parents.

Additionally, there can be a danger of supporting a type of unreflective environmentalism, at odds with the goal of integral ecology, by teaching students only to take certain environmental actions like using reusable bags without critically examining why and how those actions affect the world. In authentic environmental education, teachers should neither avoid political topics nor present them without appropriate levels of reflection and context. This challenging distinction also helps to emphasize the need for structured requirements for environmental education at each of these schools.

Any of these courses or activities that are intended to teach students about environmental issues should also be horizontally aligned and assessed with research-based standards such as the NAAEE Guidelines or the NGSS. Furthermore, these courses and activities should be compared with each other to ensure that students develop the appropriate competencies throughout their four years at a Jesuit high school. This alignment will help bring some focus to the disparate environmental activities currently in these schools. Particular focus should be given to incorporating competencies that are not currently being addressed by an activity or course. For example, the NAAEE Guideline 2.3.B requires that: "Learners understand cultural perspectives and dynamics and apply their understanding in context." This guideline might not be explicitly covered or assessed in a science course, but it could be addressed by having students visit a cultural group in their own community or arranging for students to talk virtually with students or other representatives from different cultures to learn about their views on the environment. Jesuit schools could take advantage of their educational network around the world to arrange these types of experiences. Forming a comprehensive vision or description of environmental education at each of these schools is the next step that many of these schools should take.

Finally, the teachers at these schools could benefit from coordinated support from teachers at other schools and from their own school's administration or leadership. Many of these schools have well-developed environmental education curriculum and structured environmental activities. Coordinating and sharing these resources more frequently through symposia and conferences would help ease the burden of coordinating an environmental education program, especially at schools where only one teacher is working on these issues.

Furthermore, school administrators or other leadership often play a critical role in supporting teachers to make these types of curriculum changes. As one education expert from a Jesuit university in the United States, who chose to remain anonymous, explained:

> There are some schools that are quite progressive. They have a leadership that is supporting the teachers to go beyond the test and beyond the standards. That would be fantastic to begin creating lessons that are addressing these issues... I think Catholic schools have more room to work with these standards. But as I said, it depends on the leadership, it depends on how strong they are mission driven, and it depends on whether they have an obligation to abide by the Common Core standards. (phone interview, May 18, 2017)

If these schools are going to include environmental education in deep and structured ways to form integral ecologists who are ready to address real-world environmental issues, teachers will need this variety of support to be successful.

Future work

The focused nature of this work could serve as a model for developing an innovative approach to teaching science content that synthesizes and builds on disparate efforts in science education to educate students about the environment and to encourage their actions in the real world. The most pressing work to be continued from this thesis is refining the lists and alignment of environmental competencies based on the experiences of teachers in these schools. Based on this research, some major themes to be considered in developing these competencies include requiring students at Jesuit high schools to:

- Describe environmental science as a way of applying content knowledge and skills from different subject areas to real-world problems;
- Seek out and summarize scientific information from a variety of sources to answer environmental questions;
- Consider social, ethical, and spiritual implications of environmental issues and potential solutions along with scientific information;
- Distinguish degrees of certainty or limitations in conclusions about environmental issues, especially deciding when more information is needed to answer a question with a sufficient degree of rigor;
- Explicitly critique political arguments and proposals about environmental topics based on the variety of information the students gather;
- Recognize and articulate how their personal beliefs and values connect with environmental content; and

- Practice the Ignatian Pedagogical Paradigm model by planning and taking actions that address environmental issues in the context of their own communities and evaluating the results of those actions.

Aligning traditional course content with these themes and with other standardized environmental competencies would be an influential task to help other schools integrate environmental content more immediately into their existing course structures. These alignments will need to be adapted to each school and community context, as well being regularly updated with the corresponding environmental content. Teachers, students, and community stakeholders should be consulted in this process to evaluate the best ways to improve environmental education at each school. Finally, teachers should receive time and support for professional development and networking with other teachers about using the context of environmental education to teach science content (Coenders, Terlouw, Dijkstra, Pieters, & Pieter, 2010; Vasconcelos, 2012). Schools in the JSN can use their symposia and conferences to organize sessions to connect teachers interested in environmental work. Ultimately this work will extend far beyond the Jesuit high school communities as these students make choices in their daily lives and future professions about environmental issues using the competencies they develop as integral ecologists.

