A PROJECT – BASED LEARNING 6TH GRADE SCIENCE UNIT ALIGNED TO THE NEXT GENERATION SCIENCE STANDARD: MS:ESS3-3; MINIMIZING WATER AND LAND POLLUTION.

by

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CERTIFICATION OF THESIS/PROJECT CAPSTONE WORK

We, the undersigned, certify that this project entitled A PROJECT-BASED LEARNING 6TH GRADE SCIENCE UNIT ALIGNED TO THE NEXT GENERATION SCIENCE STANDARD MS:ESS3-3: MINIMIZING WATER AND LAND POLLUTION by KELSEY DRUMMOND, Candidate for the Degree of Master of Science in Education, Curriculum & Instruction in Inclusive Education is acceptable in form and content and demonstrates a satisfactory knowledge of the field covered by this project.

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ABSTRACT

Project-Based Learning (PBL) has become a prevalent term in Science, Technology, Engineering, and Mathematic (STEM) classrooms. Teachers are introducing hands on and student-centered learning into their science classrooms to create a different atmosphere. By using PBL in the classroom environment for consecutive years of education, a gain in academic development and social skills are created. The Next Generation Science Standards (NGSS) are used heavily throughout K-12th grade as the science curriculum. With limited resources provided for middle school science teachers, this PBL unit will focus on how 6th grade students can design a model to minimize water and land pollution in the environment around their school community. Background knowledge on pollution and human impact on the environment throughout the world will help student succeed during this unit. Guest speakers and field trips to their community water source and surrounding land will help influence students design model. This unit can be modified for 7th or 8th grade science teachers teaching the same curriculum.

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A Project-Based Learning 6^{th} Grade Science Unit Aligned to the Next Generation Science Standard: MS:ESS3-3; Minimizing Water and Land Pollution.

Introduction

Teaching science in the upper elementary/middle school levels can mean accommodating many different learning styles depending on the students in your classroom. Science teachers whose school district use the Next Generation Science Standards (NGSS) often have a difficult time differentiating what to teach the students as the layout of one specific unit is very different compared to other curriculums used in a middle school setting. When comparing the NGSS to the Common Core State Standard Curriculum the NGSS MS:ESS 3: Earth and Human Activity is a total of one and one fourth pages long. (Achieve, 2018). Typically NGSS units last around 30 days depending on how many labs are incorporated by the teacher. Common Core State Standard Curriculum has each lesson of a unit planned out for a teacher in ELA and Mathematics. Science teachers who are beginning to use the Next Generation Science Standards in his or her classroom are struggling to identify how which specific criterial should be taught and in what order as the Middle School 6 – 8^{th} grade curriculums does not have a set order to be taught in. Teachers in any content area should have a clear understanding of what they are teaching their students in their specific grade level. Indeed, teachers who connect their teaching's to students' prior knowledge, interests, and life networks, will have a better outcome on the ways that their students will succeed in that content area.

If teachers do not have full understanding of the content, the reasons that he or she may be teaching the content, or the way in which the content connects to students' lives, then the teacher can introduce inaccurate information, lose student interactions and decrease student future interest in a particular career path. McConnell (2013) remarked that, "Teachers need an understanding of science concepts in order to organize and implement meaningful curriculum that includes multiple representations and models of concepts that strip away details, emphasizing essential concepts. Deep understanding of science concepts also allows teachers to assess students' understanding and identify misconceptions" (p. 216). In the following essay, I will introduce the benefits of having Project Based Learning (PBL) in science classrooms to help create better classroom learning environments. By incorporating a deeper understanding of science concepts, teachers will then be able to assess and help students achieve in the field of science during their educational years. Having Project-Based Learning introduced into any subject will create a better interest in the topic as students will be exploring, creating, and elaborating with their peers to find the best outcomes.

