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Culture and Disease in Introductory Biology Textbooks

Rachel L. Pennellatore
Worcester Polytechnic Institute

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Culture and Disease in Introductory Biology Textbooks

A Major Qualifying Project
Submitted to the faculty of
Worcester Polytechnic Institute
In partial fulfillment of the requirements for the
Degree of Bachelor of Science

Submitted by:

Rachel Pennellatore

Submitted to:

Project Advisor: Ruth Smith

Date: 3/11/08

Email: rachelp@wpi.edu

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Introduction

1. Fields and Learning

This project demonstrates a growing rhetorical need in the introductory college biology textbook to study disease as a cultural phenomenon rather than an independent, solely scientific mechanism. The importance of the recognition of the impact on how cultural factors are beginning to be understood in relation to disease is seen in a 1995 analysis of U.S. society by social researcher John McKnight:

In many countries current research demonstrates that increasing numbers of people use the medical system for reasons that *doctors* say are not physiologically based. In the United States, well over half the “patients” are classified by doctors as not having physiological problems. When doctors are asked why these people visit them, they identify a series of cultural, social, and economic problems. Therefore, their medical “care” is, by the doctor’s own definition, a placebo for the action that could address the cultural, social, economic, and political causes of the malady (McKnight, 1995, p.59).

This indicates that what is understood as medical may sometimes also and other times instead be a combination of a number of social and cultural influences and factors. This project looks at how the concept of disease is presented to introductory college biology students through textbooks, and the factors they focus on.

It examines twenty-one introductory biology textbooks, and also looks at a lecture model which teaches biology in relation to the concept of disease. It demonstrates an underlying need for college biology students to step outside their specialization in order to successfully explain and understand disease as a factor to be understood within the

society. Rosenberg, another social researcher, in his 1992 study Framing Disease: Studies in Cultural History states,

...disease is at once a biological event, a generation-specific repertoire of verbal constructs reflecting medicine's intellectual and institutional history, an occasion of and potential legitimation for public policy, an aspect of social role and individual – intrapsychic – identity, a sanction for cultural values, and a structuring element in doctor and patient interactions. In some ways disease does not exist until we have agreed that it does, by perceiving, naming, and responding to it (Rosenberg, 1992. p xiii).

Rosenberg here is identifying the concept and recognition of disease within the terms of a society. He believes that is the way in which people identify, understand, and deal with disease that in fact proves its existence.

This project uses the example of the depopulation of the Native American people in New England to encourage the study of disease as a factor of the society in which it is found. The Native Americans are a good example population to study because of the difficulties understanding their depopulation in each field. There are biological, anthropological, and historical difficulties to analyzing the fall of a five hundred year old race that lost a devastating portion of its people. The project incorporates factors such as war, social chaos, genetics, and cultural understandings of medicine and religion to look at the understanding of disease through cultural influence.

Biologists certainly do need to know the specific scientific mechanisms of disease. Yet in addition, the culture in which a disease is found can provide a variety of clues that the genetics alone do not. Historical and cultural studies provide the clues to transmission patterns, incidence rates, and societal impacts and responses. Studying where and when disease occur, in what populations, and in what forms all allow scientists to target certain genetic areas in order to do their research. Without cultural clues, it

would be more difficult for scientists to study the millions of bacteria and mutations that occur in disease.

This suggests that we should look at the communication between disciplines about disease and how it is taught. We can look at what information is and is not included in traditional teaching materials such as the textbook, and why that is. We can then set up criteria to evaluate the recognition of culture's impact on disease in biology textbooks.

The concept of disease is a good way to look at the quality of textbooks because there is a recent boom in epidemiology research. The field of biology is advancing at a more rapid pace than ever before, and the race to cure many diseases is now being undertaken. Understanding contributing cultural influences can impact the way present and future researchers approach and treat disease as a factor within the society. This concept of cultural understanding of disease is what will be evaluated in biology textbooks. Biology textbooks are often the first in addition to the predominant learning tools used by students, so it is important to understand both the conventions of biology as a discourse, and the textbook as a mode of communication in order to evaluate its methods and ideas.

2. Native Americans

It is not unusual for most introductory biology students to come to college with the disease and depopulation theory of Native Americans learned from their middle and high school history classes like I did. He or she will probably have been told that the Native Americans lacked immunity from the diseases in biology class. Social studies will

probably have educated him in the colonial and Native American wars of the time. These different theories are all taught at different times in different contexts for many students, but rarely looked at as linked contributing factors of depopulation. This is unfortunate for many reasons. For one, history provides its own interpretation of facts and information, based on the best available records. Historians work from an entirely different perspective than biologists. The study of the cultural happenings will start to explain results of the epidemic. Each field has a piece of the puzzle they focus on; they must collaborate and fit their parts together to get a complete understanding of the world. This is rarely done in the introductory biology textbook, due to the self-contained nature of biology as a field.

Native Americans are defined by both U.S. and tribal governments as the indigenous or original inhabitants of the Americas prior to European arrival. It is difficult to estimate their population prior to European arrival for many reasons, mainly that many Native Americans died before any attempt at a record was created. Those early records were written by explorers, settlers, or military and religious leaders, all of which would have had limited contact with the Native American population, and their own interests to serve as well (Haines et al., 2000). Most scholars estimate the number of Native Americans living in 1492 at the time of Columbus to be between two and fifteen million inhabitants (Young, 1994). A 1990 government census estimated that the combined population of the top 25 American Indian tribes totaled just fewer than two million people (U.S. Bureau of the Census, 1995). Their dwindling numbers have caused the American government to give them protected lands called reservations and special rights and privileges.

It is now widely known that diseases brought by the Europeans decimated the Native American population. Diseases such as smallpox, typhus, measles, whooping cough, yellow fever, chicken pox, flu, and tuberculosis had never been seen in North America previously (Diamond, 1998). The Native American population had neither immunity nor cures for these illnesses, and they spread in epidemics, killing almost everyone that caught them. Ashburn in 1947 wrote: “Death stalked from Canada to Patagonia, pestilence walked in darkness, and destruction wasted at noonday (Young, 27).”

Native Americans were indeed devastated by the exposure to foreign pathogens. However, disease alone cannot be blamed for the almost extinction of an entire race. After all, disease has always been present in societies, and certainly the Black Death in Europe claimed just as many lives (Black, 1992). The fact that Native Americans were unable to ever recover their former numbers and prosperity indicates that there were a number of variables conspiring against the recovery of the Native American population. Sherburne Cook hit upon this idea when he said that disease “acted essentially as the outlet through which many other factors found expression (Madaras et al., 35).” Disease may simply have been the final burden the Native Americans could bear in a society already plagued with warfare and social upheaval.

The Native Americans provide a difficulty in being studied by biologists because there is no direct study of those who encountered the disease in that time period. Genetics as we know it today did not exist in colonial New England. This population is a prime example of studying disease as a cultural phenomenon, because current scientific knowledge of the diseases that plagued the Native Americans can be combined with the

context of historical records and recorded cultural interactions of the time, to understand the influence each may have had on the other. Understanding disease through culture provides many clues about its pattern and effects. Moving out of the technical realm and back into the broader social realm provides a different way of thinking, and clues to the mechanisms of disease. We can begin to think about ways to understand disease in both scientific and cultural terms by analyzing the way it is studied. The textbook, the most common rhetorical device used in teaching, can be looked at for its incorporation and recognition of disease as a factor of the society in which it is found.

Background

The most common methods of teaching in college lay in course instruction and textbook reading as the easiest and most effective way to pass on knowledge to the next generation. The professors decide what they believe are the most important things to be taught, and find a textbook that aligns with their chosen subject matter. This perpetuates the cycle of studying subjects in a vacuum. Students need to understand subjects in broad relation to each other for many reasons. The most important one is to understand their world in a realistic perspective.

This is vastly evident in studying college biology. Biology is defined as the study of life. However, the word “life” takes on a drastically different meaning as applied here than in any other subject. Introductory biology in textbooks concerns itself mainly with what is alive at the moment, how it functions, and how to manipulate it. Life, in a broad sense, includes all that has gone before. Ancient cultures, creatures, and plants existed and evolved long before modern culture and technology, and impacted the world today in a variety of ways. Biology textbooks at this introductory level rarely provide an understanding of the historical, social, and cultural implications of past life on today’s world. There is a need to understand the past in order to move forward, especially in the understanding of disease. Biology as it is now taught in universities is lacking this core component.

Disease is capable of evolution and adaptation. In studying disease at the introductory level, the focus is solely on the minute differences, without regard to when

or why disease has been able to do that. Disease is resourceful, far-reaching, and sometimes beyond biological understanding, yet disease is relentlessly pursued as a scientific mechanism to be observed on a molecular level instead of a cultural phenomenon.

Studies in college biology focus on hard facts and mechanisms, without examining evidence of cultural contributing factors. Scientists want to know what mutation causes the disease, the symptoms, and what can be done scientifically to treat or cure it. But what about culturally?

McKnight (1995) claims that the advances in technology have replaced the concepts of caring and community with commodities and services. Technology is the new God, and we place our faith in science to tell us all the answers. “The possibility of health in a modern society depends, at the very least, upon our ability to free the idea of health from its subordination to managed, commodified, and curricularized activities (McKnight, 1995, p. 65).”

McKnight is implying that community and culture no longer have the impact they used to in the understanding and response to disease. As technology and research develop, adding more information to the scientific realm, it seems to become no longer necessary to look for contributing factors in society. Scientific knowledge is replacing cultural understanding instead of enhancing it.

Epidemiology, the study of factors affecting illness, is gaining attention with the rise of the AIDS epidemic. People want to know what AIDS is, what causes it, the symptoms, and what can be done to cure it. However, AIDS cannot be understood through its own mechanisms. Science does not hold all the answers. Scientists cannot explain why it is

more prevalent in some areas than others scientifically. Scientists also cannot explain why certain populations are more affected than others through genetics. These answers lie in the social and cultural realms. With no scientific cure on the horizon yet, scientists must look to the cultural aspects to provide hope. Societal studies can help explain what science cannot. Understanding the societies in which it is prevalent and prevention education are the best tools available now in combating the AIDS epidemic.