APPENDIX A

HIGH SCHOOL DATA TABLES

Table A1. School Demographic Data

School Name (State or Territory)	Website	Gender	Number of Students (Grades 9-12, except as noted)	Cristo Rey
Arrupe Jesuit High School (CO)	http://www.arrupejesuit.com	Coed	393	Yes
Belen Jesuit Preparatory School (FL)	http://www.belenjesuit.org/page	Male	854	No
Bellarmine College Preparatory (CA)	http://www.bcp.org	Male	1600+	No
Bellarmine Preparatory School (WA)	http://www.bellarmineprep.org	Coed	1000	No
Boston College High School (MA)	http://www.bchigh.edu/home	Male	1241	No
Brebeuf Jesuit Preparatory School (IN)	https://brebeuf.org/directory/science-department/	Coed	775	No
Brophy College Preparatory (AZ)	http://www.brophyprep.org/page	Male	1327	No
Canisius High School (NY)	http://www.canisiushigh.org	Male	825	No
Cheverus High School (ME)	http://www.cheverus.org	Coed	435	No
Christ the King Jesuit College Preparatory School (IL)	http://www.ctkjesuit.org	Coed	302	Yes
Creighton Preparatory School (NE)	http://creightonprep.creighton.edu/	Male	1029	No

Table A1. School Demographic Data (continued)

School Name (State or Territory)	**Website**	**Gender**	**Number of Students (Grades 9-12, except as noted)**	**Cristo Rey**
Cristo Rey Atlanta Jesuit High School (GA)	http://www.cristoreyatlanta.org	Coed	500+ (projected for 2017)	Yes
Cristo Rey High School - Sacramento (CA)	http://www.crhss.org	Coed	354	Yes
Cristo Rey Jesuit College Prep - Houston (TX)	http://cristoreyjesuit.org	Coed	522	Yes
Cristo Rey Jesuit High School - Baltimore (MD)	http://www.cristoreybalt.org	Coed	360	Yes
Cristo Rey Jesuit High School - Chicago (IL)	http://www.cristorey.net	Coed	550+	Yes
Cristo Rey Jesuit High School - Milwaukee (WI)	http://www.cristoreymilwaukee.org	Coed	400 (projected for 18-19 year)	Yes
Cristo Rey Jesuit High School - Twin Cities (MN)	http://www.cristoreytc.org	Coed	455	Yes
Cristo Rey San Jose Jesuit High School (CA)	http://www.cristoreysanjose.org	Coed	372 (grades 9-11)	Yes
De Smet Jesuit High School (MO)	http://www.desmet.org	Male	964	No

Table A1. School Demographic Data (continued)

School Name (State or Territory)	Website	Gender	Number of Students (Grades 9-12, except as noted)	Cristo Rey
Fairfield College Preparatory School (CT)	https://www.fairfieldprep.org/index.cfm	Male	901	No
Fordham Preparatory School (NY)	http://www.fordhamprep.org	Male	1015	No
Georgetown Preparatory School (MD)	http://www.gprep.org	Male	491	No
Gonzaga College High School (DC)	http://www.gonzaga.org	Male	965	No
Gonzaga Preparatory School (WA)	http://www.gprep.com	Coed	835	No
Jesuit College Preparatory School (TX)	https://www.jesuitcp.org	Male	1100	No
Jesuit High School - New Orleans (LA)	http://www.jesuitnola.org	Male	1422 (8-12)	No
Jesuit High School - Portland (OR)	http://www.jesuitportland.org	Coed	1292	No
Jesuit High School - Sacramento (CA)	http://www.jesuithighschool.org	Male	1067	No
Jesuit High School - Tampa (FL)	http://www.jesuittampa.org	Male	750	No
Loyola Academy (IL)	http://www.goramblers.org	Coed	2000+	No
Loyola Blakefield (MD)	http://www.loyolablakefield.org/page	Male	1000 (6-12)	No

Table A1. School Demographic Data (continued)

School Name (State or Territory)	**Website**	**Gender**	**Number of Students (Grades 9-12, except as noted)**	**Cristo Rey**
Loyola High School - Los Angeles (CA)	http://www.loyolahs.edu	Male	1247	No
Loyola High School - Montreal (QC)	http://www.loyola.ca	Male	750 (grades secondary I-V)	No
Loyola High School – Detroit (MI)	http://loyolahsdetroit.org	Male	170	No
Loyola Sacred Heart High School (MT)	http://www.missoulacatholicschools.org/academics/loyola/	Coed	170	No
Loyola School (NY)	http://www.loyola-nyc.org	Coed	200	No
Marquette University High School (WI)	http://www.muhs.edu	Male	1053	No
McQuaid Jesuit (NY)	https://www.mcquaid.org	Male	933 (grades 6-12)	No
Monroe Catholic High School (AK)	http://www.catholic-schools.org/index.html	Coed	125	No
Red Cloud High School (SD)	https://www.redcloudschool.org	Coed	200	No
Regis High School (NY)	http://www.regis-nyc.org	Male	529	No
Regis Jesuit High School (CO)	https://www.regisjesuit.com	Co-divisional	936 boys, 725 girls	No
Rockhurst High School (MO)	https://www.rockhursths.edu	Male	1000	No
Saint Ignatius College Prep (IL)	http://www.ignatius.org	Coed	1400	No

