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How Can Teachers Utilize A Curriculum To Expand Students' Knowledge Of Waste Management And Change Their Waste Reduction Behaviors?

Alexis Craig

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HOW CAN TEACHERS UTILIZE A CURRICULUM TO EXPAND STUDENTS'
KNOWLEDGE OF WASTE MANAGEMENT AND CHANGE THEIR WASTE
REDUCTION BEHAVIORS?

By

Alexis Craig

A capstone submitted in partial fulfillment of the requirements for the degree of Master
of Arts in Education: Natural Science and Environmental Education.

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Capstone Project Facilitator: Maggie Struck
Content Reviewer: Diana Trussell
Peer Reviewer: Danielle Simmons

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CHAPTER ONE

Introduction

Overview

In this first chapter I will focus on my personal and professional experiences that brought me to my Capstone focus; *How can teachers utilize a curriculum to expand students' knowledge of waste management and change their waste reduction behaviors?* Growing up I never really thought about where the stuff we threw away went. The only concept of waste I had was from our house involved making sure the garbage was taken out and placed on the curb for garbage day. During my undergraduate program my main focus was on fisheries and wildlife management with little focus on natural resources, unless they could be harvested or used. I did not have a real focus on waste management and reduction until I started my current role as an environmental scientist working for the North Dakota Department of Environmental Quality. This first chapter will also cover the rationale for the research question and how an in depth waste management curriculum can help improve students' waste reduction behaviors.

Personal Experiences

A Family Tradition

My introduction to the outdoors was accompanying my parents and grandparents on hunting and fishing trips. Even though we were not old enough to hunt or fish, I always enjoyed getting to tag along and sit outside. I usually passed the time playing with the surrounding grasses or watching animals and insects that were in the area. I would also be tasked with helping to go and retrieve the animals that they harvested. I was never scared or upset when I saw the dead animals, instead I found myself fascinated with

them. I enjoyed getting to see the animals up close and you could often find me studying the animals (as best as a five year old could) trying to figure out how a bird's wings worked or what a deer's antlers were made out of.

I attended my hunter's safety and education course as soon as I was old enough, and then found myself accompanying my parents and grandparents as another hunter in the group. I always found myself asking questions about the animals we had harvested, and wanted to learn as much as I could about the animals we were eating. Switching from observer to participant meant that I would spend almost every free weekend and holiday outdoors, growing my passion for wildlife and the environment.

High School Experience

I had decided in Kindergarten that I wanted to be a veterinarian when I grew up. I kept this same mindset throughout my K-12 experience, only switching career routes the last semester of senior year. Since I wanted to get into a veterinary school, I focused all of my elective choices on extra science and agricultural classes that could help me qualify for an undergraduate and veterinary program. The class that had the biggest impact on my high school career was Environmental Science. The class focused on a lot of different environmental topics and issues, and our teacher would almost always leave time for discussion of topics, instead of just lecturing and giving homework.

The class involved hands-on activities and experiments, with us usually getting to go outside to learn or gain experience about a topic we were currently covering in the class. My favorite outing during this class came when we were discussing the water cycle, water systems, and water quality. We spent the week having different lectures and discussions on the topics, which then led up to an extended class period where we would

apply what we learned. We used the information we had learned throughout the week on the Mouse River, a local river that was half a block away from the high school. Once we were at the Mouse, we were divided into different groups to obtain information about the river and what its water quality was. One group used chemical water quality test kits to determine the pH of the water and if any chemicals were present. Another group got to use a special tool to determine the current flow rate of the river, and compare it to what was currently listed on the Army Corps of Engineers. I was in the group in charge of collecting water bugs from the river, as the species present could help give a quick insight on the health of the river. Our bug species identification cards came from the Valley City State University entomology department. I still can remember spending all morning at the river, and laughing along with my classmates as one of the other students fell and filled his waders full of water.

Taking this class made me stop and think about what I wanted to do professionally, and I found myself researching different career options in the environmental field. While I still loved animals and wanted to work with them, I also wanted to be able to spend time outdoors and keep the environment healthy. I ended up withdrawing my application for a four year veterinary technician program that would help me get into a veterinary school, and applied to attend Valley City State University for their fisheries and wildlife science undergraduate program.

A New Path Discovered

For the first 2.5 years of my undergraduate program, I was set on a career path as a biologist working for a state government or the federal government. During my spring semester of my junior year, I started to volunteer during our wildlife club's junior

naturalist program. We would hold an environmental education event or activity for local elementary and middle school students once a month. The activities could include canoeing, fishing, and archery during the warmer months, and during the winter we would choose a topic, such as birds, and give a small presentation and then have educational activities after the presentation. Working with the junior naturalist program really helped me discover my passion for teaching others about the environment. I also had experience tutoring other students who would ask for help and being a teacher's assistant for multiple classes I had already taken. I soon started looking into different options to get into the education field. I determined that I did not want to be a formal teacher, and instead would fit better into an informal teaching setting. I started looking into master's programs for environmental education and ended up getting accepted into the University of Minnesota - Duluth's program. Due to some personal conflicts in which I would end up missing 80% of the first semester, I ultimately withdrew my acceptance from the program.

Professional Experience

After graduating from my undergraduate program, I found myself struggling to get a job in the natural resources field. During this time, I had to take jobs that were not in the environmental field, but almost two years after graduation I found a job for an environmental scientist position working for the North Dakota Department of Environmental Quality. I was unsure about working with landfills, as it wasn't what I had imagined myself doing during my undergraduate program, but was willing to give it a shot.

I started work with the North Dakota Department of Environmental Quality in October of 2019. I have expanded my knowledge of landfills as well as waste management and reduction since starting this position. I have taken over the educational events that my program holds or participates in, and I am currently chair of the Bismarck Earth Day Festival Planning Committee. I have found that the educational events and conferences are my favorite days of work, whether I am working with the adult landfill operators or the elementary and middle school students.

Working with the elementary and middle school students, we focus most of our education on recycling and waste reduction. Recycling opportunities in North Dakota have decreased with the recycling market's decrease and being far away from a recycling center. All recycled items from North Dakota need to be transported out of state to a recycling center, with the closest being located in Minneapolis, Minnesota. Waste reduction has really become a passion of mine, as it is something that I can do in my personal life. I have started to recycle anything that I can, buying items with recyclable or no packaging, composting, and using reusable bags during our shopping trips.

Positionality

During my undergraduate I would have never thought that I would have a professional career in solid waste management. I was not even aware it was a career option at the time. Now that I have gained two years of experience in the field, I have started to develop my own opinions on the field, along with solutions to waste reduction.

Growing up in a middle-class, white household I have been fortunate to be able to achieve my goals and have access to items or programs that I would need to accomplish them. When I was exposed to environmental justice, I noted that many landfills were

located in neighborhoods where mostly people of color lived. We do not currently have any regulations regarding environmental justice and how we determine whether a landfill can go in an area, other than the geological factors that are found in our rules. I think this has led to me having an unconscious bias for landfills and how they can affect other people, as I do not actively think about where our state's landfills are located and how they may be impacting people differently.