The Potential of Project-Based Learning

By introducing PBL into your science classroom environment, students will use authentic inquiry, work collaboratively to solve problems, explore the question in place and will be able to create a palpable product in responding to the specific question being asked. Hall (2016) explained: "Project based learning (PBL) can be defined as a constructivist approach to learning that assists students in gaining a deeper understanding of materials through process – oriented engagement in investigation of real, meaningful problems wherein students respond to a driving question" (p. 310). By implementing PBL in science classrooms, teachers will be able to provide students with connections from the real – world that may grow a students' interests to pursue a degree in a Science, Technology, Engineering, or Mathematics (STEM) discipline.

The overall academic achievement will enhance in your classroom by introducing PBL the more consistent you are implementing the teaching strategy. Han (2015) noted that, "STEM PBL has positively influenced students' non-academic performances. Students who have experienced STEM PBL show positive attitudes towards learning itself, team communication, and collaboration behavior" (p. 1092). The use of PBL can affect the classroom atmosphere in several ways. By presenting PBL, students will experience positive behaviors along with enhancing team building skills. Students will be introduced to hands on activities and filed based contexts that will up life their attitudes towards learning. As a result, "Empirical evidence strongly suggests that moving away from these traditional approaches to ones that are student-centered and interactive can lead to improved student learning" (Henderson & Dancy, 2011, p.73). Students who feel as if they are applying their knowledge of learning to the real world have a higher change of passing or being successful in the specific subject area, as it creates an awareness of applying their own skills to the real world.

As STEM programs are snowballing throughout the school districts around the world, it is important to understand the reason that this program is booming. STEM can be implemented in any grade level from Kindergarten to the College level of education. By combining PBL and STEM, teachers teaching students at any educational level will be able to create evocative learning by prompting students in future careers shadowing STEM. Tseng (2013) stated that, "The pedagogic concept of project-based learning is different from traditional learning in that it tries to develop students in active learners who actively acquire necessary knowledge to resolve problems that appear in the project, not as passive learners who always receive second hand knowledge" (p. 88). Students who use PBL strategies in their science classrooms will work in a whole class led or a small group led project to pose a question, collect information, visualize, create, and act upon their research.

Specifically, in science education, students who are introduced to Project-Based Inquiry Science curriculum at a younger age will develop habits earlier in life to help them achieve later on in their educations. Project Based Inquiry Science Curriculum entails constructing explanations and developing and using models in science education in order to emphasize student engagement in the framework or curriculum being taught. Harris (2015) commented: "New materials that provide students with more robust opportunities to engage in science practices and use core ideas to make sense of phenomena in ways that are not typically implemented in today's science classrooms can help students learn" (p. 1381). Students learn better when they are in a situation where they can apply their prior knowledge. Students are also more successful when they are comfortable and feel safe in the classroom environment, they are in. Students will become more successful in a subject if the educator introduces the ways in which their identifications are connected to the world around them. By applying real life situations to the students' learning, teachers will help increase students' interest in pursuing careers in that subject area. Introducing real life problems around them will help students question the reasons that something is happening, and what they can do to help stop it or to help make it better.

When PBL is implemented throughout an entire school year or many years of a student's education, a rise in social and academic development will occur. PBL provides students with the opportunity to develop in the following areas: problem-solving, critical-thinking skills, communication, team building, and collaboration skills, working independently, working effectively, time management, confidence boosting, and responsibility. MacMath (2017) noted that, "PBL was found to help students demonstrate the depth and breadth of their understanding and knowledge about a particular subject, better preparing them for their future educational and career opportunities" (p 178). By introducing PBL to students in early education, students will build skills in many different areas the longer that they implement PBL in their education. School districts that use PBL early on and throughout their district until the college level will see an intensification of student development in specific skills that students will be able to apply to future careers or education at the college level. By specifically adding PBL into your science classrooms, an interest in a career path in a STEM field will increase as students are working effectively and collaborating to problem solve in those specific career fields.