Table A1. School Demographic Data (continued)

School Name (State or Territory)	**Website**	**Gender**	**Number of Students (Grades 9-12, except as noted)**	**Cristo Rey**
Saint Peter's Preparatory School (NJ)	http://www.spprep.org	Male	935	No
Scranton Preparatory School (PA)	http://scrantonprep.com/s/139/start.aspx	Coed	775	No
Seattle Preparatory School (WA)	http://www.seaprep.org	Coed	720	No
St. Bonaventure's College (NL)	http://www.stbons.ca	Coed	350 (K-12)	No
St. Ignatius College Preparatory (CA)	http://www.siprep.org	Coed	1474	No
St. Ignatius High School (OH)	http://www.ignatius.edu	Male	1500	No
St. John's Jesuit High School and Academy (OH)	https://www.sjjtitans.org	Male	631	No
St. Joseph's Preparatory School (PA)	http://www.sjprep.org	Male	959	No
St. Louis University High School (MO)	http://www.sluh.org	Male	1050	No
St. Paul's High School (MB)	https://www.stpauls.mb.ca	Male	575	No
St. Xavier High School (OH)	http://www.stxavier.org	Male	1625	No

Table A1. School Demographic Data (continued)

School Name (State or Territory)	**Website**	**Gender**	**Number of Students (Grades 9-12, except as noted)**	**Cristo Rey**
Strake Jesuit College Preparatory (TX)	http://www.strakejesuit.org/	Male	1000	No
University of Detroit Jesuit High School and Academy (MI)	http://www.uofdjesuit.org	Male	750	No
Verbum Dei High School (CA)	http://www.verbumdei.us	Male	314	Yes
Walsh Jesuit High School (OH)	http://www.walshjesuit.org	Coed	1067	No
Xavier College Preparatory High School (CA)	http://www.xavierprep.org	Coed	559	No
Xavier High School (NY)	http://www.xavierhs.org/	Male	1085	No

Table A2. School Environmental Courses

School Name (State or territory)	**APES**	**Grade Level**	**Other ES Option(s)**	**Description of Option(s) (class length and grade level as available)**
Arrupe Jesuit High School (CO)	No	n/a	Yes	Renewable energies class (12)
Belen Jesuit Preparatory School (FL)	Yes	10-12	No	n/a

Table A2. School Environmental Courses (continued)

School Name (State or territory)	**APES**	**Grade Level**	**Other ES Option(s)**	**Description of Option(s) (class length and grade level as available)**
Bellarmine College Preparatory (CA)	Yes	11-12	Yes	Zoology, Botany, Earth Sciences
Bellarmine Preparatory School (WA)	Yes	11-12	Yes	Investigative Laboratory Science (9), Marine Biology
Boston College High School (MA)	Yes	n/a	No	n/a
Brebeuf Jesuit Preparatory School (IN)	Yes	11-12	Yes	Zoology, Marine Science
Brophy College Preparatory (AZ)	Yes	11-12	Yes	Environmental Science and Honors ES ("high" students can test out)
Canisius High School (NY)	No	n/a	Yes	Earth Science (9)
Cheverus High School (ME)	Yes	12	Yes	Global Science (9)
Christ the King Jesuit College Preparatory School (IL)	No	n/a	No	n/a
Creighton Preparatory School (NE)	No	n/a	Yes	Ecology (10)
Cristo Rey Atlanta Jesuit High School (GA)	Yes	11	No	n/a

Table A2. School Environmental Courses (continued)

School Name (State or territory)	APES	Grade Level	Other ES Option(s)	Description of Option(s) (class length and grade level as available)
Cristo Rey High School - Sacramento (CA)	No	n/a	Potentially	General Science
Cristo Rey Jesuit College Prep - Houston (TX)	Yes	11	Yes	Earth and Space Science
Cristo Rey Jesuit High School - Baltimore (MD)	No	n/a	No	n/a
Cristo Rey Jesuit High School - Chicago (IL)	No	n/a	No	n/a
Cristo Rey Jesuit High School - Milwaukee (WI)	No	n/a	No	n/a
Cristo Rey Jesuit High School - Twin Cities (MN)	No	n/a	Potentially	Physical Science (9)
Cristo Rey San Jose Jesuit High School (CA)	No	n/a	No	Conceptual Physics (9), Christian Service (10)
De Smet Jesuit High School (MO)	No	n/a	No	n/a
Fairfield College Preparatory School (CT)	No	n/a	No	n/a