This is analogous to the Native American smallpox epidemics. Native Americans and Europeans alike did not understand the mechanisms of this deadly and contagious disease. It took many lives with no ready cure. Science today has developed a vaccination process, and eradicated smallpox, but the study of the cultural factors involving the spread of smallpox led to the ability to do so. Studying past epidemics that also had cultural causes and effects can help current scientists link medicine and human lifestyle, to ultimately provide better life quality.

Disease both requires and allows for an understanding of cultural factors. The biology textbook is a challenge to this concept because of the commitment of the field of biology to a certain type of discourse and specialization. Biology is not oriented to speculation, or phenomena that do not immediately present themselves as observable and quantifiable. The dedication to study and experimentation exclude the more complex societal issues. “The sickness that we face is the captivity of tools, resources, power, and consciousness...that create consumers (McKnight, 1995, pp.87-88).” Again, the rapid advances of technology and scientific knowledge seem to be phasing out the human aspects of understanding disease. Biology textbooks are getting bigger, more detailed,

and more interactive, but not necessarily preparing students to work within the context of a society.

1. Development

Originally, the project aimed to provide an analysis of the way disease of Native Americans in New England was presented in historical documents. It started with a search of the library databases. The databases spanned many subjects, such as general disciplines, humanities, and history. The organization of the information across disciplines indicated that researchers in different fields all approach the topic of disease and depopulation differently. Some fields relate their conclusions and theories well, while more difficulty arises in reconciling the biological and social studies. The focus changed from simply analyzing disease to the way it is studied and taught in relation to other factors in introductory biology textbooks. The project needed to look at the way introductory biology presents disease as a cultural factor through the rhetorical device of the textbook.

The goal was to discover criteria to help evaluate the links in the student's technical education to their humanities education. In using the example of the depopulation of Native Americans spanning subjects usually considered unrelated, the project aims to give both professors and students a better understanding of why being trained in other disciplines as well as a specialization in their own is critical to doing well in their chosen fields, and how to realize the connections. It also aims to

evaluate the current methods through an analysis of the textbooks of college biology and humanities and provide criteria and recommendations for evaluating materials.

2. Literature Review

Research began with online database searches concerning the depopulation of Native Americans. The main keywords used were “Native American,” “Indian,” “New England,” “disease,” and “depopulation.” From the article hits found, it allowed for searches with narrower keywords such as names of individual New England states, and specific diseases reported as decimating the Native Americans. Research also included the references of the articles found, and the authors that the professionals were citing. In this way hundreds of articles and books dealing with the subject were found.

Even when the book or article found was not completely relevant to the topic, the intent of the information could be studied through the presentation of the writing. After six weeks of researching the factors of disease in colonial New England, there was no longer much new information turning up, and the focus moved to the way the subject was framed. One resource, Epidemic! by Peters (2005), was aimed at a juvenile audience, and so was not the type of in-depth analysis relevant to the project. However, it did present the appearance of disease in a simple way using quotes and pictures, and tying it into the happenings in the rest of the world. It posed the thoughts of audience and how the specific audience best connects to and retains the information. It also presented a viewpoint which incorporated both disease and its cultural influences. Disease was discussed not only in terms of basic scientific mechanism and symptoms, but its

transmission, effects on society, and cultural beliefs and responses. This juvenile aimed book was providing the type of analysis that I hope to see incorporated into introductory biology texts for college students.

Information on Native Americans was spread across many subjects: history, biology, anthropology, and genealogy, to name a few. Each subject had its own interpretations and opinions to offer on the depopulation of Native Americans. It became evident quite quickly that any one area could not satisfactorily explain the effects of disease. The findings were easiest broken into certain topics:

1. Historical accounts of Native American depopulation
2. Social Analyses of Native American depopulation
3. Museum Research and Interviews
4. Biological accounts of Native American depopulation
5. Introductory Biology Textbooks

The sciences take a very concrete and methodological approach, rarely reporting on anything but observed and verified data. The humanities can be concerned with everything science is not – the unproven, the debatable, and the abstract ideas of situations. It seems the areas believe they have no connection and nothing to offer the other, when they could potentially balance each other and complete information.

Historical accounts of Native American Depopulation

The American Antiquarian Society in Worcester, MA was a valuable resource to look at some firsthand sources dealing with the interactions of

colonists and Native Americans. There they house The Historical Collections of the Indians in New England, by Daniel Gookin. The book was an original copy published in 1792, and was a compilation of numbers to be sent back to England. His records were of each established Native American praying town, like Natick, in the area and their populations, along with his observations. It demonstrated an idea of the way the colonists' beliefs and customs affected the Native Americans and governed their interactions. Religious and cultural persecution of the Native Americans is apparent in the writings of many authors of the time. Primary sources such as the diaries and writings from people such as the New England reverend Cotton Mather and governor of Plymouth colony William Bradford also corroborated the massive death rates of 70 to 95 percent and circumstances in their descriptions of the major epidemics in New England in 1617 to 1619, and again in 1637 and 1639. Records from the Jesuit relations also prove the religious and cultural bias towards the Native American population. In his 1637 relation, Father Francois Le Mercier describes an encounter with a Native American medicine man who offers to pray for the recovery of the French and give them an herbal remedy:

He gave the sorcerer to understand that we could not approve this sort of remedy, that the prayer he offered availed nothing and was only a compact with the Devil, for he had no knowledge of or belief in the true God, to whom alone it is permitted to address vows and prayers (Greer, 2000, p. 80).

Another Jesuit account from Father Jean De Brebeuf says:

It is astonishing to see so much blindness in regard to the things of Heaven... This is what their vices and brutality have merited from God... still, they ought to have been more reasonable on this subject... since they were unwilling to acknowledge God in their habits and actions, they have lost the thought of him and have become worse than beasts in his sight for the lack of respect they display (Greer, 2000, pp. 41-42).

These colonial leaders establish an ethos of personal credibility by being respected officials, and their personal experiences and interactions with Natives. Their intentions can be seen as both educational, to document these people, and to glorify their religion through a perceived superiority. By looking at old maps, broadsides, and original medical publications, the way that the people of the time understood the information they had with the technology available to them became apparent. These leaders truly believed that the Native Americans were being punished with disease for not being Christian, and so the Natives served as a warning to the colonists. The cultural influence is seen through the belief of the time that disease is a punishment for unacceptable social behavior.

The historical studies help establish generally accepted statistics: tribal names, populations, dates, and events. Sources such as A Population History of North America by Haines et. Al (2000), and The Health of Native Americans by Young (1994) yielded what is considered the best estimated information. It is difficult to get completely accurate qualitative information because tribes rarely kept written records of their population, and settlers and explorers had limited interactions with the Native Americans. These sources help indicate geographic locations of powerful known tribes and rise and fall of different populations in relation to many factors, including war and disease. The project looked at large and well-known populations such as the Iroquois, the Huron, the Narragansett, the

Pequot, the Mohegan, the Wampanoag, and the Mahicans. Their descriptive narratives are based on anthropological findings, and interpretations of colonial writings. These accounts are important to the research in order to establish the type of society in which the disease was occurring. The historical writings present cultural viewpoints and how disease was recognized and understood in the time in which the project is studying.

Social Analyses of Native American Depopulation

Anthropologists began addressing not only who and when, but how and why, which seem to be two instrumental questions that differ from the nature of history. Many books study the depopulation of the Native Americans in relation to disease. There have been many works published in the last 50 years that begin to deal with the deeper issues of depopulation. Only recently, since the advent of DNA studies, have many experts had the technology available to study the Native Americans of 500 years ago. We can now carbon-date their artifacts, use scientific data to offer explanations, and analyze the events and thinking of the colonial period. Many of these analyses have appeared only in the last century, as this is an emerging field.

Ethnohistory is particularly rich with information. Hundreds of social scientists are eager to analyze the depopulation and its contributing factors. Authors involved in this area attempt to not simply provide the most accurate look at life, but to take a step further and understand the interactions on cultural, practical, and motivational levels. James Axtell, who considers himself an

ethnohistorian, has written many works which suggest the deeper cultural conditions surrounding the depopulation. He is one of the primary authors relied on for cultural analyses in this project. His works such as Beyond 1492 (1992), The Indian Peoples of Eastern America (1981), and many journal contributions deal in depth with the factors that contributed to depopulation. He recognizes the consequences of war, disease, social disorder, and other conditions that the Native Americans were dealing with. He analyzes the concurrent factors afflicting the Native Americans and provides theories to the extreme depopulation and the lack of recovery.

Black's 1992 article "Why Did They Die?" gives more than the simple disease answer. He also has addressed the need to delve deeper into the secondary causes that are not as easily explainable, and challenges readers to discard conventional explanation. Diamond's Guns, Germs, and Steel (1998) was very popular for providing an analysis of the accepted reasons for the depopulation of many different older cultures. His title indicates the major factors that changed the ancient cultures and what impact it had on the world, then and now. Diamond also recognizes the importance of interpretation to understand historical events.

Stannard's study, American Holocaust (1992), is an in-depth exploration of cultural biases, racism, war, and social upsets that lay underneath the surface of the depopulation.

Their intent is to bring forward that contributing factors were just as important. Many scholars are starting to consider themselves researchers in cross-disciplines, as strength for their own arguments. They have begun to realize that

no one area holds the full answer, and in order to make a complete argument, one must take all other arguments into account. The social and ethnohistorians are analyzing the contributing factors of depopulation. These researchers are presenting disease as a cultural phenomenon, and their arguments provide a basis to call for this type of understanding to become incorporated in the field of biology as well.

Museum Research

The Pequot Museum in Connecticut also proved a valuable resource. Their credibility is established through being operated by living descendants, although there is still difficulty even for them in reconstructing the nearly extinct population with few Native American historical documents ever written or surviving.