The success of PBL can also affect the way that students are arranged in groupings depending on the topic that they are learning. Apedoe, Ellefson, and Schunn (2012) steered research in order to assess group sizes and the impact of student learning in a PBL environment; the author commented:

> Beyond simple individual differences in ability to learn and give material given prior knowledge and cognitive ability differences, this inequality of learning may be due to one or more factors that can interact with group size: some students refuse to share the workload with team members, some students divide work into subtasks that are not equal in learning opportunities, or subtasks are so finely divided that students lose track of the larger picture. (p. 84)

In other words, the ability to group students is just as important as understanding the content that you are teaching your students. Apedoe, et, al. explained the ways in which mainstream classes would benefit with groupings of three or four, whereas advanced classes would benefit with students working in pairs.

Project Purpose

My reasoning for incorporating Project-Based Learning into the science classroom would be to create a positive learning environment for students to be engaged in learning science that works best for the specific student. Being a 6th grade teacher, I want to have a learning environment that students will eventually extend into their college years. By having students use

PBL, a positive outcome will benefit the classroom and the peers as they will be building specific skills used in PBL that will connect and extend to other subjects throughout the school year and used in the real world around them.

The research question that drives this project – *Does the use of PBL affect student learning in science?* – will help underscore the importance of the ways that Project-Based Learning will interact in a science milieu. By focusing on academic learning outcomes, students can develop outcomes that will extend beyond the classroom setting. Hall (2016) single-minded that, "Application of a PBL framework for program comparison facilitated measurement of common practices that have been found to increase STEM learning, such as higher-level instructional feedback, higher-level questioning strategies, integration of subject areas, student discussion, and student self-assessment" (p. 311). All in all, adding PBL can create a positive result on the way that your classroom environment will mold into an environment to better a student's career readiness in the real world.

In the next chapter, I will review the relevant literature in Project-Based Learning and its effects on classrooms in elementary and middle school. The literature being reviewed will help create a framework of introducing Project-Based learning with the NGSS: ESS3-3 "Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment" (p. 1).

Review of Literature

In the previous chapter, I introduced the ways that many different learning styles are used in science classrooms depending on the specific students in a classroom. Science teachers have struggled in the past with the ability to have a coherent understanding of the concepts that they are teaching using the Next Generation Science Standards (NGSS). By engaging students to collaborate with their peers and enhance their science learning by questioning real world problems or situations. Students will then become investigators on how to create a better world around them. Project-Based Learning can have beneficial strategies that will help students in the classroom that they can take with them into future educational settings. In the following chapter, I will review the relevant literature on the benefits of using Project-Based Learning in the science classroom setting.

The Effect of Project-Based Learning in Science Education

What is PBL and how can the students benefit from it in a science classroom setting? PBL has been a buzz word lately in education as teachers are reading educational magazines or attending professional development seminars. However, two theorists – Kilpatrick (1918) and Dewey (1938) – created the project method from which PBL has developed from over the years. These two theorists expressed the ways in which students are investigators with a non-passive learning process in mathematics and science. Many researchers have considered the question of why Project-Based Learning works. Hugerat (2016) expressed the ways that PBL is very different from the traditional methods of teaching. Students begin with a focus problem or a focus question that will encourage the students to work constructively in investigating, real world scenarios. PBL also allows students to become self-driven, which means that they are increasing their attitudes towards learning by creating a working process, becoming problem-solvers, and even creating a routine that will engage in future learning. Hugerat argued that non-project-based learning strategies can hinder student learning: “In a traditional non-project-based teaching strategy, learning speed is the same for each student and outputs consists of memorization” (p. 388). As researchers conduct more research on the ways in which students develop, interact, and learn as they grow, teachers can understand the ways that every student learns in his or her own way.

Han, Capraro, and Capraro (2015) connected PBL with STEM (science, technology, engineering, and mathematics) education in K-12 classrooms in order to increase deeper understanding for student success. The authors stated that, “STEM PBL is grounded in the theoretical background of constructivism where students are engaged in the diverse components of problem solving, interdisciplinary curriculum, open-ended questions, hands on activities, group work, and interactive group activities” (p. 1093). By introducing a variety of open-ended questions that allow students to work hands on and to interact with their peers, students will create great gains in the classroom, which they can use later on in their educational and career lives.