Table A2. School Environmental Courses (continued)

School Name (State or territory)	APES	Grade Level	Other ES Option(s)	Description of Option(s) (class length and grade level as available)
Fordham Preparatory School (NY)	No	n/a	No	n/a
Georgetown Preparatory School (MD)	Yes	12	No	n/a
Gonzaga College High School (DC)	Yes	11-12	No	n/a
Gonzaga Preparatory School (WA)	No	n/a	Yes	Environmental Science (one semester, 11-12)
Jesuit College Preparatory School (TX)	Yes	12	Yes	Marine Biology (two semesters)
Jesuit High School - New Orleans (LA)	No	n/a	Yes	Environmental Science, Earth Science, Physical Science
Jesuit High School - Portland (OR)	Yes	12	No	n/a
Jesuit High School - Sacramento (CA)	No	n/a	Yes	Environmental Science (11-12), Chemistry in the Community (11)
Jesuit High School - Tampa (FL)	No	n/a	Yes	Environmental Science, Marine Biology (11-12 electives), AP Human Geography (9)
Loyola Academy (IL)	No	n/a	Yes	Honors Environmental Science, Geology, Oceans and Atmosphere
Loyola Blakefield (MD)	Yes	12	Yes	Marine Science
Loyola High School - Los Angeles (CA)	Yes	11-12	Yes	Oceanography (12)

Table A2. School Environmental Courses (continued)

School Name (State or territory)	APES	Grade Level	Other ES Option(s)	Description of Option(s) (class length and grade level as available)
Loyola High School - Montreal (QC)	No	n/a	Yes	Science and the Environment (year two)
Loyola High School – Detroit (MI)	No	n/a	Yes	Earth Science (9)
Loyola Sacred Heart High School (MT)	No	n/a	No	n/a
Loyola School (NY)	No	n/a	Potentially	Engineering Science (12)
Marquette University High School (WI)	No	n/a	Yes	Environmental Science, Physical Geology (both year-long, 11-12)
McQuaid Jesuit (NY)	Yes	11-12	Yes	Environmental Earth Science (9, or accelerated 8)
Monroe Catholic High School (AK)	No	n/a	No	n/a
Red Cloud High School (SD)	No	n/a	Yes	Botany/Plant Science (one semester, elective, 11-12) Science, Technology, and Society elective (11-12)
Regis High School (NY)	No	n/a	Potentially	Science Research Project (10-12)
Regis Jesuit High School (CO)	Yes	11-12	No	Physical Science (9)
Rockhurst High School (MO)	No	n/a	Yes	Earth Science (11-12)
Saint Ignatius College Prep (IL)	Yes	11-12	Yes	Earth Science and Environmental Science (one semester, 11-12)

Table A2. School Environmental Courses (continued)

School Name (State or territory)	**APES**	**Grade Level**	**Other ES Option(s)**	**Description of Option(s) (class length and grade level as available)**
Saint Peter's Preparatory School (NJ)	Yes	12	Potentially	n/a
Scranton Preparatory School (PA)	No	n/a	No	Applied Chemistry
Seattle Preparatory School (WA)	No	n/a (scheduled grades 11-12 for 2017-2018)	No	Theology elective on "Economics, Ecology, and Ethics"
St. Bonaventure's College (NL)	No	n/a	No	Interdisciplinary approch to include eco-literacy in curriculum
St. Ignatius College Preparatory (CA)	No	n/a	Yes	Environmental Science (11-12)
St. Ignatius High School (OH)	No	n/a	Yes	Environmental Science, Marine Science
St. John's Jesuit High School and Academy (OH)	No[a]	n/a	Yes	Environmental Science
St. Joseph's Preparatory School (PA)	No	n/a	Yes	Environmental Science (11-12)
St. Louis University High School (MO)	Yes	12	Yes	Environmental Science (1 semester, 11-12)
St. Paul's High School (MB)	No	n/a	No	n/a

Table A2. School Environmental Courses (continued)

School Name (State or territory)	APES	Grade Level	Other ES Option(s)	Description of Option(s) (class length and grade level as available)
St. Xavier High School (OH)	No	n/a	Yes	Marine Science, Conceptual Chemistry
Strake Jesuit College Preparatory (TX)	Yes	11-12	Yes	Oceanography and Limnology (year-long, 11-12)
University of Detroit Jesuit High School and Academy (MI)	No[a]	n/a	No	n/a
Verbum Dei High School (CA)	No	n/a	Yes	Environmental Science (elective, year-long, 12)
Walsh Jesuit High School (OH)	Yes	11-12	Potentially	Green Chemistry (1 semester, 11-12)
Xavier College Preparatory High School (CA)	Yes	12	Yes	Integrated Science (year-long with 1/4 dedicated to ES, 9)
Xavier High School (NY)	No	n/a	No	n/a