The biggest biases that could impact my research would focus around the waste reduction and recycling behaviors. Due to my upbringing and my current financial security, I have no problem spending extra money to reduce waste impacts, such as buying more expensive items that have less packaging or being able to recycle the items that we cannot get around purchasing. Before this project, I had never really looked into how it might not be feasible for other people to reduce their waste impact. Even if it was feasible to put a recycling program in a city, it might not be the most important policy for that city. They may be battling a drinking water problem, and using money to start a recycling program would cause more environmental or human health problems than it would fix.

Rationale

While recycling is not the only answer to improving environmental health, I feel waste management and waste reduction knowledge are important topics for students to learn about. Many of the educational resources for waste management focus only on recycling and reducing your footprint. Most of these educational resources are also geared towards adults, as they include information on programs present in the city. If recycling is covered in the classroom, it is only taught over a few days and then it is

never covered again. Even with the limited education available, people can still end up wish-cycling. Wish-cycling is recycling items that cannot be recycled (Farnsworth, 2020). These items can then contaminate the load available for recycling, and instead all of the items in that load will have to go to the landfill.

In order to understand recycling, students need to have an understanding of waste management and landfills. Understanding where their garbage is going and the impact their garbage can have on the environment can help to promote good recycling practices. Even if students are not in charge of their household garbage, their ideas can influence their parents' thoughts and behaviors. Using this educational curriculum, teachers and students can work with their local and state governments to help promote recycling and proper waste management in households, schools, and at their landfills. Even if it does not have a positive impact on their recycling behaviors, it will still allow students to experience and understand where their garbage is going and the impacts their waste management behaviors can have on the environment.

Summary

Nature has always been a passion of mine, but if my family did not have a family tradition of hunting and fishing, I probably would not be pursuing a career in environmental education today. I think I would have gone to a veterinary school, but I would not be recycling or thinking about the impact myself and others are having on the environment. While hunting and fishing greatly influenced my undergraduate program choice, my high school environmental science class also helped me choose a college to look into and then attend.

During my undergraduate education I really started to explore more career options that a fisheries and wildlife science degree could get me. During this time I found my other passion of teaching. While I had some experience teaching during my teaching assistant positions and tutoring others, it did not really hit me that I wanted to teach others until I started my work with the junior naturalist program. This really influenced my decision to start looking into environmental education, and how I could get into the educational field so close to graduation.

While I did not think the environmental scientist position with the North Dakota Department of Environmental Quality would be a good fit for me, it has ended up influencing my personal and professional life. Taking this position let me start a master's program, and it has also allowed me to start working at educational events. This position influenced my decision to make an educational curriculum on waste management and recycling. This curriculum will help answer the question: *How can teachers utilize a curriculum to expand students' knowledge of waste management and change their waste reduction behaviors?*

In Chapter Two, I will be focusing on waste management including the history of waste management, current waste management, waste definitions, recycling, and composting. I will also be looking at effective teaching methods and North Dakota state education standards for middle school students, and how this will influence how the curriculum is set up. Chapter Three will include an in-depth look at the educational curriculum, the curriculum audience, and techniques that were utilized. Chapter Four will reflect on the capstone project and my learning experience throughout.

CHAPTER TWO

Review of the Literature

Introduction

Chapter One focused on the experiences and rationale that led me to the research question: *How can teachers utilize a curriculum to expand students' knowledge of waste management and change their waste reduction behaviors?* To answer this question, I will be developing a waste management curriculum that can be used by both formal and informal educators. In order to develop this curriculum, I will be conducting a literature review of the following broad topics: the history of waste management, waste management, recycling, and North Dakota educational standards.

The first topic that will be explored is the history of waste management. Understanding the history and how it has impacted current waste management standards will be key to students understanding current rules and regulations, both at a state and federal level. After discussing the history of waste management, the second topic will shift focus to present day waste management. This topic will cover the different types of waste, disposal options, and current rules and regulations for waste management. Understanding current waste management practices will be important for students to understand, as most do not think about where their trash is going after it gets put out on the curb for pickup. These two topics will set up the base knowledge that students will need before exploring waste reduction.

The third topic that will be explored is waste reduction. This section will focus on waste reduction, recycling, the recycling market, and access to reducing, reusing, and recycling waste. The last section for this topic will focus on how students can use this

information to increase their waste reduction behaviors in their personal lives, schools, and communities.

The final topic that will be covered in this literature review is education, with a focus on environmental education and the North Dakota middle school education standards and how the curriculum can be developed to meet them. In the first part we will focus on environmental education and its role in behavior changes in students. After we have learned more about behavior change, we will shift focus to past waste management curriculums that have been developed and implemented, and how they impacted students behaviors and attitudes towards waste management and waste reduction.

The North Dakota standards will be used in order to ensure that the curriculum will be able to be used by educators to meet educational standards, as the curriculum will be developed to be used by both formal and informal educators in North Dakota. While the curriculum will focus on waste management in the United States and North Dakota, it will be flexible so educators in other states can adapt it to their own state or use it as a guide to develop their own curriculum. Educators will need to explore their own state's educational standards to ensure they are meeting them.

History of Waste Management

Federal History

In this first section we will be looking at the history of waste management. We will first look at the history at a national level, which will then be followed by a narrowed look into the history of waste management in North Dakota. Prior to 1965, most waste that was generated in the United States was handled at a local level, with no regulations from federal or state governments. In 1965, the Solid Waste Disposal Act was passed by

Congress (Solid Waste Disposal Act, 1965). According to the United States Environmental Protection Agency (EPA), this act was developed to improve solid waste disposal methods throughout the United States (United States Environmental Protection Agency, n.d.-c). This act focused on the growing amount of waste being generated in the United States, and how it was becoming less feasible to keep waste management at only the local and state level. While it would maintain delegation to these levels, the act looked to offer federal assistance through the development of financial and technical assistance that could be used to improve waste management and waste reduction on a national level. Focus was also put on the inefficient and improper methods of disposal that had been occurring at local levels that was in turn creating public health hazards. Some of these hazards included air and water pollution, an increase in vector diseases, and accidents occurring at the sites (Solid Waste Disposal Act, 1965).

The Solid Waste Disposal Act was amended in 1976 and became the Resource Conservation and Recovery Act (RCRA) on October 21, 1976 (United States Environmental Protection Agency, n.d.-c). RCRA is separated into nine different subtitles, and is the current primary law for disposal of wastes in the United States. Subtitle A and B set the general provisions, set up the Office of Solid Waste, and the authority of this office. Subtitle C focuses on hazardous waste management, and Subtitle D focuses on state and regional solid waste management, specifically regarding sanitary landfills. Subtitle E set the duties for the Secretary of Commerce in Resource and Recovery. Subtitle F set the federal responsibilities and Subtitle G were other miscellaneous provisions (Resource Conservation and Recovery Act, 1976).

The Hazardous and Solid Waste Amendments of 1984 were the first amendments to the RCRA regulations. The main amendments provided in this update required the end of managing hazardous waste through land disposal, updated the corrective actions that would be required if a release of pollutants was discovered, and a section on waste minimization (United States Environmental Protection Agency, n.d.-c). Other amendments included hazardous waste classification changes, management of used oil, enforcement actions, public participation and citizen suits, underground storage tanks, and extending the life of sanitary landfills (The Hazardous and Solid Waste Amendments, 1984).