The use of PBL can affect the classroom environment in a number of ways Hansen and Gonzalez (2014) commented that, “Project-based learning and authentic, or ‘real world,’ learning generally work and in hand, engendering a body of literature that examines their effect simultaneously; however, these studies tend to be case studies or school-based analysis” (p. 142). By introducing PBL, students will experience positive behaviors along with enhancing team building skills. Students will be introduced to hands-on activities and field-based contexts that will increase their attitudes towards learning. As a result, “Empirical evidence strongly suggests that moving away from these traditional approaches to ones that are student-centered and interactive can lead to improved student learning" (Henderson & Dancy, 2011, p. 73). Students who feel as if they are applying their learning to the real world have a high chance of passing or being successful in that specific subject, as it creates an awareness of applying their own skills to the real world.

Holthuis, Deutscher, Schultz, and Jamshidi (2018) elaborated on the ways to create a framework for PBL for the NGSS. Three crucial fundamentals were stated as to the means of successfully using PBL in a science classroom aligned with the NGSS: "Access multiple forms of information needed to successfully complete the learning tasks; apply and demonstrate their knowledge in different ways; actively engage in their learning by making choices and decisions demonstrating self-directed learning; and reflection on their learning and make revisions based on self-assessment, peer review, and/or teacher feedback" (p. 25). The vital takeaway that teachers must understand when incorporating PBL in their classrooms is that these projects begin with an open-ended question and that it most likely will not only have one correct right answer as the result. Students in the science classroom might not have expected their results as their initial predictions could have led them in a different direction than the student intended.

Teachers in science education have also faced negative student attitudes towards science. Tseng, Chang, Lou, and Chen (2013) expressed the ways that students have found science as "boring and impractical subject" as students felt they were memorizing the science material rather than exploring in science (p. 89). The student's attitudes towards science were mainly focused on the way in which a teacher was teaching the science curriculum: "This may be due to the fact that science teachers focus mainly on theoretical understanding rather than practical work, which reduces the opportunities for students to implement their science experience" (p. 89). By adapting PBL strategies in the science classroom, Tseng, et al. found from interviews and questionnaires that students' attitudes towards science took a spin in the positive direction. As an end result, most students from the questionnaire and interview concluded that science can affect their daily lives by solving real world problems in the classroom. Merrit, J., et al. (2017) breaks up the definition of PBL into multiple categories based off of the subject/profession using the PBL approach. These categories are addressed as: clinical-medicine education definition, functional or curriculum design definitions, constructivism or project-based learning definitions, or conceptual change definitions. Looking closer at all of the separate definitions the constructivism or project-based learning definitions connects the best to the curriculum project I am creating: "Constructivist-inspired PBL, also known as project-based science learning, defines PBL as learning through projects that focus on problems in their real-life settings" (p. 4). By creating PBL that will be interactive for students to focus on real-life problems around them, then students will be more engaged and motivated to learn about preventing or fixing the current problem.

When incorporating PBL in the classroom, it is important for the teacher to provide students with as many resources as possible to use for the open-ended question given. A type of foundational skill that helps students to present information to their peers on the findings of that open-ended question includes web maps. Hou and his team (2016) particularized on how web maps are beneficial for student learning: "Many studies have found that the application of web maps allows learners to present digital geographical information through the methods of visualizing, manipulating, reading, inquiring, summarizing, and analyzing; it also enhances learners' geographical concepts through dynamic geographical presentation and helps them construct knowledge and develop the concepts of space and reasoning" (p. 89). By using web maps students in the classroom can connect cognitive thinking with spatial thinking. Providing students with web maps will allow students to give the audience as much information about the open-ended question using visuals such as geographical concepts and presentations to make comparisons and a deeper understanding of the problem presented. In PBL, the teacher can provide multiple resources for the students to use to help answer the open-ended question in the beginning of the project. It is up to the students to pick the tools that will benefit their learning in order to produce an answer for the open-ended question.