[a] Available online through the Jesuit Virtual Learning Academy (JVLA)

Table A3. Informal Environmental Activities

School Name (State or territory)	Some Environmental Club or Group	Name of Group	ICC Institutional Participant	ICC Individual Participant
Arrupe Jesuit High School (CO)	No	n/a	n/a	n/a

Table A3. Informal Environmental Activities (continued)

School Name (State or territory)	Some Environmental Club or Group	Name of Group	ICC Institutional Participant	ICC Individual Participant
Belen Jesuit Preparatory School (FL)	Yes	Green Club	n/a	n/a
Bellarmine College Preparatory (CA)	Yes	Student Environmental Action Society	Yes	Yes
Bellarmine Preparatory School (WA)	Yes	La Terra (Earth Corps)	n/a	n/a
Boston College High School (MA)	No	n/a	n/a	Yes
Brebeuf Jesuit Preparatory School (IN)	Yes	Conservation Club	n/a	Yes
Brophy College Preparatory (AZ)	Experiential	Immersion trips with environmental focus	n/a	n/a
Canisius High School (NY)	Yes	Crusaders for the Environment, Outdoorsmen Club	n/a	n/a
Cheverus High School (ME)	No	n/a	Yes	Yes
Christ the King Jesuit College Preparatory School (IL)	No	n/a	n/a	n/a
Creighton Preparatory School (NE)	Experiential	Outdoors Club, Zoology Club	Yes	Yes

Table A3. Informal Environmental Activities (continued)

School Name (State or territory)	Some Environmental Club or Group	Name of Group	ICC Institutional Participant	ICC Individual Participant
Cristo Rey Atlanta Jesuit High School (GA)	Experiential	Garden Club, some environmental service	Yes	n/a
Cristo Rey High School - Sacramento (CA)	No	n/a	n/a	n/a
Cristo Rey Jesuit College Prep - Houston (TX)	Experiential	Garden Club, Woods Club	Yes	n/a
Cristo Rey Jesuit High School - Baltimore (MD)	Experiential	Service programming around environmental issues	n/a	n/a
Cristo Rey Jesuit High School - Chicago (IL)	No	n/a	n/a	Yes
Cristo Rey Jesuit High School - Milwaukee (WI)	Yes	Environmental Stewardship Club	n/a	n/a
Cristo Rey Jesuit High School - Twin Cities (MN)	No	n/a	n/a	Yes
Cristo Rey San Jose Jesuit High School (CA)	Experiential	Outdoor Hiking Club, STEM Club	n/a	Yes
De Smet Jesuit High School (MO)	Experiential	Outdoor Club	Yes	Yes

Table A3. Informal Environmental Activities (continued)

School Name (State or territory)	**Some Environmental Club or Group**	**Name of Group**	**ICC Institutional Participant**	**ICC Individual Participant**
Fairfield College Preparatory School (CT)	Experiential	Fishing Club, Science Club	Yes	Yes
Fordham Preparatory School (NY)	Yes	Greenhouse/Environment Club, Marine Biology, Outdoor Adventuring	n/a	Yes
Georgetown Preparatory School (MD)	Yes	Environmental Club	Yes	Yes
Gonzaga College High School (DC)	No	n/a	Yes	n/a
Gonzaga Preparatory School (WA)	Yes	Recycling Club	n/a	n/a
Jesuit College Preparatory School (TX)	Yes	Environmental Awareness, Anglers, JSCUBA	Yes	Yes
Jesuit High School - New Orleans (LA)	Yes	Green Club, Herpetology Club, Urban Farming	n/a	n/a
Jesuit High School - Portland (OR)	Yes	Green Team, Outdoors Club, STEM Club	Yes	Yes
Jesuit High School - Sacramento (CA)	Experiential	Organic Gardening	Yes	Yes
Jesuit High School - Tampa (FL)	Yes	Environmental Club	n/a	Yes
Loyola Academy (IL)	Yes	Students Against Violating the Earth (SAVE)	n/a	Yes

Table A3. Informal Environmental Activities (continued)