There are many mannequins of Native Americans, accurately portrayed in various aspects of their daily lives. These are usually accompanied by videos or listening devices, to give the patron the option to accumulate as much or as little information as they are interested in. There are also plenty of artifacts housed in the museum, to give the viewer a true sense of what life was like in that period.

The documentary films portrayed the colonists and Native Americans historically accurately, and took into account cultural factors, viewpoints, motivations, and differences of the Native and European peoples. The audience effect of reading an historical account of a war and watching the devastation of death and captivity is vastly different. It is easiest to appeal to people through the pathos of human interest and emotion integrated into the story. The multimodal approach of the Pequot

Museum appeals to the generational move towards interactive information and a digital age, as more people gain access to technology. The visual, digital, and print modes allow for all types of learners to access the information. The museum is a great example of different ways to interact with information as suggested by Rogers and Abell (2007). The museum aims not only to preserve the memory of a once powerful people, but to educate the public on the social and cultural issues surrounding the history.

The Pequot Museum also did what most historical sources either cannot or do not, and that is providing the Native American point of view. It may be because not many Native American primary documents exist, however, it is crucial when dealing with the interactions of two peoples to represent both sides.

Their presentation of disease is based on a cultural presentation. They do not portray the transmission or effects the way biology would, but rather in a social context of how the disease spread and its broader cultural impacts. The exhibits dealing with disease portray Native Americans falling ill as well as the responses of the Native community. The accompanying storyboards tell of the social implications and consequences of the disease, as well as other pressing social conflicts with the Europeans. The struggles such as war, cultural bias, and social disorder are explored and recognized as contributing factors. The scientific mechanisms are not presented at a molecular level as it would be in a textbook; the disease is explored purely through a social and cultural sense. It gives the viewer an appreciation for disease as related to real life.

Biological Accounts of Native American Depopulation

After seeing these different approaches, the project needed to look at the way in which college biology would approach the topic of depopulation. However, this is the area in which there was the most difficulty finding sources. Nothing could be found on the topic of the depopulation of the Indians from a biological evidence standpoint. Studies in scholarly electronic biological databases such as PubMed, ThompsonGale, BioOne, and Science Direct were related to highly specific studies of one gene, and also a study of modern Native Americans. Modern Native Americans have mixed with European people for over 500 years now and so results from these people are unlikely to be representative of colonial Native Americans. Neither were there studies that dealt with colonial Native Americans, or offered any biological explanations for their depopulation. Yet disease is a biological mechanism, and has long been the widely accepted explanation for the Native American depopulation, so where was the biological proof? Proving Native Americans died solely of European diseases would involve studies of known symptoms and mechanisms of the disease, contagiousness, and mortality. There must be some evidence offered by the biological community to back up this hundreds of years old claim. Multiple and varied searches of the databases produced nothing I could find to satisfy this criteria. Testing the research methods used by the project, consultations with research librarians were set up, and also failed to turn up relevant results.

Both librarians came up with the same methods and results that the project had used. The search included many of the same databases, trying different combinations of the keywords previously tried, with the same results – specific studies unrelated to the colonial Native Americans. It was intriguing that the subject one would be most inclined to think had the answers indeed had none. Why did biology choose to ignore the Native American depopulation, and not respond to the criticisms of other fields for not doing so?

At this point some faculty in the biology department were contacted to see if there were some missing resource they could share to find the information needed, and to also see if it was true that this information was actually not out there, to get their opinions on why it is not addressed in a larger manner. Two faculty members indicated that there was not a biological assessment of the depopulation of Native Americans from a purely scientific standpoint. This indicated the concern and discourse of the biological community. For introductory biology to not explore this entire depopulation would assume it had no relevance to the biological field. In fact, biology should be a key factor in the study of depopulation. Biology could look at the mechanisms of the diseases the Native Americans were plagued with, their attempts to cure the diseases, and study recovery and death rates. Disease is most certainly a biological issue. Despite not having colonial genetics to analyze, introductory biology textbooks should acknowledge the connection of disease to history and society to successfully understand the whole picture.

Interviews

Three interviews were also conducted with members of the biology faculty. According to one professor, the broad cultural understanding of disease is a good idea, but has not been widely implemented for a variety of reasons.

Professors have limited class time to cover an exhaustive list of specialized scientific topics. It simply would not be feasible to spend much time outside of the specialized training.

Also, many professors may not feel comfortable teaching that broad information. They are specially trained just as they are training specialized students. Since professors may not hold degrees in areas of the humanities, they are hesitant to delve deeply into issues surrounding them.

This itself reveals a way to analyze the reasons behind why the subject of introductory biology is organized in the manner that it is. The professor's response indicates an understanding of the logos of incorporating a social understanding of disease. The textbooks could be compared to study the level of integration, as well as the rhetorical methods used for the presentation of the subject and its importance.

Introductory Biology Textbooks

In examining twenty-one introductory biology textbooks, there were a few implications to be considered primarily. The earlier textbooks, published in the 1960's, seem to have more of a social and cultural concern in them. This is interesting because it indicates a shift in understood importance in the texts. The later textbooks move away from this cultural awareness as the interest in epidemiology research and disease mechanisms rapidly rises. The newer texts incorporate far more of the

observable mechanisms and contain fewer studies and examples in cultural awareness. From looking at a variety of texts over a period of approximately forty years, some criteria to evaluate the connection between disease and cultural influences can be determined. These texts and criteria will be discussed in full in a later chapter.

Methodology

The methodology chapter establishes the problem of presenting disease as a cultural phenomenon in introductory biology textbooks. It also provides the criteria for textbook analysis.

Establishing the Problem

Developing the project's central problem of assessing the way biology textbooks teach disease arose from a multitude of other research. In trying to find information on the New England tribes of colonial times, the research was spread across many disciplines, and perspectives on events and interpretations varied with each field. There was little to no information on the depopulation of Native Americans in the biological field, while the humanities were overflowing with studies. This prompted the question of how the concept of disease and culture is understood in different disciplines. It examines biology textbooks as well as ethnohistory and anthropology texts to gather an understanding of disease among the Native Americans, and how to provide criteria based on this analysis to assess biology textbooks for their presentation of disease as a cultural phenomenon.

Establishing an Analysis

Textbooks are often the authority for establishing student understanding in universities. There are hundreds of introductory biology textbooks on the market that could be chosen for comparison on an introductory college level, and this project selected twenty-one found at Worcester Polytechnic Institute to be studied. They could be compared in content, extent of the subjects, teaching methods, organization, stated and implied purpose, voice, and approach to biology. The textbooks were analyzed for connections between biology and humans, biology and other fields, and recognition of disease as a cultural phenomenon. The criteria for analyzing textbooks in addition to the cultural factors that could be included in discussions of disease will be discussed more fully in the next chapter.

Criteria for Analysis

The project used three criteria to evaluate the effectiveness of the textbook.

1. Recognition of connection between biology and fields in the humanities
2. Recognition of biology with a connection to humans and culture
3. Recognition of disease as a cultural phenomenon, through factors such as:
 - i. Genetic Susceptibility
 - ii. Social and Environmental Factors
 - iii. Health and Medical Practices
 - iv. War and Religious Convictions
 - v. Social Disorder

These three criteria and cultural factors were used to determine the level of biology textbooks' connections to understanding disease as a factor of the culture in which it is found. These criteria can be applied to the editor's notes, the organization of the chapters, as well as the chosen content. The organization of the chapters speaks to the characterization of biology, and the content reveals its discourse's agenda.

The basis for the criteria stems from two kinds of research. Research was required in the humanities fields, including history, ethnohistory, anthropology, cultural studies, and sociology to determine the social and cultural factors which have an influence on disease. The second type of research involved examining the twenty-one introductory biology textbooks to apply the criteria for evaluation.

Sources

The twenty one textbooks studied were gathered from Worcester Polytechnic Institute, from the Gordon Library and the Department of Biology. As a nationally ranked university of science education, W.P.I. would be expected to have the leading and current textbooks for a biology education. The textbooks gathered from the university would be expected to provide a comprehensive look at biology education.

Outcomes of Research

The research produced three results: research on cultural factors affecting the depopulation of early Native Americans, a textbook analysis, and an exhibit on cultural depopulation factors that will be displayed in the biology department of Worcester Polytechnic Institute.

Cultural Factors Affecting Native American Depopulation

Native Americans had their populations decimated after the contact with Europeans. Disease has long been held as the culprit, but in reality, many other factors contributed to the significant damage done to the numbers of Native Americans in New England.

i. Genetic Susceptibility

Many Native Americans did in fact die from exposure to a disease brought by the Europeans. There are a few reasons the Indians may have been more susceptible to succumbing to the illnesses. It is thought that people originally migrated to America over the land bridge called Beringia that connected Asia and North America approximately 12 to 15,000 years ago (Haines et. Al, 2000). This was during the last ice age. It is believed at this time the temperatures in the crossing were unfavorable to the pathogens associated with many of the European diseases. It was simply too cold for the disease bacteria to survive the crossing (ibid). The European diseases were not present anywhere in North America,

although North America had its own diseases such as anemia and respiratory infections (Madras et al., 2007).

This leads to a discussion of immunity. Many researchers call what happened in New England a “virgin-soil epidemic,” meaning that the disease spread rapidly amongst these native peoples who had never been exposed before, and thus had no resistance to the diseases.

Many of the diseases that killed off the Native Americans were endemic in Europe, meaning they were always present in society. Europe was more densely populated and industrialized, so Europeans gained immunity by constantly being exposed to small pockets of disease (Peters, 2005). The Native Americans lived in smaller groups, further apart, and with little interaction between tribes. They had not before seen these crowd diseases that needed a multitude of hosts to survive. Epidemics are characterized by a rapid onset, short duration, and leaving a high number of dead. People stricken with the diseases either died or recovered with immunity. The period of European contact after 1492 has been repeatedly referred to in the last years as the American Holocaust by Stannard, an ethnohistoric researcher, due to the devastating population loss.