When incorporating technology in their teaching is just as important for teachers to comprehend the best ways of using technology as it is for the students in the classroom. ChanLin (2008) expressed: “When integrating technology into learning, students are more likely to build on what they learn from technological skills and experiences when their existing knowledge is acknowledged and made central to the learning process” (p. 57). Teachers who are planning the lesson must create a setting open to technology in the best interest of their students’ knowledge in using the tools. If students do not have the knowledge of the ways to use the tools of technology, it will create a more difficult process in the PBL lesson. This will add to more time focusing on how to use the technology in the classroom and less time creating and expanding their knowledge on the concept being presented.

As important as it is for students to be able to incorporate PBL in their learning, it is just as important for a teacher to understand the ways in which to provide successful teaching strategies to promote student growth. Teachers also need to feel comfortable and to have a positive attitude toward the teaching strategies being taught in their classrooms. McConnell, Parker, and Eberhardt (2013) conducted a study on teachers’ understandings of science concepts by asking teachers to explain a general phenomenon and then to explain who and/or how that phenomenon works. As a result, McConnell and his research team discovered that, “There is clearly a need for teachers to have deep understanding of the science concepts they teach. If teachers have only superficial knowledge of the topics they teach, instructional design and delivery are impacted" (p. 741). Professional development is crucial for teachers in any subject in order to strengthen key concepts in that area of education. Having a strong understanding in the content and core ideas being taught in the classroom will strengthen student academic growth in that subject. As Kizkapan & Bektas (2017) remarked: "project based learning should be performed for the adaptation of students and teachers before treatment" (p. 37). PBL can be a long process for teachers to create in their classrooms, but recent discoveries have found the importance of teacher knowledge in the subject area and content being taught to the students in his or her classroom. In Kizkapan & Bektas' study the ability to challenge students to think in different ways will enhance their outcomes: "it is aimed to make a contribution to students' academic achievement by improving students higher order skills such as critical thinking, planning, problem solving, and creativity" (p. 39). Students need to have the time to think critically and express their findings as they are researching the open-ended question.

The benefits of using PBL have been researched by many educational theorists over time. In a study by Hall and Miro (2016), positive results concluded: "Application of a PBL framework for program comparison facilitated measurement of common practices that have been found to increase STEM learning, such as higher-level instructional feedback, higher-level questioning strategies, integration of subject areas, student discussion, and student assessment" (p. 318). By focusing on academic learning outcomes, students will be able to develop outcomes that will extend beyond the classroom setting. Hall and Miro's (2016) research suggested that students learn more effectively when they are in environments where they can apply their knowledge to real-life scenarios. Students will become more successful in a subject if educators introduce these project-based lessons in which their understandings are connected to the world around them. By applying real life situations to the students' learning experiences, teachers will help increase students' interest in pursuing careers in that subject.

Looking at Project-Based Learning and the ways in which it connects to the Next Generation Science Standards, The *Framework for K-12 Science Education* aligns with the NGSS. Harris (2015) commented:

> The *Framework* emphasizes that science is not just a body of knowledge but also a set of practices for investigating, modeling, and explaining phenomena in the natural world. In addition, it calls for students to make sense of phenomena or design solutions to problems by focusing on a limited number of disciplinary core ideas and crosscutting concepts using science and engineering practices over multiple years, so that students have opportunities to build deeper knowledge (Pellegrino & Hilton, 2012) and revise their understanding over time. (p. 1363)

Students learn better when they are in an environment where they can apply their knowledge. Students will become more successful in a subject if the educator introduces the ways in which their identifications are connected to the world around them. By applying real life situations to the students' learning, teachers will help increase students' interest in pursuing careers in that subject.