School Name (State or territory)	**Some Environmental Club or Group**	**Name of Group**	**ICC Institutional Participant**	**ICC Individual Participant**
Loyola Blakefield (MD)	Yes	Environmental Club	Yes	n/a
Loyola High School - Los Angeles (CA)	Yes	Pro-Earth, Eco Adventures, Earth and Space Science	n/a	n/a
Loyola High School - Montreal (QC)	Experiential	Wilderness Club, urban gardening	n/a	n/a
Loyola High School – Detroit (MI)	No	n/a	n/a	n/a
Loyola Sacred Heart High School (MT)	No	n/a	n/a	n/a
Loyola School (NY)	Experiential	Outdoor Club, Science Club	Yes	Yes
Marquette University High School (WI)	Yes	Environmental Science homeroom	n/a	Yes
McQuaid Jesuit (NY)	Yes	Biodiversity Project, Environmental Club	Yes	n/a
Monroe Catholic High School (AK)	No	n/a	n/a	n/a
Red Cloud High School (SD)	Experiential	Science/Engineering Club, Greenhouse and Earth Day projects	n/a	n/a
Regis High School (NY)	Experiential	Aquatic Sciences Club	n/a	n/a
Regis Jesuit High School (CO)	Yes	Environmental Club	n/a	Yes

Table A3. Informal Environmental Activities (continued)

School Name (State or territory)	Some Environmental Club or Group	Name of Group	ICC Institutional Participant	ICC Individual Participant
Rockhurst High School (MO)	Yes	Eilert Ecology Club, Outdoors, Zoology	Yes	n/a
Saint Ignatius College Prep (IL)	Yes	Outdoor Ecology, Recycling, Ignatians for the Ethical Treatment of Animals	n/a	n/a
Saint Peter's Preparatory School (NJ)	Yes	Science Club	n/a	n/a
Scranton Preparatory School (PA)	Yes	Students for the Ethical Treatment of Animals, P.R.O.T.E.C.T.	n/a	n/a
Seattle Preparatory School (WA)	Yes	Green Team, Global Justice Coalition	n/a	n/a
St. Bonaventure's College (NL)	Yes	Gardening Club, Recycling	n/a	Yes
St. Ignatius College Preparatory (CA)	Experiential	Gardening, Outdoors Club	Yes	n/a
St. Ignatius High School (OH)	Yes	Green Team, Fishing Club	n/a	Yes
St. John's Jesuit High School and Academy (OH)	Experiential	Bird-watching, Fly Fishing, Off-Road Outdoorsman	n/a	n/a
St. Joseph's Preparatory School (PA)	Experiential	Fishing Club	n/a	n/a

Table A3. Informal Environmental Activities (continued)

School Name (State or territory)	**Some Environmental Club or Group**	**Name of Group**	**ICC Institutional Participant**	**ICC Individual Participant**
St. Louis University High School (MO)	Yes	Sustainability Committee, Outdoor Adventures, Fishing	Yes	Yes
St. Paul's High School (MB)	No	n/a	n/a	n/a
St. Xavier High School (OH)	Yes	Sierra Club, Marine Biology, Fishing	n/a	n/a
Strake Jesuit College Preparatory (TX)	Yes	Ecology, Fishing Clubs	n/a	n/a
University of Detroit Jesuit High School and Academy (MI)	Yes	Environmental Club, Outdoor	n/a	n/a
Verbum Dei High School (CA)	Yes	Green Club	Yes	n/a
Walsh Jesuit High School (OH)	Yes	Environmental Club	n/a	Yes
Xavier College Preparatory High School (CA)	No	n/a	n/a	n/a
Xavier High School (NY)	Yes	Environmental Awareness Club	Yes	Yes

APPENDIX B

ENVIRONMENTAL COMPETENCIES ALIGNMENT

Table B1. Alignment of Environmental Competencies

NAAEE Strand	NAAEE Sub-Strand	NAAEE Guideline	Primary NGSS Performance Expectation(s)	Potential Traditional Course(s) Alignment	Context-Based Chemistry Article Connection(s)
1: Questioning, Analysis, and Interpretation Skills		1.A) Questioning	HS-PS4-2 HS-LS3-1 HS-ETS1-1	Environmental Science (research project)	(Cam & Geban, 2011)
		1.B) Designing investigations	HS-PS1-3 HS-PS2-3 HS-ESS2-5 HS-PS1-6 HS-PS2-5 HS-LS2-7 HS-ESS3-1 HS-ETS1-1 HS-ETS1-3	All Science	(Jackson, 1998)
		1.C) Collecting information	HS-PS2-5 HS-PS1-3 HS-LS1-3 HS-ESS3-2 HS-ESS3-5	All Science Environmental Science (research project)	(Jackson, 1998) (Neerinck & Palmer, 1979)
		1.D) Evaluating accuracy and reliability	HS-PS2-1 HS-PS4-4 HS-LS4-1 HS-PS4-2 HS-LS4-5 HS-LS2-6 HS-ESS1-5	English Social Studies All Science	(Cam & Geban, 2011) (Zollen, Tsaparlis, Fatsow, & Lubezky, 1997)
		1.E) Organizing information	HS-PS4-1 HS-LS2-4 HS-PS2-6 HS-LS3-3 HS-ESS2-2 HS-ESS3-5 HS-ESS3-6	All Science	(Habraken et al., 2001) (Overton, Byers, & Seery, 2009)