The act was amended again in 1992 with the Federal Facility Compliance Act. This act helped to strengthen enforcement at facilities that were regulated at the federal level (Federal Facility Compliance Act, 1992). RCRA was then amended in 1996 to provide regulatory flexibility for land disposal of wastes that may have been classified as hazardous, but could be treated to then be disposed of in a solid waste landfill. There were also some updates provided to the groundwater monitoring for solid waste and some technical corrections to the Solid Waste Disposal Act (Land Disposal Program Flexibility Act, 1996). The Land Disposal Program Flexibility Act of 1996 was the last amendment to the RCRA regulations (United States Environmental Protection Agency, n.d.-c).

North Dakota Waste Management History

Waste management in North Dakota was regulated at the local level until RCRA was passed at the federal level. Most communities had their own landfill or dumps that handled their city's waste disposal. North Dakota adopted the Solid Waste Management and Land Protection Act during the 1975 state legislative session, and has amended the

act in five other legislative sessions (North Dakota State Department of Health and Consolidated Libraries, 1993). This act can be found in Chapter 23.1 of North Dakota Century Code, with rules being found in two chapters of the North Dakota Administrative Code (NDAC): the Solid Waste Management and Land Protection Rules can be found in NDAC Chapter 33.1-20 and the Hazardous Waste Management Rules can be found in NDAC Chapter 33.1-24.

Two new acts to update waste management in North Dakota were submitted and approved by the 1991 legislative session. The first was the Solid Waste Reduction and Management Act. This act established eight solid waste management districts, set regulations for a public education program, updated rules and regulations for solid waste in the state, set waste reduction guidelines, established an environmental compliance background review for applicants for a solid waste permit, established preconstruction site reviews, established operator certification requirements, and prohibited disposal of lead-acid batteries, used motor oil, major appliance, and untreated infectious waste at sanitary landfills (Solid Waste Reduction and Management Act, 1991). The Hazardous Waste Law Exemptions Act established that oil and gas exploration and production waste, waste generated from the combustion or gasification of coal or other fossil fuels, waste from ore and mineral processing, and cement kiln dust waste would not be considered hazardous waste, and instead would fall under solid waste (Hazardous Waste Law Exemptions Act, 1991).

With the passing of the new federal and state regulations, 106 dumps throughout North Dakota were closed, and 85 sanitary landfills were permitted under the act when it was first passed in 1975. In 1987 the number of permitted facilities had risen to 110

landfills, but by 1993 approximately 42 landfills were still operating under solid waste permits issued by the state. Many sanitary landfills were closed due to being located in unsuitable sites, the increase in service areas, and higher costs to maintain compliance with the new state and federal regulations (North Dakota State Department of Health and Consolidated Libraries, 1993).

Summary

Regulation of waste in the United States and North Dakota was limited before the passage of the Solid Waste Disposal Act in 1965 (United States Environmental Protection Agency). Most waste was managed at the local community level, but a growth in waste generation led to the need for federal and state regulations. Regulations looked to maintain waste management at the state and local level, but to provide assistance through financial and technical assistance, especially with concerns that poor management was leading to public health hazards. The passage of the Resource Conservation and Recovery Act in 1976 helped establish and provide standards for waste disposal throughout the United States (Resource Conservation and Recovery Act, 1976). This led to changes in how North Dakota regulated waste disposal, with the adoption of the Solid Waste Management and Land Protection Act in 1975 (North Dakota State Department of Health and Consolidated Libraries, 1993). The passage of both the federal and state acts led to establishment of waste management regulations and rules that have improved waste disposal practices, and both are still applicable in the present day. In the next section we will take a closer look at these acts and tie them into current waste management practices.

Waste Management

Waste Types

In this section we will be looking at the different types of waste, how they are managed and disposed of, and finally we will look at waste regulations in North Dakota. “Waste management is the collection, transport, processing, recycling, or disposal of waste materials,” (McLeod, 2008, p. 55). To understand current waste management, students will first need to look at and understand the different types of waste that are produced throughout the United States. When looking at the rules and regulations, waste management in the United States considers all waste to be solid waste. Solid waste is defined as the following in the North Dakota Century Code (NDCC) (Environmental Quality Act, 2017):

Solid waste means any garbage; refuse; sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility; and other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities. (p. 25)

Solid waste covers all waste except for those identified as being exempt by the United States Environmental Protection Agency (EPA). Solid waste can be broken into categories based on their origin: agricultural waste, yard waste, municipal waste, commercial waste, industrial waste, and special waste; or by their characteristics: hazardous waste, regulated infectious waste, putrescible waste, and inert waste (North Dakota Department of Health and Consolidated Laboratories, 1993). Solid waste regulations can be found in Subtitle D of the RCRA regulations (Resource Conservation

and Recovery Act, 1976). Hazardous waste is considered its own category of waste due to the different rules and regulations that have been established for it.

According to the EPA (Learn) “hazardous waste is defined as a waste with properties that make it dangerous or capable of having a harmful effect on human health or the environment.” Due to the effects that hazardous waste can have, separate rules and regulations were established in RCRA regulations for the waste, and can be found in Subtitle C (Sengupta, 2017). Because of the effects that hazardous waste can have on humans and the environment, these regulations were made with a cradle to grave concept for all who would deal with the waste, including generators, transporters, and the owners and/or operators of the treatment, storage, or disposal facilities (United States Environmental Protection Agency, n.d.-e). Some examples of hazardous waste include: chemicals, used batteries, used oil, pesticides, aerosol cans, and mercury containing equipment (Sengupta, 2017, pp. 77-106).

While hazardous waste is still considered a solid waste, all other waste that does not qualify as a hazardous waste is placed into the solid waste category. As stated earlier, solid waste regulations can be found in Subtitle D of the RCRA regulations Resource Conservation and Recovery Act, 1976. When developing this curriculum, we will place the remaining solid waste into the following categories: inert waste, municipal waste, industrial waste, special waste, and regulated infectious waste to be consistent with landfill types found in the NDAC Chapter 33.1-20.

Inert wastes are wastes that generally would not contaminate water or form a contaminated leachate. Leachate is a liquid that passes through or comes from solid waste and contains soluble or suspended materials from the waste (North Dakota Solid Waste

Management Rules, 2019). Inert wastes include all construction and demolition materials, concrete, asphalt, wood, bricks, tree branches, metal, appliances with freon removed, glass, and other materials that would not form a leachate (United States Environmental Protection Agency, n.d.-d).

Municipal waste is any waste that is generated by households, motels, recreation facilities, public and private facilities, and retail businesses (Environmental Quality Act, 2017). This waste is what most educators and students would be most familiar with when thinking about garbage and trash that is generated in their everyday lives.