Project-Based Learning can create an atmosphere unlike any other learning environment: Apedoe, Ellefson, and Schunn (2012) emphasized how: "Collaboration is an essential component of many project-based learning environments. It provides opportunities for students to extend their thinking, share ideas, and draw on the expertise of others" (p. 84). Creating an environment where students can work together and bounce ideas off each other will create an atmosphere where students feel comfortable. By students communicating their ideas and findings, they will enhance their knowledge and the knowledge of the students around them. Hanney & Savin-Baden (2013) characterized project-based learning into two stages known as project innovation and project implementation: "The fit between project-based and problem-based learning can be thought of as a 'fit over time.' The first stage of a project that of 'innovation', is exploratory in nature and involved students in encounters with problem scenarios in a way that encourages them to engage with, and manage, their own learning. The second, or implementation stage of a project, then seeks to deliver an artifact, service or other output to a real or simulated client" (p. 12). Connecting Apedoe, et al., and Hanney and Baden's findings of Project-Based Learning, it is an important reminder for the teacher leading the PBL to encourage students to be as creative, critical, and hardworking collaboratively to address the open-ended question.

Conclusions

The purpose of this curriculum project is to incorporate the Next Generation Science Standard MS-ESS3-3 with Project -Based Learning in a sixth-grade science classroom. This curriculum project allows students to design and model how to minimize human impact on our planet specifically in the Western, New York area. By incorporating Project-Based Learning (PBL) in a science classroom, students will adapt skills to succeed in and out of the classroom. Students will not always be on the same pace as the peer sitting next to them. So why not incorporate PBL into your classroom? Using PBL students can work at their own speed to create, explore, and self-correct their learning as he or she gets to the result of answer the open-ended question. By incorporating PBL in middle school science classrooms, my curriculum project has the potential to increase students' interest in careers in the STEM fields. The next chapter will provide a detailed description of the steps taken to develop and design the curriculum aligned with the NGSS MS-ESS3-3.

Methodology

The purpose of this curriculum project was to create a science unit regarding the ways to minimize human impact on the environment using the Project Based learning (PBL) method. Students will become researchers and engineers to discover the human impacts on the environment around them, as to the ways in which they can minimize activity in order to create a healthier environment to live in. By aligning the Next Generation Science Standard: NGSS-ESS3-3 with PBL, students would be able to develop a method in order to help minimize human population and its impact on the environment around them. In the following chapter, I will detail the methodology of Project-Based Learning and the Next Generation Science Standard MS:ESS3-3.

Conceptual Framework

Project-Based Learning

For the purpose of this curriculum project, Project-Based Learning (PBL) is a teaching strategy which is an essential element to building student learning in any subject. Using PBL in science education will help students become aware of what is going on around them and try to figure out a solution or a way to educate the community. The Buck Institute for Education of Novata, California has introduced a *Gold Standard PBL,* which consists of 7 essential project design elements. The main reason that the Buck Institute created the *Gold Standard PBL* was to make sure that teachers in any subject area would be able to follow a model for any type of project being done. Buck Institute (2015) specified: “if done well, PBL yields great results. But if PBL is not done well, two problems are likely to arise. First, we will see a lot of assignments and activities that are labeled as “projects”, but which are not rigorous PBL, the students will suffer. Or, we will see projects backfire on underprepared teachers and results in wasted time, frustration, and failure to understand the possibilities of PBL. Then PBL runs the risk" (p. 1). This gold standard's outline will help teachers and schools to organize and improve their practices in order to make sure students are receiving the highest quality of product and organized process in creating their project.

The Buck Institute (2015) explained that each of the 7 essential project design elements is broken up into three specific learning goals: key knowledge, understanding, and success skills. The interpretation of the findings detailed: "Student learning of academic content and skill development are at the center of a well-designed project. Like the lens of a camera, our diagram puts the focus of PBL on preparing students for successful school and life experiences" (p. 1). By teaching this PBL science unit in a 6th grade middle school setting, the students will be able to take their knowledge and skills learned from the *Gold Standard PBL* for their future education.