Biologists also claim that the Native Americans may have been particularly susceptible for genetic reasons. Since tribes lived secluded from one another, researchers claim they may have been genetically homogenous (Haines et. Al., 2005). With no genetic diversity, there would have been no differences in genes for resistance, and many viruses were adaptable anyhow. They may also have lacked antibodies that Europeans had developed from previous exposure in

childhood (Madras et al., 2005). Their immune systems may have been stressed from other life factors. Native Americans that survived one disease may have a weaker immune system and then be more susceptible to another disease. There are a number of mechanisms that could fall under the topic of immunity. Simply claiming the Native Americans had no immunity is no longer a satisfying explanation. However, the biological factor is most difficult to prove.

There has been much speculation and theory; yet it is now unlikely to determine the genetic makeup of populations that have been dead for hundreds of years. A 2005 study by David Mitchell indicated that it may be possible for small amounts of ancient DNA, or aDNA, to survive in certain conditions. Yet aDNA studies are severely limited by their low yield, extensive degradation, and contamination with modern DNA. Therefore, testing the genetics of descendants is flawed. Many surviving Native Americans have mixed with other Native American populations and Europeans, leaving no pure population to test. Biological explanations for now must remain theory.

ii. Social and Environmental Factors

Many social and environmental factors also played a role in the susceptibility of the Indians. The changes in the environment after European contact are reflected in the disease pattern. According to Jared Diamond (1998), many diseases arose from domesticating animals. The germs they carried mutated and spread to humans. In North America, there were very few domesticated animals before 1492. Native Americans tended to be a hunter-gatherer type of people, and

mostly had no use for domestic animals, thus eliminating their exposure to the germs carried by them also.

The Europeans also really opened the possibility of trade. Europeans bartered with Native Americans and Europeans for food, furs, tools, and many other objects. This was a social custom before unheard of for the Native Americans. Each tribe was self-sufficient and rarely interacted with others. Contact with Europeans exposed the Native Americans to the pathogens they carried. The first epidemics were seen along the coastlines, as the European ships arrived. As trade eventually spread through New England's waterways, so did disease (Madras et. Al., 2005). Tribes also began trading with each other. It is possible that some inland Native Americans died of epidemics brought by other Native Americans, never even having seen a European.

As more and more ships arrived from Europe and Africa, bringing not just traders and explorers, but settlers and slaves, they brought wave after wave of disease. Children were the greatest carriers of disease, as adults had had some previous exposure and oftentimes were not sick (ibid). The ships also carried new types of disease-spreading vermin and insects.

The agricultural development also affected the Native American populations. Native Americans did grow some crops such as maize, squash, and pumpkin. However, many Native Americans were already as a whole malnourished, producing only a basic subsistence. Malnourishment has been proven to be "the most common cause of secondary immunodeficiency in the world (Madras, p.

36).” It has effects like skin breakdown, weakening the body’s first defense against infection. It also increases susceptibility and mortality rates (ibid).

Some European livestock began to overrun the native crops. Designating grazing land and building fences often sparked more land conflicts with the Native Americans and Europeans. Madras (2005) claims that the European building led to some deforestation, in turn causing temperature changes and flooding. The spike in planting also led to rapid soil erosion, affecting ability to produce food.

iii. Health and Medical Practices

In general, the Native Americans were considered a healthy people, outside of epidemics, especially by the Europeans of the time. The Indians were not disease free, however, yet they maintained a better level of health than the Europeans of the time. In New England’s Prospect, William Wood observes, “ I have been in many places, yet never did I see one that was born either in redundance or defect a monster, or any that sickness had deformed, or casualty made decrepit, saving one that had a bleared eye and another that had a wen on his cheek (Vaughn, 1993. p. 82).”

Indeed the Native Americans may have appeared healthier for a variety of ways they dealt with their sick. In the villages, the sick children were cared for gently, even by their fathers. If they were traveling, the weakest who would not survive the journey without great care and struggle were ordered to be killed as a mercy. The same was said of the sick and frail old in times of hunger (Hultkrantz, 1997).

In general, they shared not a fear of death, but a general avoidance of it. Tribal members would do anything to stay alive as long as possible, as life was a gift. They also were said to have been observed bathing frequently, which accounted for some of their preserved health. Some would not accept the clothing of the Europeans because it was hard to keep clean, and the Native Americans would not subject themselves to the insects and dirt covering their bodies (ibid.) John Josselyn described the Native Americans as tall and handsome people who could live to one hundred if nothing befell them. John Lawson in his observations commented that the Native Americans:

...are never troubled with the Scurvey, Dropsy, nor Stone. The Phthisick, Ashma [sic], and Diabetes, they are wholly Strangers to. Neither do I remember I ever saw one Paralytick amongst them. The Gout, I cannot be certain whether they know what it is, nor not. Indeed, I never saw any Nodes or Swellings, which attend the Gout in Europe; yet they have a sort of Rheumatism or Burning of the Limbs, which tortures them grievously, at which time their Legs are so hot, that they employ the young People continually to pour Water down them. I never saw but one or two thus afflicted (Vogel, 1970. p. 141).

It was a common observation not only among these men but Jesuit priests, other explorers, and settlers that the Native Americans seemed to have working remedies for all sorts of ailments and were generally a more healthy people than their European counterparts.

The Native Americans and Europeans had little knowledge of how to cure epidemic diseases. Each culture had their own ideas and medicines, which differed greatly from each other. Medical knowledge and know how was dramatically primitive by today's standards. There were no hospitals. Both cultures had connected sickness with spirituality. Native Americans did in fact have valid medicinal remedies and cures that truly worked. Their understandings of injuries and disease were based on a system of

beliefs, which at times may have appeared to outsiders illogical, pagan, or simply unscientific. Their medicine involved more than cures; it was a set of ideas and concepts.

Native Americans first and foremost had a different understanding of injury and disease. For the most part, external injuries would be handled and understood the same way as European medicine of the time. Causes of external injuries were easy to discover and understand. The Native Americans were able to effectively and rationally treat many external injuries such as fractures, skin wounds, dislocations, bruises, and many bites.

However, their understanding of internal injury and disease was where they diverged from accepted European medicine. European medicine of the time was not necessarily scientifically accurate either, but the colonists regarded Native American medicine as wrong for their spiritual and religious connections to disease. Even if the colonists had sometimes made connections to God and disease, the Native Americans did not believe in the God of the English, and so much of their beliefs and cures were regarded as satanic and pagan.

The Native Americans believed internal injury or disease had a supernatural connection. If they had no known herbal remedy, they relied on the knowledge of a shaman, who was a magic man supposedly possessed with superior powers from the gods, or someone similar to diagnose and treat the problem.

Unfortunately for the Native Americans, their medicines and rituals were no match for European disease, and in fact many of their cures actually worsened the diseases. There were many contagious diseases plaguing New England at the

time; most settlers called all of them the smallpox or plague, so it was difficult to determine at times what disease was actually being suffered.

The Europeans were no better off by comparison. They claimed Native American medicine was based on magic, and determined that Native Americans must worship the devil. Their doctors were simply apprenticed to another doctor for six years. There were no painkillers for surgeries. Their tools were blunt, and the doctors, unaware of germs, usually did not wash their hands. People died of complications from surgery as often as the diseases (ibid). Many of the religious settlers thought disease was a punishment from God for some sin they had committed, and many priests also dabbled in medicine. Many doctors thought disease was caused by a poison, and used methods such as bleeding, or making the patient go to the bathroom or throw up to remove the toxin. The spread of disease got so bad in New England that in 1677, the first medical publication in America appeared. It took the form of a broadside made by Thomas Thacher, and was entitled A Brief Rule to Guide the Common People of New England How to Order Themselves and Theirs in the Small Pocks, or Measles. Thacher may have gotten his information from his son in England, where medical texts were more widely available (Viets, 1937).

Thacher was not a doctor; he even describes himself as merely a “well wisher to the sick.” This was the first attempt to help people identify and prevent sickness from a medical standpoint.

iv. War and Religious Convictions

The Native Americans also lost many lives due to war and conflict with the New England colonists. The colonists were mainly Christian religions, and considered the Native Americans to be heathens and devil-worshippers. The colonists, with a serious lack of medical knowledge, saw the diseases that plagued the Native Americans as a sign from God that the Native Americans were being punished, and that the colonists were being rewarded. They saw it as a sign that land was being cleared for them. They thought that since the Indians did not do much permanent settling of the land, then they were not the actual owners of the land (Gookin, 1792). One of the main supporters of this theory of religious persecution was Cotton Mather, a popular New England minister and author in the late 1600's and early 1700's. Mather produced many writings on the subject of Native Americans and religion. In one of his diaries, Mather writes:

The Indians in those parts had newly, even about year or two before, been visited with such a prodigious pestilence, as carried away not a *tenth* but *nine* parts of *ten* (yea, 'tis said *nineteen* of *twenty*) among them: so that the woods were almost cleared of those pernicious creatures, to make room for a better *growth*. It is remarkable that a Frenchman who, not long before these transactions, had by a shipwreck been made a captive amongst the Indians of this country, did, as the survivors reported, just before he dyed in their hands, tell those *tawny pagans*, "that God being angry with them for their wickedness, would not only destroy them all, but also people the place with another nation, which would not live after their brutish manners." Those infidels

blasphemously replied, “God could not kill them;” which blasphemous mistake was confuted by an horrible and unusual *plague*, whereby they were consumed in such vast multitudes that our first planters found the land almost covered with their unburied carcasses; and they that were left alive were smitten into awful and humble regards of the English, by the terrors which the remembrance of the Frenchman’s prophesie had imprinted on them (Williams, pp.20). The Native Americans did not have medical knowledge of the diseases either, and also saw the fact that their people were decimated while vastly fewer settlers died as a religious punishment. Some Native Americans even took baptism for their families in the hopes of being saved.