Industrial waste is waste that does not fall into the classifications of hazardous waste and they are either formed from the combustion or gasification of municipal solid waste, or they are generated from the industrial and manufacturing processes (Environmental Quality Act, 2017). Special wastes are wastes that do not fall into the hazardous waste classifications and can be generated at energy conversion facilities, through the crude oil and natural gas exploration and production, during mineral and ore processing, and during surface coal mining operations (Environmental Quality Act, 2017).

Our final waste category that will be covered in the curriculum is regulated infectious waste. Infectious wastes are any wastes that may contain pathogens that can cause a human or animal to contract the pathogen when exposed to it (Environmental Quality Act, 2017). Most wastes in this category are generated at hospitals, health clinics, dentists, etc., but they may also be generated in households.

Waste Disposal

Setting trash cans out on the curb is often the last thought that many people have about the waste that they generate in their daily lives. Now that we have a broad understanding of the different types of waste, we will look into how the wastes can be disposed of. Most wastes are disposed of in landfills, both nationally and internationally.

Landfills are designed and built for the types of waste that will be disposed of in them. Inert waste landfills may not take municipal waste, as they are not built to take municipal waste. RCRA regulations set the design, engineering, monitoring, and operation standards that the landfills are held to (United States Environmental Protection Agency, n.d.-a). Waste disposal in a landfill involves burying it and covering it with a clay and vegetative cover. Waste that is placed in the landfills is usually compacted to help increase the stability of the waste and to help increase space for more waste (McLeod, 2008). Monitoring at the site will often include groundwater and landfill gas monitoring, but can vary depending on what type of waste is present. Landfills are also limited in where they are allowed to be sited. Landfills are not allowed to be placed in areas that would impact environmental or human health, but specific siting regulations are dependent on the state.

Certain waste types may also be incinerated instead of buried in a landfill. Waste is combusted through high temperatures, and the waste is converted into heat, gas, steam, and/or ash (McLeod, 2008). Some people do have concerns with incineration, as there are usually gaseous pollutants generated during the process (McLeod, 2008). Incineration is more common in areas that have a larger population and areas for siting landfills may not be present or feasible. Incineration is one method that is used to treat hazardous waste.

After treatment, the hazardous waste may be disposed of as a solid waste. This will be dependent on the type of hazardous waste it is, as some wastes cannot be treated, and must be stored or disposed of in engineered hazardous waste landfills (United States Environmental Protection Agency, n.d.-b). This same method can be used to treat infectious waste, but again is dependent on the type of infectious waste that is being treated.

Surface impoundments and injection wells are used to dispose of liquid wastes. Most landfills will also have a surface impoundment unit included to help manage the leachate that is produced at the facility (United States Environmental Protection Agency, n.d.-b). The liquid waste may be disposed of through evaporation out of the surface impoundment or pumping the liquid waste to a wastewater treatment plant or injection well, dependent on the landfill waste type, liquid waste type, and/or other chemical characteristics of the waste.

Waste Disposal in North Dakota

Most wastes disposed of in North Dakota are landfilled. There are 13 permitted active municipal waste landfills. All municipal waste generated in the state is disposed of in these landfills or disposed of out of state at other permitted municipal waste landfills (North Dakota State Department of Health and Consolidated Laboratories, 1993). These landfills may also have an inert unit or separate inert landfill permitted at the facility, as waste generated by the public usually falls into these two categories.

Inert waste landfills are numerous throughout the state, as many cities and smaller towns have inert landfills to ensure access to waste disposal closer to home. There are about 76 permitted inert waste landfills in the state, along with around 156 permit-by-rule

inert landfills (North Dakota Department of Environmental Quality, 2017). These landfills follow the same state regulations and inspections that are required by the North Dakota Administrative Code and the Solid Waste Program. The difference between these landfills is the size of the community they serve. If a community has 1,000 or fewer people, they will qualify for a permit-by-rule inert landfill (North Dakota Solid Waste Management Rules, 2019). They will not have to go through the state's permitting process, and instead fill out a notification form to notify the Department of Environmental Quality that they opened a landfill, and they will then just have to follow the rules and regulations for inert waste disposal. For communities larger than 1,000, a permitted inert landfill is required. This will require the city to go through the Department's permitting process to show that the facility will be run to meet all state rules and regulations required.

Other wastes that are generated in the state include: special waste from coal power plants, oilfield special waste, and industrial waste. There are eight permitted power plant facilities in North Dakota. Most of these facilities have more than one permitted disposal unit. They also may have surface impoundments for their leachate management or to store and treat wet ash from their plant. Some even have an inert waste landfill to dispose of construction and demolition waste that is generated at the site.

Oilfield special waste is generated during crude oil exploration and production. Most of these wastes are disposed of at one of the 11 permitted oilfield special waste landfills in the state. These sites only have one permit associated with their facility, but all of them have surface impoundments for management of the leachate produced at their

landfill. Wastes generated that have a higher radiation level are transported and disposed of at out of state facilities that can accept it.

There are only two permitted industrial facilities in the state and three sugar beet processing facilities that have multiple permits for the wastes that are generated at the facility during the process. There are only four permitted infectious waste facilities in the state of North Dakota, with only two of them being used to treat the waste. Waste at the other two facilities is collected and stored there until it is transported to a treatment or disposal facility (North Dakota Solid Waste Management Rules, 2019).

There are no permitted hazardous waste landfills in North Dakota, so most hazardous waste must be transported out of state to an appropriate disposal facility. Household quantities of hazardous waste are exempt from the hazardous waste regulations, but most municipal waste landfills will have a household hazardous waste collection facility for the public to bring used oil, used paint, batteries, etc. that the city can then recycle or process for disposal (North Dakota Department of Environmental Quality, 2021).

Summary

All waste is considered solid waste according to the EPA, but it can be categorized depending on its characteristics or origin. Regulations for their disposal can be found in the RCRA regulations under Subtitle C for hazardous waste and Subtitle D for all other solid waste (Resource Conservation and Recovery Act, 1976). We focused on hazardous waste, inert waste, municipal waste, industrial waste, special waste, and regulated infectious waste to help students understand the North Dakota regulations and rules for waste disposal. We then went through the different disposal options for the

waste types to help show that there are multiple ways to manage waste, along with showing different options that students may not be aware of if the disposal option is not available in their area. After exploring disposal options, we took a closer look at waste disposal in North Dakota, along with the different permitted entities that are available throughout the state for waste disposal. While recycling is a waste disposal option, it was not covered in this section as we will be taking an in-depth look at recycling in the next section of this literature review.

Recycling

Reduce, Reuse, Recycle

In the last section we took a look at present waste management, including the types of waste and disposal options. Recycling is an important part of waste management, and a great disposal option versus burying the waste in a landfill. “In 1960, Americans generated 2.68 pounds of garbage per day; by 2017, it had grown to an average of 4.51 pounds,” (Cho, 2020, para. 1). Recycling can help save money, energy, and natural resources. Out of the 3 Rs, recycling is the most common when one looks at waste management, as the waste is already there. According to the EPA (Recycling), “recycling is the process of collecting and processing materials that would otherwise be thrown away as trash and turning them into new products.”