Audience

The audience intended for this curriculum project would be for any 6th grade science teacher with class sizes ranging from 20-25 students. The students are from a city school district in Western New York. This city is just less than 5 square miles and is located right along one of the Great Lakes – Lake Erie. The population of this city is around 11,848. The Middle School population is 440 students, which includes students in grades 6-8 (Public School, Review, n.d., p. 1). Out of the 440 students, 242 (55%) of students are male and 198 (45%) of students are female (Public School, Review, p. 1). The ethnicity of the students in the school district varies as 230 (53.3%) of students are Hispanic or Latino, 167 (38%) of students are White, 27 (6.1%) of students are Black or African American, 14 (3.2%) of students are Multiracial, and 1 (0.2%) student is American Indian or Alaska Native (Public School, Review, p.1). The socio-economic profile for the city includes 66% of household income is under $50K, 25% is between $50K-

$100K, 8% is $100K-$200K. Whereas 22.7% of the city population is in poverty (Public School, Review, p. 1). The city's Educational Attainment consists of 15% of no degree, 40% with a high school degree, 31% have some college, 8% have a Bachelor's degree, and 6% of the population in the city has a postgraduate degree (Public School, Review, p. 1).

Procedures

During the course of developing this curriculum project on PBL in the science class environment, the author took the following steps:

Step One: Collaboration with Professionals and Identifying the Audience

To begin the procedure regarding the decision on developing a unit on PBL based on the NGSS, I first had to meet with the science professionals at my school district in order to collaborate with specific NGSS taught at each grade level. In the summer over 2018, the science department for 6th, 7th, and 8th grade at the middle school got together in order to discuss the specific Next Generator Science Standards that would be used for each grade level. As the NGSS has only a Middle School (MS) section of standards that can be taught at any of the 6th – 8th grade levels. This time was crucial for me and the other professionals to collaborate to make sure the standards were not being missed nor being taught multiple times throughout grades 6 – 8. During this discussion the principal of the school district asked all the teachers how much planning time they would like for each standard being taught. The final decision by the professionals and me were to aim for 30 days of teaching for each unit. After the time frame was discussed the specific standards were addressed for each grade level; the professionals broke into smaller groups of 2 – 3 teachers (depending on the grade level) to discuss specific grade level needs.

Step Two: Conducting Research on New and Old Next Generation Science Standards

The second step was a bit more challenging compared with the first step as during the few days of planning time that we had, we were presented with new NGSS information. The NGSS were changing and the new standards would be tested in the 2022 New York State 8th Grade State Test, meaning that students enrolled in 5th grade as of the 2018-2019 school year would be tested on the new NGSS. This made the other 6th grade science teachers and I question whether to switch to the new standards or to continue with the old standards. The other teachers and me, with the help of the middle school principal, have decided to combine the new and old NGSS standards for the 2018-2019 school year and then teach strictly the new NGSS in the 2019-2020 school year. In order to do this, the other two 6th grade science teachers and I compared both the old and new standards in order to come up with a years' worth of curriculum. With that being said, the group of professionals and I came up with 5 different units lasting around 30 days each in order to complete the 6th grade science curriculum.

Step Three: Determining Next Generation Science Standards Curriculum Requirements

When looking at the NGSS curriculum, there is only one to two pages of information that are addressed. When I first began to teach science, I was frustrated and confused as to why so little information was given to the instructors on what to teach in the subject of science. But I then took a closer look and enjoyed the flexibility of creating lessons that are based around the students' background knowledge and the interests that they have for each unit. When I was first looking at the Earth and Human Activity unit, one standard stood out to me that I really wanted to have students explore: *MS:ESS3-3: Apply scientific principles to design a method for* *monitoring and minimizing a human impact on the environment.* This standard was perfect for aligning to PBL, as students are creating a method to minimize human impact on the environment. With the school district being so close to one of the Great Lakes – Lake Erie – I thought the students would be able to have plenty of background knowledge on the environment around them. This curriculum project was intended to be used for many science teachers teaching the Next Generation Science Standards and teachers should adapt the unit to their school districts community around them. This curriculum project was created to enhance student centered performances using this specific NGSS.

Step Four: Use the Project Based Learning Buck Institute Gold Standard PBL and Design a Unit in Science.