Daniel Gookin also provided some evidence to support the theory that it was God’s will for the settlers to take Native American land. In his Historical Collections of the Indians of New England, he starts by referencing sections of the Bible as proof. He cites ps. Lxxii. 8,9. “He shall have dominion also from sea to sea, and from the river unto the ends of the earth. They that dwell in the wilderness shall bow before him; and his enemies shall lick the dust.” To them this could not more clearly have implicated the Native Americans, and established their orders. He also uses ps.ii.8. “Ask of me, and I shall give thee, the heathen for thine inheritance, and the uttermost parts of the earth for thy possession.” The Puritan settlers needed no further convincing that it was their divine duty to make war on the Native Americans.

The Native Americans stood no chance in war against the colonists. Their bows and hatchets intended for close combat were no match for the colonists’ rifles. They also differed vastly in their reasons and tactics in war. Native American wars were rarely, if ever, fueled by the same political and economic reasons that Europeans

declared war for (Stannard, 1992). Native Americans usually started war as a result of personal insult and injury, and first offered opportunity for retribution. According to a Lanape Indian, “We are minded to live at Peace: If we intend at any time to make War upon you, we will let you know of it, and the Reasons why we make War with you; and if you make us satisfaction for the Injury done us, for which the War is intended, then we will not make War on you (Stannard, pp. 110).” The Native Americans also tended to wage war in small strikes, and also to customarily spare the women and children of the enemies, none of which was abided by by the colonists.

One of the best examples of this type of genocidal warfare was the Pequot War of 1636. The English started this conflict in supposed retaliation for the killing of one English colonist who was not even particularly regarded or important. Their original plan was to kill all the men and sell the women and children into slavery. When the Native Americans began to run and scatter, they instead killed all the Native American warriors rushing out to fight, and watched the rest of the village burn to the ground, killing the hiding women, children, and elderly. This proves the genocidal nature of the colonists, because no society can survive without its women and children. William Bradford describes the reaction:

It was a fearful sight to see them thus frying in the fire and the streams of blood quenching the same, and horrible was the stink and scent thereof: but the victory seemed a sweet sacrifice, and they gave praise thereof to God, who had wrought so wonderfully for them, thus to enclose their enemies in their hands and give them so speedy a victory over so proud and insulting an enemy (Stannard, pp.114).

After the war, there were two ways the colonists dealt with Native Americans: annihilation and enslavement. Other Indians were hunted down and killed. Villages were burned, Native American warriors mercilessly slaughtered, and women and children, if they were lucky, sold into slavery. Others were drowned or buried alive.

More carnage raged on, destroying the Naragansetts and the Wampanoags in King Phillip's War in 1675-1676 (ibid). Stannard also describes, "The hunting of Redskins became for the time being a popular sport in New England, especially since prisoners were worth good money, and the personal dangers to the hunter was now very slight (Stannard, p. 116)."

No modern concept of mercy was shown to any Native American. Another story describes the capture of a very old Native American man. The soldiers enjoyed torturing the harmless old man. "Some would have had him devoured by dogs, but the tenderness of some of them prevailed to cut off his head (Stannard, p. 117)." Looking at the population before and after European contact of the Native peoples gives a sense of the damage done. Stannard claims that the Abenaki people had a destruction rate of 98 percent. The Mahicans were 92 percent destroyed; the Mohawks were 75 percent destroyed. The Pocumtuck had a destruction rate of 95 percent, and so on for many of the Native peoples. These estimates were made before King Phillip's War, and also before the smallpox epidemics of 1677-8 (Stannard, 1992). Those that died of disease may have been those granted the most mercy.

v. Social Disorder

The social chaos left behind by all the factors ended up being a depopulation factor in itself. One contributing factor that devastated the Native Americans was the loss of their elderly and children. Those two groups were most susceptible to disease. With no children, there were no future generations to carry on. The elderly were also very important to the Native Americans. The elders of the tribe kept the customs and wisdom of the people. With their deaths, there emerged cultural disorientation and many power struggles in the tribes (Madras, 2005).

Even with the most fertile aged population left, it was not easy to recover. Many Native Americans may have lost a spouse to disease, disrupting the family order of the tribe. Also, many diseases affected the fertility of those who did survive (Haines et. al, 2000).

In addition, with so many Native Americans falling ill or dying, many tribes missed their annual plantings and hunts, making them even more susceptible to starvation, malnutrition, and the next wave of disease. There were also not enough members of the tribe left to care for the sick, bury the dead, and raise a family. The Native Americans lived in fear of the colonists hunting them down, and were continuously forced off of their lands. Indeed, the effects of disease had their own separate effects that added to the plight of the Native American.

These factors, as explained in terms of the colonial Native American, also have broader implications that can be applied to any cultural study of disease. These most influential factors on the Native Americans can be looked for and evaluated in terms of

effect and transmission of disease on nearly any culture and any disease. These may not be the only cultural factors that influence disease, but are relevant to this project.

Analyses of Biology Textbooks

Textbooks are the primary teaching tool used in classrooms. They are considered to be comprehensive in their subjects, with the ability for the professor to choose which topics they consider most important. Their larger size and weight, in comparison to other academic texts, implies an air of comprehensiveness and finality. This is also seen in the titles of many of the textbooks. Many of the books included in this analysis are simply titled Biology. This would imply that the textbooks are all-encompassing. Everything a student needs to know about the subject of biology is contained within its pages. The titles are meant to be “unnoticeable, uncontentious, all things to all people. In this manner the textbook claims its seriousness and conservatism; part of the sober business of scientific inquiry (Gabriel, 1994, Organization Vol 1, p. 380).”

Within the field of biology, textbooks tend to look alike, containing much of the same content and being organized similarly. This suggests to the student that information is organizeable, fragmented, and predictable (Gabriel, 1994). Gabriel also argues that by its own nature, textbooks are “unable to portray organizations as

anything but stable, square, and structured (Gabriel, 1994; Organization, Vol. 1 p.377).”

The rhetoric of textbooks sets an authoritative air. “Language does not simply reflect reality, but constitutes it (ibid).” The way editors write a textbook allows them to present the concepts and ideas they find important in their ways, disguised as fact. The rhetorical frame of professional writing, then, is self-perpetuating through a student’s openness to learning and the lecturer’s reliance on text.

With the field of biology expanding, there is no limit to the eventual size of a textbook. The task of textbook editors, according to one textbook, is to present a clear picture of the subject without overwhelming the student with details (Villego, 1967).

There have been many studies in recent years examining the state of biology, its textbooks, and how it is taught. In a study by Carter et. al (1990), their research on introductory college biology courses revealed that professors had little concern with teaching the history, philosophy, or ethics of biology. This does not allow the student to think critically or give them opportunity to solve problems in a collaborative and productive manner, but rather focuses solely on retention of memorized knowledge. Carter et. al believe this approach limits the potential for intellectual growth.

Another problem found in many textbooks is the lack of purpose. Students must know why they are studying biology, beyond simply a requirement. When the curriculum can be tailored to match career objectives, especially to engineering students, then the core curriculum can improve. Carter et al. also state that in a survey

of biology students, 80 percent of the respondents majoring in biology indicated that the introductory courses were a “waste of time.” Those who wish to teach are provided a poor example with the current organization, and those who wish to pursue a career in the life sciences are not having their needs for a meaningful base curriculum met.

The research in this project examined 21 introductory level biology textbooks. It included different publishers and editions of textbooks to examine the way biology is presented as a whole. All of the textbooks were from the years 1967 - 2008, when biology really began to experience many breakthroughs and come to the forefront of research. It examined the past textbooks and looked at the progression of biology and how it is presented.

The introductions and editor’s notes on the texts were used to establish the editor’s thoughts, goals, and purposes of the text. The way the chapters were organized and presented, and the extent of the different topics was used to analyze what information was considered essential and how the ideas should be learned in a biological field. The rhetorical concepts of logos, ethos, and pathos (OWL at Purdue, 2007) can be applied and assessed in the textbook analysis.

The textbooks all contain an ethos, or author’s persuasion. Textbook authors are naturally assumed to be experts on the subject, and so biology students are willing to accept the information provided without question based on the credibility of the editor himself, by virtue of his title. Many editors have many years of background in biology research and education. Exhaustive bibliographies also lend to the credibility of an editor.

Credibility lends an incredible power to the acceptance of material. John McKnight in his 1995 book, The Careless Society, states “There is no greater power than the right to define the question. From that right flows a set of necessary answers. If the servicer can effectively assert the right to define the appropriate question, he has the power to determine the need of his neighbor rather than meet his neighbor’s need (McKnight, 1995, p.48).” Yet the reader of a textbook is naturally assumed to be one of suggestibility. Gabriel (1994) says that the textbook as a rhetorical device “comforts and reassures. It ‘asserts’ and it ‘infuses’ to a relatively passive, but normally willing, recipient... The reader is rarely asked to make a choice, accept, reject, or criticize (Gabriel, 1994, Organization Vol 1, p. 385).”

The structure of the textbook defines the shape and extent of the subject in a linear pattern for the introductory learner authoritatively. Students would assume the information is correct and complete and see no need to think about potentially missing connections. Typographically, the editor can choose to make certain words or ideas bold, present a diagram, or italicize, all rhetorical writing tools to draw the reader’s attention to the message of the author, rhetorically giving those concepts elevated importance and authority.

The second rhetorical device seen in the biology textbooks is logos. Logos relies on the logic of an argument and evidence to persuade the reader. Biology minded students and professionals tend to be very detail oriented and require a presentation of sufficient information to believe and understand a concept.

This concept can be demonstrated by popular tools of the textbook: definitions and lists (Gabriel, 1994). Textbooks are expected to provide definitions, by their nature.

Textbooks provide what are assumed to be facts and fix concepts. The editor has the power to use whichever definition fits his needs, and have it accepted unquestioned. Gabriel (1994) says definitions are advantageous because they provide the introductory student with meaning and a convenient bit of information able to be memorized and repeated. However, definitions then exclude all phenomena that do not comply with its rhetoric.