Recycling includes the collection of the waste materials, processing them into new items or products, and then purchasing the products that are made out of recycled materials. Some items that can be recycled include: paper, batteries, plastics, glass, used oil, tires, and even household hazardous waste (Keep America Beautiful, 2021). Separating these items out of household trash can help save space in the landfill, along

with limiting the amount of natural resources that would be required to make new products of the same kind. Recycling can even be conducted at a landfill, with some municipal waste landfills able to recycle their methane gas that is produced through the waste breakdown process. This gas is then processed to be used as electricity. The City of Fargo MSW Landfill in Fargo, North Dakota currently has a gas to energy system that is used to heat the Cargill plant's boiler systems and produce almost 7.3 million kilowatt-hours of electricity annually (Zeman, n.d.).

The other two-thirds of the 3 Rs is reduce and reuse. Where recycling is looking to repurpose a material that has already been used, reduce looks to reduce the creation of waste and reuse looks to reuse the waste without further processing into a new product. Some options to reduce and/or reuse waste include: buying items with less or no packaging, using cloth towels instead of paper towels, bring your lunch in a reusable container, reduce your shower times to save water, use email, use refillable printer cartridges, and donate or buy from thrift stores (North Dakota Solid Waste & Recycling Association, n.d.).

Recycling Market

The United States recycling market relied on China to handle most plastic that was recycled prior to 2018. After an import ban was passed that stopped the flow of these recyclable materials, the United States moved to other countries to export their recyclable materials to. After more bans were put into place, many of the United States recyclable materials had nowhere to go (Cho, 2020). According to Cho (2020), Stamford, CT made \$95,000 from recycling in 2017. In 2018, Stamford had to pay \$700,000 to get rid of its recycling. Since much of the recycling was outsourced from the United States, the bans

are having a negative impact on the recycling market. Much of the infrastructure needed to keep the recycling market going in the United States was not developed due to relying heavily on exporting the materials. With the decline in the economic value of recycling, many programs were ended, leading to more of the waste being disposed of in a landfill or incinerated (Kimmelman, 2021).

With the decline in the recycling market many programs ended due to financial issues. Recycling programs in North Dakota had the added issue of having to pay for transportation of the collected recyclable materials to Minneapolis, Minnesota. Minneapolis is home to the closest recycling processing facility for all towns in North Dakota. Many programs ended or downsized operations, such as the Kalix recycling program in Minot, North Dakota. Kalix had to downsize their operations because of the continued low prices in the market, and could not continue to accept recyclables (Johnson, 2020). They now only accept classified documents for disposal. Even with the downsize in recycling programs throughout the state, we have also seen curbside recycling programs starting up in different cities. Many of the larger cities in North Dakota have a curbside recycling program, with some cities starting to look at the options available to them. According to the city's websites, Bismarck, Devils Lake, Dickinson, Fargo, Grand Forks, Jamestown, Mandan, Wahpeton, and Williston all had a curbside recycling program or recycling center that was open for residents to drop off recyclable materials. Minot, where the Kalix recycling program was, is currently in the process of starting a curbside recycling program for residents.

Even with improvements to the recycling market on a state and national level, which lead to better access for citizens to recycle, there are still other challenges that

surround recycling. According to Cho (2020), of the 267.8 million tons of waste that was generated by citizens in 2017, only 94.2 million tons was recycled. Wishcycling is a large challenge in the recycling industry, as it can lead to contamination of the other recyclable materials in the load. Wishcycling is the process of putting non-recyclable items in the recycling bin with the hope that they can be recycled (Huun, 2021).

Summary

The 3 Rs of waste management are an important part of helping to improve our waste habits. Reduce and reuse mainly focus on reducing and reusing items before they enter the waste stream. Recycling focuses on taking wastes from the waste stream and processing them to turn them into a new product. Recycling can help take items out of the waste stream, helping to save space, and ultimately money, in a landfill. After China banned the importation of plastics and other materials in 2018, the United States recycling markets have decreased. This has led to many citizens, cities, and/or companies having to pay to recycle products, leading to a decrease in recycling throughout the nation. Many recycling programs, in both the United States and North Dakota, had to downsize or close due to the financial burden that was a result of this. While there was an initial downsize in programs, North Dakota has seen many cities starting to implement curbside or recycling programs for their citizens to use. Wishcycling has had a negative impact on recycling, as many loads that have wishcycle items become contaminated and are then disposed of in landfills. Now that we have covered the last disposal option for waste, we will be shifting focus in the next section to education and the North Dakota educational standards.

Education

Environmental Education

Behavior Change. According to Heimlich and Ardoin (2008), there are three variable levels that environmental citizenship behavior is based on. The first level is categorized as entry level, and can include sensitivity, ecological knowledge, and attitudes. The second level is ownership and includes knowledge of environmental issues, personal investment in the issues, and knowledge of their consequences or commitments to the environmental issue. The final level is empowerment and can include environmental action skills, their position on control and intent to act.

These levels show an understanding of environmental education and how it can factor in developing students' environmental knowledge and literacy. This in turn, shows that environmental education is an important tool to develop student's knowledge of the environment and foster more environmentally friendly behaviors (Braun et. al., 2018). These levels can be used to influence the development of a waste management curriculum to meet the end goal of positively influencing students' waste reduction behaviors.

Using curriculums to promote behavioral changes can have limitations, as found by Boyes and Stanisstreet (2012). The first limitation is in the age of the students. Unless a curriculum is developed for a post-secondary classroom, many students are not yet able to vote on legislation or influence behaviors in their homes. While students may want to promote a behavior change at home, they can be limited by price to implement or other family members' attitudes towards the behavior. Braun et. al. (2018) found that the greatest factor in their study on environmental education and behavior change was the

country of residence. Using a standardized educational unit can limit students' long term behaviors or attitudes on the subject (Heimlich and Ardoin, 2008). With this disconnect, Braun et. al. (2018) suggests that the environmental education program or unit's goals are aimed at the local social and natural pressures that can be found on the subject. The potential effectiveness for environmental education can also be limited by the topic. Boyes and Stanisstreet (2012) found that environmental education programs that had a stronger relationship in reducing global warming led to a higher willingness for students to undertake the behavior change. While recycling is a low factor in reducing climate change impacts, it is still a positive factor in reducing climate change.

Waste Management Curriculum. Recycling behaviors are influenced by many factors. Cost, access to programs, educational awareness, social norms, and home life can influence if a student and/or their family will participate in waste reduction (So et. al., 2016). Increasing student's knowledge of waste management will not automatically increase students' waste reduction behaviors. So et. al. (2016) and Hayashi et. al. (2019) found quality teacher feedback led to a better waste management educational program that would result in a positive recycling behavior change. So et. al. (2016) found that inquiry based learning along with the feedback led to the most positive results, while Hayashi et. al. (2019) proposed that feedback's role in the educational process was to make students' more aware of their behavioral consequences, which would increase their chances of behavior change.

Barr (2007) found that having access to recycling tended to increase people's recycling habits and that the waste problem would most likely be resolved only when policies are implemented. Hayashi et. al. (2019) also recommended population

involvement in decision making would increase the chance for the behavior change to be maintained after it had been passed. Using this information, one could ensure that a final project is developed for the end of a waste management curriculum. This project would help students bring awareness and work to develop a school or community policy that could increase recycling behaviors at the level they developed the policy for.