Table B1. Alignment of Environmental Competencies (continued)

NAAEE Strand	NAAEE Sub-Strand	NAAEE Guideline	Primary NGSS Performance Expectation(s)	Potential Traditional Course(s) Alignment	Context-Based Chemistry Article Connection(s)
1: Questioning, Analysis, and Interpretation Skills		1.F) Working with models and simulations	HS-PS1-1 HS-PS1-8 HS-PS2-2 HS-PS2-4 HS-PS3-5 HS-PS4-3 HS-LS1-2 HS-ESS1-4 HS-ESS2-6 HS-PS1-4 HS-PS1-7 HS-PS3-1 HS-PS3-2 HS-PS4-1 HS-LS1-4 HS-LS1-5 HS-LS1-7 HS-LS2-5 HS-ESS1-1 HS-ESS2-1 HS-ESS2-3 HS-ESS2-4 HS-ESS3-3 HS-ETS1-4	All Science	(Stieff & Wilensky, 2003) (Habraken et al., 2001)

Table B1. Alignment of Environmental Competencies (continued)

NAAEE Strand	NAAEE Sub-Strand	NAAEE Guideline	Primary NGSS Performance Expectation(s)	Potential Traditional Course(s) Alignment	Context-Based Chemistry Article Connection(s)
1: Questioning, Analysis, and Interpretation Skills		1.G) Drawing conclusions and developing explanations	HS-PS1-2 HS-LS1-1 HS-LS3-3 HS-ESS1-2 HS-ESS2-7 HS-PS1-5 HS-LS1-6 HS-LS2-1 HS-LS2-2 HS-LS2-3 HS-LS3-2 HS-LS4-2 HS-LS4-3 HS-LS4-4 HS-ESS1-6 HS-ESS3-1	All Science	(Cam & Geban, 2011) (Stieff & Wilensky, 2003) (Zollen, Tsaparlis, Fatsow, & Lubezky, 1997) (Overton, Byers, & Seery, 2009) (Ultay & Calik, 2012)
2: Knowledge of Environmental Processes and Systems	2.1: The Earth as a Physical System	2.1.A) Processes that shape the Earth	HS-ESS1-5 HS-ESS1-6 HS-ESS2-1 HS-ESS2-4	Physics Earth Science	
		2.1.B) Changes in matter	HS-PS1-4 HS-PS1-6 HS-ESS1-3	Chemistry	
		2.1.C) Energy	HS-PS1-5 HS-PS3-2 HS-ESS2-3 HS-PS1-8 HS-PS3-3	Chemistry Physics	

Table B1. Alignment of Environmental Competencies (continued)

NAAEE Strand	NAAEE Sub-Strand	NAAEE Guideline	Primary NGSS Performance Expectation(s)	Potential Traditional Course(s) Alignment	Context-Based Chemistry Article Connection(s)
2: Knowledge of Environmental Processes and Systems	2.2: The Living Environment	2.2.A) Organisms, populations, and communities	HS-LS2-8 HS-LS4-3 HS-LS4-5 HS-LS3-3	Biology	
		2.2.B) Heredity and evolution	HS-LS1-4 HS-LS3-1 HS-LS3-2 HS-LS4-2 HS-LS4-4 HS-ESS2-7 HS-LS1-1 HS-LS4-1	Biology	
		2.2.C) Systems and connections	HS-LS2-1 HS-LS2-2 HS-LS2-6 HS-ESS2-2 HS-ESS2-7 HS-LS4-5	Biology Environmental Science	(Overton, Byers, & Seery, 2009) (Bennett, Lubben, & Hogarth, 2007) (Ultay & Calik, 2012)
		2.2.D) Flow of matter and energy	HS-PS1-7 HS-PS3-1 HS-PS3-4 HS-LS1-3 HS-LS1-5 HS-LS1-6 HS-LS1-7 HS-LS2-3 HS-LS2-5 HS-ESS1-1 HS-ESS2-4 HS-LS2-4	Biology Chemistry Environmental Science	

Table B1. Alignment of Environmental Competencies (continued)