Lists are rhetorically seductive for many reasons. Their pneumatic potential, if short, appeals to both professors and students alike to aid memory and learning, but not the concept of argument. Gabriel (1994) claims lists are substitutes for argument, designed to save time. Lists work especially well when combined with the rhetorical tool of “timeless authority.” Authors and researchers are included not to be accepted or rejected, but to become incorporated as items on lists (ibid).

What one does not see in a biology textbook that could be a potential benefit to the integration of different fields is pathos. Pathos is an emotional appeal to the reader. Introductory biology as it stands as a discipline has no need for emotion. Its work is based solely on scientific data. However, if specific situations relating to humans could be incorporated into textbooks, students would more understand the humanistic reasons for biology’s work. Understanding and curing disease is a laudable goal in any situation, but by including an emotional appeal, students stand to achieve a more complete understanding of the disease as it occurs in society. Understanding human nature in addition to mechanisms of disease can provide insight into transmission patterns, cultural effects of the disease, and allow an emotional motivation as well as a knowledge based motivation for future biological studies.

Social researcher Mary Hamm, in her 1991 study addresses the issue of integration of discourses in textbooks. She claims that television today is presenting students with the biological issues the textbooks are not, causing confusion in students. Students are learning about the societal and ethical problems facing the world today without having learned the biology or connective cognitive thinking skills to analyze them. Students do not live in a bubble, and with the advent of multimedial ways of accessing information, textbooks are falling behind in their approach and ability to present a full picture. She cites a National Science Foundation study indicating that 90 percent of teachers are using textbooks to teach concepts 95 percent of the time. Yet states with their funding and governmental educational agencies are setting the standards for the books used. It appears that everyone but the students and professors are shaping the textbooks and forcing publishers in certain directions.

Including cultural studies of disease could influence students and researchers to learn and work from a human interest viewpoint as well as a scientific curiosity. Expanding the rhetorical tools of the textbook to incorporate the concept of pathos can help science to cease phasing out the concepts of community and culture, and provide a complete look from all aspects on the factors that impact disease, while not diminishing the authority of textbook. Rather, incorporating more of a pathos into a textbook could help students increase in their range of understanding and identification in relation to disease as a cultural phenomenon.

Recognition of Connection between biology and ethnohistory and anthropology

One trend noticed in the textbook analysis was to segregate biology from the other subjects. Biology was presented as highly important in all the texts, for a variety of reasons which applied strictly back to the realm of biology, such as advancing technical knowledge, understanding organismal mechanisms, and scientific manipulation of life. In many of the textbooks, the opportunity for segregation arises from a kairos, or contingency, of the subject's growth. Biology in recent years is rapidly advancing, and the excitement surrounding the new knowledge is creating a rhetorical space for biology to claim its superiority and importance.

This is strikingly evident in the claim of a 1994 textbook titled Biology: Exploring Life edited by Brum, McKane, and Karp. In a discussion of society and culture, they respond:

Anecdotal evidence is the heart of misinformation. It often leads to absurdly irrational beliefs...Anecdotal evidence has also misled people in their attempts to understand themselves and the nature of life. One particularly prevalent anecdote asserts that the fact that we don't understand all aspects of life proves that life is a mystery beyond human understanding. Scientists, however, believe that all phenomena in the universe have rational, verifiable explanations (Brum et. al, 1994 p.31).

In 1959, Arnold Grobman commented on the fragmentation of biology in his article "The Biological Sciences Curriculum Study." Arnold believes:

Biology does have special problems. Its challenges are somewhat less clear than those of chemistry and physics. Its fundamental underlying principles often are obscured by the emphasis that is placed upon comparisons between groups of organisms, or upon different levels of organization, or upon terminology and classification schemes, which are too frequently presented as ends in themselves. The science is greatly fragmented and workers in different sub-disciplines often have difficulty in communicating with one another. In consequence, some students do feel that biology is a diffuse, uncorrelated science which is uninteresting,

and, very likely, unimportant (Grobman, 1959. AIBS Bulletin Vol. 9 No. 2 p. 22).

This student attitude is reinforced by the textbook, in organization, in content, and in stated purpose. Introductory Biology (1973) edited by Ehrlich says that the problem facing all humans, biology students and nonbiology students alike, is how to advance to the golden age of microbiology. The health and happiness of the human race is dependant on a better understanding of ecology and the human nervous system. This is a limiting view in terms of societal studies at large. Of course as biology progresses and medicine advances, humans will live healthier and longer. Part of the argument structure, or logos, of extending length and quality of human life is presented as the ultimate purpose of biology. However, in an integrative environment, this should not be the main goal of humanity. Introductory biology should ideally be presented in context to every other subject to break barriers and form a more complete understanding of the world at large, not simply in terms of biological mechanisms. His audience is expected to be mainly biology students, but he expresses a confidence that his logic will also present the importance of the learning community for biology to students who are not studying biology as a major. He acknowledges no connections to humanities, or reasons why that might be important.

Ehrlich also claims that most people will go through life with only a superficial knowledge of all areas, because there is simply too much information at the disposal of man (Introductory Biology, 1973). The view is that you cannot ask a student to know more about a subject than a professional who does not work in the specific field would know. This would only perpetuate the segregation of the topics.

Professors could indeed ask students to obtain an integrative look at subjects, but the long-held divisions could prove difficult to change. The project's claim is not that people should know everything about all areas, but rather that they should have an understanding of how to connect different subjects, and understand the importance of doing so.

Baker and Garland, (1967) in their Study of Biology, offer that it takes more space in a textbook to do analysis than to simply provide descriptions, and so editors are faced with the task of having a large, lengthy textbook or to eliminate the work behind the required knowledge. Again, many editors use logos to persuade the readers of their choices. Lengthy textbooks are used as a method of persuasion to perpetuate the segregation of topics. If one starts to integrate material, the rhetorical question of where it ends is presented. Could there not be an argument that all topics are related and therefore must be divided for convenience? Perhaps, but some subjects are more closely dependent on each other, and should be tied together to provide comprehensive learning experiences. This could be a disadvantage because students could begin to connect to the material better with a view of the analysis rather than using the textbook as a reference for memorized material. Being able to see the progression of work and the steps involved can allow students to understand processes rather than recite details through memorization with no knowledge of why or how things came to be.

Campbell's Biology, published in 1987, shows a quite restrictive approach to biology. He demonstrates the applicability of biology again in only biological terms, in medical advances. Biology is a multidisciplinary science, he claims, yet

he does not move out of a biological framework to connect biology outside of a scientific research and medical field to incorporate it as part of a multidisciplinary education. For biology majors, he says, the study of biology will create a versatile scientist. For engineering majors, biology will have applications towards other science courses. For liberal arts majors, biology will give them a sample of the variety of sciences to be studied (1987). This is a total disregard for science existing outside of or relating to anything but itself. Science should certainly be applicable in many real life social situations, regardless of major. Curtis (1979) claims that science is limited only to what is observable and measurable. Scientists do not step outside their field, he claims, because scientists have no special qualifications in political or ethical controversies. Scientists simply have the rapidly advancing technology. He claims biology does not include discussions on politics or ethics, because science does not have a stand on them. He mentions that on many biological issues, you will find scientists on either side of the debate. These issues do not deal with fact, and so are not traditionally included in biology studies. However, understanding the implications of a technology could greatly influence future generations to make well-informed decisions. Students absolutely must know more than just the mechanisms of biology.

Biology: Science for Life (2004) opens with a quote from E.O. Wilson:

Because science, told as a story, can intrigue and inform the non-scientific minds among us, it has the potential to bridge the two cultures into which civilization has split – the sciences and the humanities. For educators, stories are an exciting way to draw young minds into the scientific culture (Belk, Borden, 2004. p. vii).

This text recognizes the split of the disciplines, but recognizes its purpose as pulling nonmajors into biology, rather than incorporating the two subjects

together fully, a subtle distinction that makes quite a difference when discussing integration. This text also does include connections to human life, yet still solely within a biological framework. It mentions a need to apply biological knowledge to real issues, because a conceptual knowledge will not provide all the answers. However, the editors also mention that the reason for incorporating nonmajors into the subject is that these people will have the power to vote on governmental issues involving biology, and so must appreciate the significance of the subject. Every real world issue presented was still connected to biology, such as gene therapy and bioengineering.

Recognition of biology with a connection to humans and culture

Another trait noticed in the analysis was the tendency to ignore humanity as part of biology. This is crucial in understanding the way biology is seen as self-contained. If there is no human involvement acknowledged in the purpose of the studies, then there is no need to involve social and cultural studies in connection to biological processes. This indicates a reason for a lack of pathos seen in many textbooks. There is no need for an emotional appeal for a subject that excludes human involvement. In examining the organization and topics covered in 21 introductory textbooks, the majority of the material focused on mechanisms in the plant and animal domains.

This point is also reinforced by field studies analyzing biology textbooks. Carter et. al's 1990 study of biology textbooks showed that most textbooks examined began with molecular and cell biology, which students are least familiar at an introductory level. The organization of the books is centered on the professor instead of the students.

Ehrlich's 1973 textbook opened with a unit on the diversity of life, which included just plants and animals. Chapter one includes a section on social relationships; however, it focuses on a troop of baboons. It describes the living arrangements, reproduction habits, familial structure, and societal norms of a baboon troop. Ehrlich acknowledges, "The baboon troop is not an independent entity. The troop acts on its environment, and its environment, in turn, affects the troop (Ehrlich, 1973, Introductory Biology, p.14)." This concept of cultural impact is strangely absent in any discussion relating to humanity. Moving on to chapter 11, titled "Defense" the material covered just elements of immunity, immune response, and antibodies. Disease was not even listed as a key word in the index.

From the kingdom classifications to Mendel's genetic work with plants to Darwin's theory of natural selection, much of the basic biology students must learn is unrelated to humanity. Only two textbooks mentioned humanity more than in passing.