North Dakota Educational Standards

In this section we will be exploring the North Dakota educational standards and how the development of this curriculum can be used to meet the middle school education standards. A waste management curriculum should be interdisciplinary, as it can cover multiple subject standards. The North Dakota Department of Public Instruction (2019), states:

Standards are written broadly enough so that each grade level can apply the standards to multiple areas of learning. The standards themselves do not specify a course in which the study needs to take place; rather standards can be applied to multiple grade levels and areas of study. (p. 9)

Social studies standards can be broken down into civics and government, economics, geography, North Dakota studies sections, United States History, World History, Sociology, and Psychology (North Dakota Department of Public Instruction, 2019). Some standards that a waste management curriculum can meet for social studies fall into the areas of civics and government, economics, geography, and sociology.

Science content standards can be broken down into earth and space science, life science, physical science, and engineering technology. The engineering and technology standards are integrated into all science standards for K-12 education in North Dakota

(North Dakota Department of Public Instruction, 2019). This standard uses the engineering design process, to help students understand the link between science and engineering. This standard helps to make the science standards interdisciplinary with mathematics standards, as analyzing and interpreting data and computational thinking fall into the science and engineering standards. Some standards that a waste management curriculum can meet fall into the areas of earth science, physical science, and engineering technology.

Exploring and understanding the different state educational standards before and during curriculum development is a key component to ensure that both formal and informal educators will be able to use the waste management curriculum. In order to make it well rounded, social studies content standards were also reviewed. The curriculum will be able to meet both science and social studies education standards for North Dakota, and will help to engage students in these areas of study. More detailed information on content standards that the curriculum meets will be discussed in Chapter Three.

Summary

In this section we took a look at environmental education and the North Dakota educational standards. Environmental education can play a key role in influencing behavior change in students, but it can also have limitations. Looking at previous studies on developing waste management curriculums has helped to give insight into the best way to develop a waste management and waste reduction unit for middle school students. Quality feedback from educators was one of the most important aspects of developing a curriculum that would influence a positive behavior change in students. We also took a

look at the North Dakota educational standards and found different standards that the waste management curriculum would be able to address. These standards will be explored more in our next chapter.

Summary

In this chapter, we explored the history of waste management at a national and state level, current waste management practices, recycling, and the North Dakota educational standards. Regulation of waste in the United States and North Dakota was limited before the passage of the Solid Waste Disposal Act in 1965 (United States Environmental Protection Agency). Most waste was managed at the local community level, but a growth in waste generation led to the need for federal and state regulations. The passage of the Resource Conservation and Recovery Act in 1976 helped establish and provide standards for waste disposal throughout the United States (Resource Conservation and Recovery Act, 1976). This led to changes in how North Dakota regulated waste disposal, with the adoption of the Solid Waste Management and Land Protection Act in 1975 (North Dakota State Department of Health and Consolidated Libraries, 1993).

These acts helped to establish today's current waste management regulations. In order to understand the regulations, one needs to know the different types of waste. After learning about the different waste types, we explored the different waste disposal options that were available for the wastes. These disposal options are regulated in Subtitle C, for hazardous waste, and Subtitle D, for solid waste, in the RCRA regulations (Resource Conservation and Recovery Act, 1976). We then narrowed our focus down to waste disposal in North Dakota, learning that most of the waste generated in North Dakota is

landfilled. Regulations for waste disposal in North Dakota follow the RCRA regulations, but state specific rules can be found in the North Dakota Administrative Code Article 33.1-20.

The final disposal option that we covered separately was recycling. Recycling takes wastes from the waste stream and processes them to turn them into a new product. Recycling can help take items out of the waste stream and help to save space in a landfill, or with waste disposal if landfills are not an option for disposal in the area. China's 2018 ban on plastics importation has led to a decrease in the United States recycling markets. This led to many citizens, cities, and/or companies having to pay to recycle products, and ultimately led to a decrease in recycling throughout the nation. While there was an initial downsize in programs, North Dakota has seen many cities starting to implement curbside or recycling programs for their citizens to use.

In the final section we explored education, with a focus on environmental education and the North Dakota middle school education standards. In the first part we focused on environmental education and its role in behavior changes in students. After we learned more about behavior change, we looked at past waste management curricula that have been developed and implemented, and how they impacted students behaviors and attitudes towards waste management and waste reduction. We then finished this section by looking at the North Dakota middle school science and social studies educational standards. This information will help with the development of the curriculum to make it a useful tool for both formal and informal educators. Both science and social studies content standards can be met, allowing for an interdisciplinary educational tool to be made. Using the civics and engagement content standards can help educators create

community or school based projects to start a recycling program, even if it's just an educational recycling program, that students can lead.

All of this information will help to answer our research question: *How can teachers utilize a curriculum to expand student's knowledge of waste management and change their waste reduction behaviors?* and help us develop our curriculum model in Chapter Three. Chapter Three will give us an in-depth look at the curriculum, including the curriculum audience, techniques that will be utilized, frameworks and theories used, and North Dakota education standards that will be met. While the curriculum will be developed using the North Dakota education standards, it will be made flexible and broad enough so that educators in other states will be able to use it as a guide/framework to set up their own waste management curriculum using information on waste management and education standards found in their state. In Chapter Four we will revisit the literature review, discuss the implications and limitations of the project, look at future research and opportunities to expand on the project, and finally explore the benefits that the project has to the waste management profession.

CHAPTER THREE

Project Description

Introduction

In the previous chapter, we established a background on waste management, recycling, and behavior change in environmental education. Using this information, I will develop a middle school waste management and reduction curriculum that will help answer: *How can teachers utilize a curriculum to expand student's knowledge of waste management and change their waste reduction behaviors?* The first section will cover the project description, including a section on the research framework that was used to develop the curriculum. The next section will cover who my intended audience is. Next, we will take a look at the North Dakota educational standards that the curriculum meets, and the timeline for creating and implementing the curriculum. The final section will look at how I will assess the effectiveness of the curriculum in changing students' waste management and reduction behaviors.

Project Description

Research Framework

I developed a waste management and reduction curriculum using the United States as a broad focus and North Dakota as a narrow focus. To develop my curriculum, I used the Understanding by Design (UbD) framework by Wiggins and McTighe (2011). There are eight main tenets of the UbD framework for designing curriculum, but the three tenets that were the most important to me were: a primary goal of UbD is developing and deepening a student's understanding of a topic; understanding is revealed when students autonomously transfer their learning through performance; and effective curriculum is

planned backwards (Wiggins & McTighe, 2011). Using this framework, I backwards planned my lessons to ensure that I met the goals and outcomes that I had developed for my curriculum.

Curriculum Development

I used the final curriculum goal of improving students' waste reduction behaviors to start my backwards planning of the curriculum. First, I developed three lessons on recycling and the positive environmental impacts it has. After the recycling lessons were developed, I needed to develop lessons on waste management, including where the waste goes, the different types of waste, and included a field trip to a local landfill along with an activity that explains how landfills are made. These lessons focused on setting the base knowledge of waste management that will help lead students into the last lessons of the curriculum on recycling. All lessons were developed using information for the United States as a broad focus and then narrowing it down to North Dakota information, allowing students to see how waste is managed and reduced locally.