NAAEE Strand	**NAAEE Sub-Strand**	**NAAEE Guideline**	**Primary NGSS Performance Expectation(s)**	**Potential Traditional Course(s) Alignment**	**Context-Based Chemistry Article Connection(s)**
2: Knowledge of Environmental Processes and Systems	2.3: Humans and Their Societies	2.3.A) Individuals and groups		Social Studies Student Club	(Jackson, 1998)
		2.3.B) Culture		Social Studies Student Club	(Jackson, 1998)
		2.3.C) Political and economic systems		Social Studies Student Club	(Jackson, 1998)
		2.3.D) Global connections	HS-ESS3-2 HS-ETS1-3	Social Studies Student Club	
		2.3.E) Change and conflict		Social Studies Student Club	
	2.4: Environment and Society	2.4.A) Human/enviro nment interactions	HS-LS2-7 HS-ESS3-1	Environmental Science Student Club	(Jackson, 1998) (Bennett, Lubben, & Hogarth, 2007)
		2.4.B) Places		Environmental Science Theology	
		2.4.C) Resources	HS-ESS3-1	Environmental Science	(Jackson, 1998)
		2.4.D) Technology	HS-PS2-6 HS-PS4-5 HS-PS4-2 HS-ESS3-4	All science	(Jackson, 1998)
		2.4.E) Environmental issues	HS-ESS3-6	Environmental Science (experiential)	(Jackson, 1998)

Table B1. Alignment of Environmental Competencies (continued)

NAAEE Strand	**NAAEE Sub-Strand**	**NAAEE Guideline**	**Primary NGSS Performance Expectation(s)**	**Potential Traditional Course(s) Alignment**	**Context-Based Chemistry Article Connection(s)**
3: Skills for Understanding and Addressing Environmental Issues	3.1: Skills for Analyzing and Investigating Environmental Issues	3.1.A) Identifying and investigating issues	HS-ETS1-3	Environmental Science (research project)	(Cam & Geban, 2011) (Overton, Byers, & Seery, 2009) (Stieff & Wilensky, 2003)
		3.1.B) Sorting out the consequences of issues	HS-ESS3-5 HS-ESS3-3	Social Studies Theology	(Cam & Geban, 2011) (Stieff & Wilensky, 2003)
		3.1.C) Identifying and evaluating alternative solutions and courses of action	HS-LS4-6 HS-ESS3-2	Environmental Science (action)	(Cam & Geban, 2011) (Stieff & Wilensky, 2003)
		3.1.D) Working with flexibility, creativity, and openness		All science Theology	(Cam & Geban, 2011) (Coenders, Terlouw, Dijkstra, Pieters, & Pieter, 2010)
	3.2: Decision-Making and Citizenship Skills	3.2.A) Forming and evaluating personal views	HS-PS4-4	All science Theology	(Neerinck & Palmer, 1979) (Cam & Geban, 2011) (Zollen, Tsaparlis, Fatsow, & Lubezky, 1997) (Bennett, Lubben, & Hogarth, 2007) (Coenders, Terlouw, Dijkstra, Pieters, & Pieter, 2010) (Ultay & Calik, 2012)

Table B1. Alignment of Environmental Competencies (continued)

NAAEE Strand	NAAEE Sub-Strand	NAAEE Guideline	Primary NGSS Performance Expectation(s)	Potential Traditional Course(s) Alignment	Context-Based Chemistry Article Connection(s)
3: Skills for Understanding and Addressing Environmental Issues	3.2: Decision-Making and Citizenship Skills	3.2.B) Evaluating the need for citizen action		Environmental Science (action) Student Club	
		3.2.C) Planning and taking action	HS-PS3-3 HS-ETS1-2	Environmental Science (action)	(Bennett, Lubben, & Hogarth, 2007)
		3.2.D) Evaluating the results of actions	HS-ESS3-4 HS-ETS1-3 HS-ETS1-4	Social Studies Environmental Science	(Bennett, Lubben, & Hogarth, 2007)
4: Personal and Civic Responsibility		4.A) Understanding societal values and principles	HS-ETS1-1 HS-LS2-7	Social Studies Theology	(Lieberman & Hoody, 1998) (Cam & Geban, 2011)
		4.B) Recognizing citizens' rights and responsibilities		Social Studies Theology	
		4.C) Recognizing efficacy	HS-ETS1-2	Environmental Science (action) Theology	
		4.D) Accepting personal responsibility		Environmental Science (action) Theology Student Club	(Neerinck & Palmer, 1979) (Zollen, Tsaparlis, Fatsow, & Lubezky, 1997)

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VITA

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