Even concepts which do apply to humanity, such as viruses, immunity, genetics, and disease are presented strictly in terms of biological mechanisms, without mention of people. There are no discussions of implications, causes or effects, or society. In fact, concepts that one might study together from a social standpoint, such as disease, genetics, and immunity are usually contained in entirely different chapters, perhaps hundreds of pages apart. This segregation of related topics reveals a disjunction of connected learning. If students are not even exposed to related biological concepts sequentially, it becomes increasingly difficult to create an integrated learning space for other subjects and society. In Campbell's 1987 Biology, Unit three is about the gene, but covers genetics only from Mendel's experiments to recombinant DNA

technology. Unit six covers plants, while unit seven explores animals. Unit eight moves straight to ecology, again leaving out humanity, and disease not even listed as a concept in the glossary. The same can be seen in Biology published in 1979, edited by Curtis. Section three, covering genetics, includes no discussion of disease. Section four, the diversity of life chapter, includes prokaryotes, protists, fungi, plants, invertebrates, and arthropods. Humanity as a whole is ignored as even a life form.

Villee's 1969 textbook, Biology, does contain a chapter including disease, but only the mechanisms of infection, immunity, and allergy are explained. There is a section on "common infectious diseases." However, each disease gets approximately a paragraph's attention, describing only its symptoms and mechanism. There is no discussion of why they were common, where, or its impacts.

Ehrlich, Holm, and Brown produced Biology and Society in 1976. Their chapter six, "Kinds of Living Things" included only cells, animals, plants, protista, monera, and viruses. Humans again are absent. Further, in chapter 15 titled "Behavior" it covers coevolution, reproduction, and social behavior, but only in terms of animals that live in groups and social insects. Chapter 16 then studies "Culture" but includes just hunting and gathering, the agricultural revolution, and the development of the city due to the agricultural revolution. They do present an acknowledgment of culture when they say that "a culture represents the interaction of the genetic potential of people with their environment and their history (Ehrlich et.al, 1976 p.507)." This is an expression of the type of studies that could benefit biology students. However, their chosen examples were not entirely within the realm of that statement, and certainly not expanded upon in a significant manner. Their example of this simply

stated that you would not expect an Aboriginal person to play the piano, because there are no pianos in their culture. This does not show the entwining of a culture with its biology and history.

Life: The Science of Biology 8th edition (2008) claims to be the only introductory textbook that presents a story at the beginning of each chapter, to involve the students in the real world more readily. However, upon examining the stories, these too have the potential to be highly integrative while falling short from doing so. The links between all life are classified merely as being made up of the same chemicals and cells, disregarding life and society.

Similarly, Biology (2008) includes feature investigations, which prove to be no more than historical accounts of biological discovery, without mention for their societal implications. Biology: 8th edition (2008) says biology is an integrative science. Yet the editors include among its integrative topics only ecology, physiology, and evolution. It reverts back to the earlier trends of excluding human study, and places much value on the visual learning process.

Biological Science (2005) does not even include a chapter on disease and immunity. It did include a section about the role of history, which seemed to be the first indication of introductory biology incorporating history. The section explained why certain organisms existed in certain places and not others. It was all attributed to geographic dispersal. If an organism was not found in a place, then there were simply geographic inhibitors, such as mountains or oceans which prevented the spread of that species.

Even in discussions that attempt to incorporate our society, the implications are again turned back to biological. Chapter 18 of Ehrlich et. al's Biology and Society textbook is called "Your Role in the Future." They encourage students to interact in society, and give an example of political implications. However, it is not done in a way which demonstrates a clear need for the understanding of biology's impact on culture. They ask, "Would you want to vote for a representative who had never heard of ecological succession which explains eutrophication?...It is not very wise to elect officials who have no knowledge of or interest in how the biosphere functions (Ehrlich et. al, 1976, p.523)." There is no explanation of why a politician would need to know that, why it was so important, or its potential effects if it was not carried over into society. The attempts to place biology into culture are simply not enough. These textbooks are relying on a perceived superiority of the biological field without producing evidence or examples that inextricably tie them to our culture. There is no doubt as to the importance of biology in today's culture. Yet these textbooks, as the primary resource of the next generation of both scientists and citizens alike, must expand upon their examples to convey the evidence for incorporation.

It has been shown that the connection between humans and biology in these textbooks is not adequate. First and foremost, the overwhelming lack of a study of humans removes them from biology in general, nevermind an integrative study. Studying the behaviors and patterns of animals is indicative of a sort of cultural awareness, but not in the full sense needed to understand disease as found in human society comprehensively.

It is today considered almost politically incorrect to generalize cultures of people. However, it cannot be denied that different cultures practice different ways of living, encounter different social and environmental factors, and hold different beliefs. If these overarching known cultural factors can provide insight into transmission, understanding of, and response to disease, then we should not look at them as discrimination, but as clues to a full understanding of how humans in different conditions interact with disease.

There were three textbooks studied that made progress towards explaining the importance of an integrated curriculum, if not integrating it themselves. These textbooks showed both an acknowledgement of humanity, and an understanding of the implications of biology beyond its own substantiation. Biology: Exploring Life 2nd Edition (1989), edited by Brum, McKane, and Karp, included scenarios at the end of each chapter to show applications of the knowledge. Their “Bioline” and “Human Perspective” articles touched on the importance of the knowledge to the scientific community and the society as a whole as far as what medical knowledge can do for the human race. However, the articles were often unrelated to each other, and did not include any references to understanding history as a way to study current situations. This is important for reasons cited by Bybee in his 2002 article “Biology Education in the United States: The Unfinished Century.” He claims rapid scientific advances and conflicts about them have taken a toll on textbooks and biology professors. He further proclaims a need for a cultural understanding of biology:

If the past 100 years provide any indication of what we will confront in this century, science- and- technology related issues will continue in the headlines and will very likely increase. Individuals and societies will have to decide on many issues involving scientific research and technological innovations. These

decisions will not be easy... Often, individuals harbor the misconception that science can tell us what should happen. A basic education in biology must extend beyond the introduction of concepts and help students realize the limits of science and technology relative to global issues. Decisions about major issues, such as global climate change and infectious diseases, extinction of species, or bioterrorism, involve assessment of alternatives, risks, costs, and benefits. Further, and very important, students should have the experience of considering who benefits and who suffers, who pays and who gains, and what the perceived and actual risks are and who will bear those risks (Bybee, 2002. *BioScience* Vol 52 No. 7. p. 565).

Concepts of Biology, A Cultural Perspective, (1973) by Buffaloe and Throneberry delve into the need for biology to connect with other fields. They voice the concerns that professors will not trespass into the academic domains of others, yet it is necessary to incorporate other fields in the context of your own field. One does not need to be an expert in other areas, but realistically their work does include basic knowledge from other fields. Professors must present the idea that combined knowledge is real and necessary (ibid).

They further cite that many early scientists such as Bacon and Descartes were also philosophers. Many problems in philosophy, religion, sociology, psychology, and many other fields essentially boil down to problems in biology, and failure to acknowledge the impact of biology on the spiritual, social, and practical needs of humanity will result in confusion and nonsense (ibid). This book did present biological concepts, yet separated the biological knowledge from discussions about the topic of biology itself. It did not discuss the immediate uses of that knowledge in any fields. Although it made many arguments in line with the context of this project, it failed to provide a clear and cohesive connection between the chapters and society.

Biology and Society (1976), by Ehrlich, Holm, and Brown present the concept that understanding the operations of biology can make a person able

to make more socially responsible decisions. However, this argument is not backed by evidence. They also claim that humans have the unique ability to examine their own nature, and usually fail to do so. This again refers back to the tendency of humans to exclude themselves from the study of biology. Culture is not considered part of a biological context, and is often ignored. They claim to present the principles of basic biology in the context of problems confronted by humans; however, they fail to move outside a biological realm. Their learning objectives presented at the beginning of each chapter do not include any societal connections. While there are certainly improvements to be made in the three textbooks presented here, they do incorporate an understanding of the importance of the link between the science and humanities to provide a full and realistic education. The problem with these textbook does not involve a problem with purpose, just in methods of presenting the right type of integrated material in ways that make sense for both types of discourses. This leads to a discussion of a lecture model, instead of a textbook.

There is a study undertaken by William Guilford published in Cell Biology Education in 2005 that explores centering biology education around a humanistic perspective. In his experiment, Guilford uses a four step process to integrate humanities and biology.

1. Introduce a disease. Guilford presents the students with a known defect to be studied, along with its symptoms, effects, and other basic medical information.

2. Teach the relevant biological concepts. Guilford then reverts back to the traditional biology of teaching the mechanisms of disease and defect, along with other technical aspects of the processes.
3. Present molecular pathology of disease. Any known causes are studied.
4. Discuss current clinical approaches to handling the disease.

Guilford's student surveys and feedback indicate increased class participation, increased attention, and a positive response to the learning method from the students. It gives the students a chance to both understand the biological concepts and the impact they have on humanity.

At the time of the publication of the study, Guilford indicated he was not aware of any textbook which was centered on diseases or biotechnological applications. If this type of approach could be transformed into a textbook, it would satisfy the criteria presented here to recognize disease a cultural phenomenon.

Recognition of disease as a cultural phenomenon

Life: The Science of Biology 8th edition (2008) was the only textbook examined in this project that does contain a full discussion of a current disease, AIDS. The prominence of AIDS among certain cultures is handled by claiming the areas of high incidence lack access to adequate and affordable health care. AIDS is not a disease

yet cured by medical treatment, so access to health care, while having an impact on the prevalence of some diseases in societies, is not a satisfactory explanation here. The cultural issues that are in the forefront discussions in other fields, such as widespread acceptance of unprotected sex and ritual genital mutilation in Africa, both heavily contributing cultural factors, are absent from the discussion in the biology textbook.