After I finished developing the curriculum, I developed a final project that educators will be able to use with their students. The final project has students come up with different community or school projects that will promote waste reduction in their community or school. Students will then be able to vote on which project they would like to complete, and the class can complete the project together. This project can also be used without completing the project voted on by the class, but it will still show students that they are able to make a difference, while they apply the knowledge they have learned during this curriculum, in their everyday lives. Example project ideas include having a

school recycling competition, setting up a recycling program, either in their school or community, or having a highway cleanup.

In this section we looked at the research framework that was used to develop the curriculum. We also looked at the curriculum development using the backwards planning that was defined in the research framework. The final item we looked at was the development of a final project to complete the curriculum. In our next section we will look at the intended audience that the curriculum was developed for.

Audience

This curriculum was developed for use in North Dakota middle school, grades 6-8, classrooms. While this audience was the main focus of the curriculum, it was also developed for educators in different formal and informal settings to use as well. Educators in North Dakota may modify the curriculum to fit in their elementary, middle, or high school classrooms, or they may choose to use one or two lessons and modify them as well. I have used the Candy Landfill hands-on activity in an informal educational setting during our Bismarck Earth Day 6th-Grade Festival to help introduce students to waste management. I also developed the curriculum so educators in other states will be able to use the curriculum or lesson plans for guidance to develop their own lessons using local information on waste management and reduction.

North Dakota Educational Standards

This curriculum meets multiple North Dakota educational standards, in both the science and social studies standards. The lessons may be modified by elementary or high school educators to meet their standards as needed. The following social studies disciplinary core ideas are met in the waste management curriculum:

C.6_12.4.5 Demonstrate active participation in civic life; and

G.6_12.5.2: Analyze how human changes to the environment in one region or place can affect another.

The following science disciplinary core ideas are met in the waste management curriculum:

ESS3.A Natural Resources;

ESS3.C Human Impacts on Earth Systems;

ET1.A Defining and Delimiting an Engineering Problem;

ET1.B Developing Possible Solutions; and

ET1.C Optimizing the Design Solution

I ensured that the lessons were developed to meet these standards to allow formal educators in North Dakota to be able to use the curriculum in their classroom. I also wanted to ensure that the curriculum would be interdisciplinary, as waste management can meet multiple educational standards or needs based on the lesson plan. This also will allow flexibility on where the lessons or entire curriculum can be used, and will allow students to see various areas that waste can impact without the curriculum only focusing on the science of waste management.

Timeline

Initial research for this capstone project began in August 2021. I focused my research on educational frameworks and standards for North Dakota, as I have a professional background in waste management and reduction. Development of the curriculum started in January of 2022, and completion of the curriculum was achieved in April of 2022. Final submission of the Capstone project was completed on May 6, 2022.

After submission of the curriculum, I will be sharing the project with the North Dakota Department of Environmental Quality (NDDEQ) and Department of Public Instruction (DPI). Some lessons that are developed in the curriculum will be used at public outreach events attended by the NDDEQ. I would also like to see formal teachers in the state of North Dakota using the curriculum, even if it is only one or two lessons, starting with the 2022-23 school year.

Assessment

Assessments of the lessons will vary based on the content that is presented in each one. Some lessons incorporate a field trip or hands-on activity, where students will be able to apply their learning and see what they have been learning about. Other lessons end with having an open ended discussion with students to see what their thoughts are on the content of that lesson. The final assessment for the curriculum is the community or school project. This will allow students to use the information that they have learned throughout the curriculum to develop a project that will help to promote recycling and waste reduction in their community or school. Educators may or may not choose to execute the final project, but students are still able to show understanding of waste management and reduction in North Dakota.

Summary

In this chapter, we looked at the Understanding by Design research framework, developed by Wiggins and McTighe (2011), that helped guide the curriculum development. I used the backwards design approach from this framework to ensure that I met the curriculum end goal of improving student waste reduction behaviors. After looking at how the curriculum was developed, we then looked at who the intended

audience for this project is, but also explained that the curriculum was developed for educators to modify it, if they were not using the curriculum for North Dakota middle school students.

After we looked at the intended audience, we took a look at the North Dakota educational standards disciplinary core ideas that the project meets, to ensure that North Dakota educators can use the curriculum in their classroom. This was then followed by a timeline for completion of the research, project, and implementation of the project through the North Dakota Department of Environmental Quality and Department of Public Instruction. I then ended with how the project and individual lessons would be assessed to ensure that students were obtaining information that they could use in their own personal lives. In Chapter Four, I will provide the results of my project, its implementation, and my reflection on the curriculum development process. We will also look at the limitations of this project and the potential for future research and project development recommendations.

CHAPTER FOUR

Conclusion

Introduction

This curriculum was developed to increase student's understanding of waste management and waste reduction in order to promote a positive behavior change in the student's waste reduction behaviors. A specific focus on North Dakota was emphasized, as Braun et. al. (2018) suggests that the unit's goals are aimed at the local social and natural pressures that can be found on the subject, in order to increase the long term effects of the behavior change. Many waste management curriculums that have been developed to date, focus on a broad general understanding of solid waste management. Without having local focus, many of these curricula may not have as much success in implementing the positive behavior change in student's waste reduction behaviors. Keeping these thoughts in mind, the goal of this research was to determine: *How can teachers utilize a curriculum to expand student's knowledge of waste management and change their waste reduction behaviors?* In Chapter Four, we will revisit the literature review and discuss how it influenced my work. We will also look at the possible implications and limitations of my project, and potential future research or projects in the waste management area. Finally, we will look at how the project is a benefit to the waste management profession and how we can communicate or use the results of this capstone project. Throughout these sections, major learnings from my curriculum development will also be explored.

Literature Review Revisit

My literature review was split into two major sections: waste management and reduction information and educational information. Working in the Solid Waste Program for the North Dakota Department of Environmental Quality has greatly increased my knowledge of the waste management industry, and I found myself leaning on information I had obtained from my professional career. Most of the literature review in this section consisted of finding diverse resources that contained the information I knew I wanted to include in my literature review.

The education literature review impacted my capstone project and how it was developed, as I had never made a unit curriculum before. Using this section, I found information on how to best set up the curriculum that would result in the greatest chance of a positive behavior change in students' waste reduction habits. Braun et. al. (2018) influenced my decision to give waste management information on a broad and national level, but then had activities narrow the focus down to local North Dakota facilities. With the focus on local facilities, students may be more interested in the information and activities that they are learning about, and then take the information home to their families, resulting in a behavior change in not only the students, but their families as well.

Hayashi et. al. (2019) recommended population involvement in decision making to increase the change for the behavior change to be maintained after the curriculum was completed. This piece of literature really stuck in my mind while developing the curriculum, as I wanted students to maintain their waste reduction behaviors after they had completed the curriculum. This led to developing an extension activity after the last lesson in the curriculum that has students develop a community or school recycling

program/informational presentation to promote waste reduction in their community or schools. I don't think I would have thought of including this activity in the curriculum, had I not read this during my literature review, and then constantly thought about it while working on my paper and curriculum development.