This neglects to consider the different ways in which disease emerges, changes, and travels within cultures.

There were similarly no cures for the diseases present in early New England and little to no biological understanding of the diseases either. Their transmission and impact would have to be understood and responded to in terms of society and culture.

The AIDS epidemic is analogous to the early Native Americans in that the cultural influences are often overlooked in understanding the disease.

Exhibit

The project produced an exhibit that could be used in a biology department. The exhibit was a series of seven story boards, similar to the ones displayed in the Pequot Museum. Story boards were chosen for their ability to stand on their own as far as presenting information, and their multimodal incorporation of pictures and text. Seven storyboards were chosen to allow for minimal analysis but enough content to draw a

person into the topic, encouraging them to begin to think about the implications of disease as a cultural phenomenon. They are however constrained by the conventions associated with storyboards. There is a space limitation, taking into account these exhibits conventionally contain text and pictures. Also, with one storyboard per cultural factor, it does not allow for in-depth analysis as a research paper would. At most there could be up to five key points per board, to allow for visual white space and font size legibility.

They display the numerous factors that contributed to the depopulation, as well as replications of Native American or colonial artwork of the time. It describes the importance and impact of the factor, and showcases quotes from historical figures, displaying mentalities of the time. This incorporated both the sciences and humanities, as well as presented a multimodal approach to the integration.

Findings and Conclusions

The research brought forth a variety of rhetorical issues with the way biology studies disease and its connection to ethnohistory and anthropology. The textbooks themselves provided a look into the problems with the discourse between disciplines.

The first finding is the self-containment of biology. As science rapidly advances, new research and developments are increasing biology's sense of distinction and emphasizing its isolation from other disciplines. We live in a world where science can be used to save or destroy lives equally, and societal discussions and ethical thinking must come into play. These textbooks have all indicated that as the field of biology advances, it is becoming more and more self-contained.

Another finding from the research is that biology previously was concerned with cultural understanding, and is abandoning its attempts to include the cultural as well as scientific discourses, while fields such as ethnohistory and anthropology are beginning to emerge in these contexts.

It seems the advance of technology may have pushed integrating disciplines into the background in favor of integrative learning methods. Many texts are focused on the accompanying supplementary visual and interactive materials. They are no longer concerned with the connectivity of the subjects, just catering to the different learning needs of students. If professors realized the value of integrative disciplines, perhaps publishers and editors would include not only interactive subject material, but produce material to connect to which spans the different fields. Their multimodal visuals, examples, and news stories could easily include historical, social, cultural, and political

implications linking any subjects, if there was recognition of the need and a demand for it.

This indicates a benefit to more integrative texts along with supplementary materials. Textbooks are not yet at the level of integration which is becoming required to be a successful professional. The literature and tools in the biology field seem to be content to be self-contained. This will harm students who do not learn these skills in a society which is beginning to emphasize and value collaboration and the importance of integrative study.

Recommendations

The textbook must adapt to the changing times. The textbook is unlikely to be replaced in the near future as the primary instruction tool in universities, yet the content in the textbooks is not satisfying the changing understanding of disease and culture. Integrating knowledge and theories from biology and fields such as ethnohistory and anthropology should take primary concern over multimodal approaches. The problem is not with the methods available for interacting with material, it is with integrating these discourses for a meaningful understanding of society.

Biology textbooks should incorporate human society and culture as an important factor of science in relation to disease as the older textbooks were once concerned with. As Mary Hamm stated, students are being confronted with biological decisions every day in society and politics, and yet are getting their information from the television and internet. Biology textbooks should present their knowledge in relation to society and human culture so that we may make informed decisions.

Specific to disease, textbooks should incorporate the model used by Guilford. Guilford is opening up the connection between these disciplines and showing the importance of disease as a cultural phenomenon. Centering student learning based on disease and its impacts helps students make connections between biology and society. His model has shown positive results, and there is currently no textbook I am aware of that uses this approach to disease as a cultural phenomenon. Textbooks should teach a cultural understanding of disease as well as the scientific mechanisms to produce well-rounded students prepared to function in our society.

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Appendix A

One of the project findings supports the possibility of an incorporation of biology as linked to other disciplines, and could suggest ways to think differently about the communication between the sciences and humanities.

Studies of Integrated Curricula

The separation of disciplines that could benefit from collaboration indicated an advantage to having an interdisciplinary education. Research indicated that the issue spans many disciplines. Addressing the depopulation involved works by researchers in many fields, and each had information not dealt with in another area. Also, the field researchers tended to point out discrepancies and shortcomings in the works of other fields. The disease of Native Americans could not be fully explained within one discipline. To really understand the full context, information is needed from history, anthropology, cultural studies, humanities, social sciences, and technical sciences.

After researching the problem of successfully integrating different fields, and the types of disciplines, research looked for information about interdisciplinary curricula. These too are recent developments in academic curricula. There are many theories as to why it is important, and also a variety of methods tested to integrate subjects. These vary widely on the subjects that one is trying to connect. The literature that has been most helpful has come from the ERIC database, an educational database.

Academic integration of sciences and humanities is not yet a widely accepted theory, due in part to the self-imposed segregation of the fields. It has been speculated much on,

about the benefits of it and ways to implement it. Many of the articles were case studies conducted at various universities and the results they obtained.

Rogers and Abell (2007) call for interdisciplinary instruction that organizes content and processes from a variety of disciplines around a central issue or topic. Evidence from their study indicates that when students have a variety of ways to interact with knowledge represented across several disciplines, they have a better opportunity to connect on a deeper level and learn more effectively. Using several disciplines to present the same issue also takes into account individual student differences in learning and allows them to approach both their background knowledge and the new information with new angles and in a more complex thought process (ibid).

An article in the *Technical Horizons in Education* Journal says “Today’s society cannot be compartmentalized by single skills or individual attitudes that relate to isolated subjects, and education shouldn’t be either (Autodesk Inc, p. 1). Students need to be prepared for real world demands, and integrated curriculum is a step towards achieving that. The article also makes the claim that integrating subjects is a more efficient way to deliver information since the realm of subjects students need to learn is ever expanding. Interdisciplinary instruction also encourages students to find their own problem solutions from many areas. Their creativity and productivity is increased (ibid). McCullough puts the idea into action by suggesting “...on a given building project, you will have a dozen different consultants-including an architect, a designer, a soils expert, an energy person, and a landscape designer. The reality of executing such a project requires delivering so much information in so many formats... (ibid).” Another study by Rogers and Abell in 2007 indicates that reading and writing connect to sciences through processes such as

“observing, comparing/contrasting. Inferring, explaining with evidence, and communicating (Connecting with Other Disciplines, *National Science Teacher’s Association Feb 2007* p.58).” There is one caution that blurring the lines between disciplines may devalue each individual subject, but the benefits far outweigh the concerns.

Even as far back as the 1880’s, researchers such as Huxley and Arnold called for the incorporation of humanities and sciences, producing schematics showing the relationships between the subjects. Mayer, a current historian of science, says “...scientific training provided no genuine education, no training of the human beings in mind and character as citizens of a free country (On the Historical Relationship Between the Sciences and Humanities, *Bulletin of Science, Technology, and Society*, August 2001).”

There are many more researchers conducting experiments within universities whose studies show dramatic improvements in students when they are taught subjects as linked to one another. Students consistently perform better in all areas when taught integratively. The literature proves a need for more subjects to be taught as inter-related in order to produce a generation of well prepared and successful individuals.

Appendix B

Alternative Teaching Methods

The research also suggests incorporation of not only text-based learning in the classroom. The Biology Teacher's Handbook presents a variety of learning tools to better encourage student learning that will also help connect disciplines.

Visual Learning

Bloom presents a progression of mental processes which the student advances through depending on the type of activity (Klinckman, p.346):

- a. memorization
- b. translation
- c. interpretation
- d. application
- e. analysis
- f. synthesis
- g. evaluation

A well-educated student should be able to perform at the lower end of the mental processes. This requires engaging them in more than reading and referencing text. Textbooks are written with a different word density than other materials, and often students cannot focus and interpret the closely packed information (Klinckman, 1970). Pictures and visuals illustrate points better.

One recommendation would be to incorporate films into course study. Films are a valuable learning tool for many reasons. Students learn through story better than memorization (Campbell, 1987). Also, instructors can use portions of films; they do not need to show a whole film as many of them feel compelled to do. Films also capture what text cannot. Films can capture interactions, emotion, body language, social cues, and behavior. Films can move across the world, or through time (Klinckman, 1970). Films are rarely made by biologists, and thus incorporate social aspects and connections. In this case, there are many films made on the Native Americans that incorporate the social conflicts as well as disease.

Even better than films are utilizing institutions. Whether through group or individual trips, the instructor can avoid the insecurity of stepping outside of his specialized area by talking with staff and coordinators. Students will be able to learn from individuals across fields and connect them in their own ways. The Pequot Museum is a valuable resource for allowing each student to access the intersection of society, history, and biology.

Supplementary Materials

Especially in biology classes, there tends to be only one assigned text, usually the textbook. Since textbooks have been shown to be mostly inadequate as far as integrative learning, professors could assign texts that illustrate the real world implications of the knowledge. The literature review produced many books and studies written by researchers in different fields that applied the biological situation to historical events. The

important thing is to get professors to find resources that they are comfortable with, that teach what they feel they cannot, enough to impart an understanding of the need for the material. Understanding biology and its mechanisms is only as good as understanding the conditions of the society it is used in.

Most importantly, it is crucial to use a variety of teaching materials, to allow students the most opportunity to connect with material in ways they learn best. Combining writings of different perspective and genre in addition to the textbooks often dense and dry instructional tone can allow students to experience the knowledge in relation to real events. It puts an actual situation to learn and analyze in front of a student instead of minutely organized and disjointed technical facts. Films, storyboards, and pictures have been proven effective learning aids for their visual effects, which highly encourage student learning and remembrance. We cannot expect students to learn integrative material if they are not also taught integratively.