In this section, we revisited my literature review, and discussed the pieces that influenced the development of my curriculum. While I had two major sections in the review, the education resources were the most beneficial when developing my curriculum. These resources helped me take the information, both old and new, from the waste management literature and implement them into the curriculum, to reach my end goal of promoting waste reduction behavior changes for students. In the next section, we will look at the implications of my project.

Implications

The key takeaway from my literature review was to focus my activities and information presented in the lessons on a local level. While I initially started wanting to make a large curriculum on waste management on a large national scale, with smaller sections that focused on North Dakota, I instead changed my lesson plans to have a larger focus on North Dakota, and then a smaller focus on a national scale. While I am not an educator full time, I will be looking to see how I can implement the same ideas and concepts into our annual landfill operator training courses, and other educational events that I represent the North Dakota Department of Environmental Quality at. When attending, I hope to implement or use parts of the lessons at these events to ensure that the information that I am giving to students will positively impact their waste behaviors and also give them an interest in waste management.

Since I am not a full time educator, I also have been working with my program manager and contacts with the North Dakota Department of Public Instruction to share the curriculum to educators throughout the state. We have not fully finished how or when it will be shared with educators, but we have also planned, if not shared directly with educators, to put the curriculum on our Department's website to direct formal and informal educators to.

Limitations

While I plan to try and implement, or at least make available, the curriculum throughout North Dakota, there are some limitations. One of the largest limitations that I can think of is time. Will the educators have enough time to implement the curriculum in their classrooms, and if not, is there a way for them to implement some of the lessons? To combat this issue, the curriculum was designed to meet North Dakota science educational standards, along with a social studies standard if the community/school program extension activity is included.

Another limitation is the waste management and recycling industry presence in North Dakota. While North Dakota has many different landfill and recycling facilities in the state, many are spread out or regional facilities, with many smaller towns not having access to a landfill or recycling facility locally. This could cause complications for the landfill field trip, as smaller towns may have to take an entire day for traveling and touring the facility. North Dakota also does not have a material recovery facility, and field trips to recycling facilities are limited to community and private recycling collection centers.

Finally, teacher interest and knowledge in waste management could have an impact on the curriculum implementation. If teachers are not interested in teaching the curriculum, it will not reach its intended audience. Even if they are interested in teaching about waste management and reduction, they may not have the knowledge or confidence to teach the curriculum fully. To combat this, the North Dakota Department of Environmental Quality would like to work with educators that would like to implement this curriculum, but time and coordination could still limit the success of the curriculum. The literature review could also be a good starting point for educators that would want to use this curriculum.

In this section, I went over the limitations of implementing the curriculum, along with providing some possible solutions to the limitations. Time, teacher interest and knowledge, and the waste management and recycling industry presence in the state could all limit the use of the curriculum, along with other limitations such as financing, logistics, transportation, etc. In the next section we will discuss the opportunities for future research and projects.

Future Research & Opportunities

This curriculum was developed to give middle school students an overview of waste management and waste reduction, with the end goal of implementing a behavior change in students' waste reduction behaviors. While conducting my literature review, it was nice to see that other waste management lesson plans and activities had been developed, however, many of them were made for one or two lesson plans. With global warming, an increase in production of products, and landfilling, waste reduction has become important for families and individuals to complete.

While this curriculum is a good introduction to the waste management and recycling industries, it can be expanded upon. My hope is to continue to grow the curriculum to have multiple units on waste management and waste reduction. I would like to develop more lessons on the types of waste, going over hazardous wastes, and even diving into Superfund sites. There are many different topics that could be covered and added to make this a large multiple-unit curriculum, granted that educators would have time to implement it in their classrooms. This curriculum could also be developed to be implemented in high schools, while expanding it to show the different careers that are available in these industries.

To help combat the limitation of teacher knowledge and interest, development of teacher workshops on waste management and waste reduction could be developed to give educators the information and tools they need to successfully implement the curriculum. These workshops could also help provide feedback on the curriculum to help improve and potentially expand the curriculum with their new ideas. Use of specific activities/lesson plans at educational events could also help generate interest in the curriculum.

Public outreach is an important part of promoting proper waste management and recycling programs. Use of this curriculum could help generate student interest in recycling that they could take home to their families. One could even use this curriculum as a starting point of developing an adult curriculum on waste management and reduction to promote policy changes or expansion of recycling businesses, community programs, or bringing a material recovery facility to North Dakota.

In this section, we looked at possible future expansions of this curriculum, along with other future work or branching off of the curriculum to start new projects. I would like to continue to expand the curriculum, including lessons on hazardous waste. Development of teacher or adult workshops could help promote the curriculum throughout the state, which could ultimately lead to policy changes in the state promoting waste reduction behaviors. In the next section we will look at how my results are communicated to the intended audience.

Results Communication

The goal of my curriculum was to promote an increase in waste management knowledge and increase waste reduction behaviors through middle school science and social studies standards. I hope to share this knowledge with North Dakota middle school educators, and other formal and informal educators outside of North Dakota that would like to utilize this curriculum as a starting point to make their own state specific lessons. I will be working with my Solid Waste Program Manager on putting the curriculum on our Department's website under our Division Publications. We also have some contacts with the North Dakota Department of Public Instruction, and are working with them so North Dakota educators can have direct access to the curriculum and that they are meeting the state education standards that are listed in the lesson plans.

Benefits to the Profession

In order to reach the end goal of promoting a positive change in students' waste reduction behaviors, students need to understand waste management. With students having an understanding of waste management, it can help bring more exposure to the waste management and recycling industry. Waste management and reduction are

important careers to ensure that environmental and human health is maintained. Waste reduction behaviors are also important in reusing products, limiting products, and recycling them with the ultimate goal of limiting the amount of virgin natural resources that are being used in production of products.

Conclusion

In this chapter, I revisited the literature review and discussed which resources impacted my capstone project the most and why they impacted it. Then we looked at the possible implications and limitations of the enactment of the curriculum. Next we looked at some possible future opportunities, research, and projects to expand the curriculum. We also looked at how the curriculum would be shared with educators in North Dakota through the Department of Public Instruction and the North Dakota Department of Environmental Quality's website. Finally, we looked at the benefits of this curriculum to the waste management and recycling industries.

Development of this paper and curriculum aimed to answer the question: *How can teachers utilize a curriculum to expand student's knowledge of waste management and change their waste reduction behaviors?* This question helped focus my literature review, and the development of the curriculum. Throughout this process, it was important to ensure that educators and students understood waste management and how we dispose of waste, before they would look at waste reduction behaviors. It also showed that we have started or have developed some educational programs and curriculums on this topic, but we still have work that needs to be completed to help promote these behavior changes in students and the community. My hope is that this curriculum will serve as a starting point for increasing people's knowledge of the waste management industry, which in turn may

increase their waste reduction behaviors; and then lead to future curriculums and projects that will result in the same end goals.

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