Back in the summer of 2018 when planning the curriculum for the 2018-2019 science school year, the school district had a district wide meeting to discuss the 5-year plan. In this five year plan the administration wanted to create a hands-on student-centered learning experience that the students will be able to take with them in any career they will peruse. With that being said, I had a mission to create a PBL science unit using a standard from the MS: ESS3 Earth and Human Activity Unit. Students have one of the Great Lakes right in their school's backyard. This unit talks all about the ways that humans all over the world are impacting the environment. By aligning the *Gold Standard PBL* to the NGSS curriculum, I would have the future students create their own method of educating people in their community on ways to minimize human impact on their community's environment. Using research from the Buck Institute for Education (2015), I was able to address each step of the Buck Institute (2015) *Gold Standard PBL* elements in order to help my students become successful engineers and educators in their communities. As this was a long-term goal set by our principal, I would not be incorporating this curriculum project until the 2019-2020 school year with adjustments to student's background knowledge, and prior knowledge.

In the next section of Chapter Three, I will talk through each of the *Gold Standard PBL* as to the ways in which I created this curriculum to align both PBL and the NGSS to a 6th grade middle school classroom setting.

Scope and Sequence

By aligning the NGSS: MS-ESS3-3 with PBL strategies, students will follow the 7 *Gold Standard PBL* elements throughout the process of creating a way to minimize human activity in the environment around them. All seven steps on the PBL are crucial for student success in completing the product of a public production. Below you will find each step in the process of *Gold Standard PBL: Seven Essential Project Design Elements*. It is important to note that there is not a specific time frame that each element should be performed as students are leading their learning and designing the method and the teacher is there for support, collaboration, and feedback. Some students might not need as much time determining one element compared with another. But a good window of time frame to complete this curriculum project would be 15-20, 40-minute class periods with two to three days specifically for a field trip and guest speakers.

Element One: Challenging Problem or Question

Beginning your new unit, the teacher will propose a challenging problem or question to engage the students in what they will be researching. The specific question students will be asked for this curriculum project includes: *How can you design a method to help minimize water or land pollution in our environment?* The objective of this PBL unit will also be presented during the first day: Students will investigate ways humans interact with water or land pollution in the environment around them. During the project, students will create a method that can educate and encourage ways to minimize pollution in the environment around them. There will be a whole class discussion as to what the question is enquiring, and the class will create a list of information that they would like to learn more about (see Appendix A). After a whole group discussion, students will decide if they would like to work with a partner or independently, they will also discuss roles for each partner, sign a partner agreement form or an independent agreement form (see Appendices B & C).

Element Two: Sustained Inquiry

The second element to the *Gold Standard PBL* is sustained inquiry, which is the method where students will investigate and seek new information on the question presented in day one. Element two will take one full class period to brainstorm the possible topics to be investigated further. During this section, students should not be able to look something up on the Internet and then continue with their design project. Instead students should be introduced to real public service directors and be able to visit different places in their community. Some examples that students might come up with include: Lake Erie Coastal Management, North County Transfer Station Recycling and Landfill, City Grounds Crews, Steel Plant Productions director, or the city water/sanitation plant. In addition to meet with professionals as guest speakers in the specific land and water concentrations, the students should take a field trip to the local area being addressed in their Driving Questions. As the teacher, I would coordinate a field trip to four different waterfront locations which their method for monitoring human impact could address: (Point Gratiot Beach, Cedar Beach, The Boardwalk, or Wright Park Beach). If the teacher was unable to coordinate a field trip or guest speakers to come in as per student request to help answer the driving question. Then a virtual field trip via Weebly would be made by the teacher in order to address student information along with documentaries, news articles, or emails from specific directors of corporations. It is important to note that when guest speakers are presenting, students would be broken up into groups. This way, students who would need to only hear certain guest speakers present would be able to spend their time focusing on the information they need in building their project. Students would sign up for two to three presentations which can be held at different times throughout the class periods. In addition, students would need to have specific questions written down before guest speakers have arrived in order to make sure time is spent accurately during the second element of PBL.

Element Three: Authenticity

The third element focuses on the real student concerns and impact of the school or community. This section puts the driving question into perspective as to the ways that the students can connect to it. The students are designing a way specifically to help minimize land or water pollution in their environment. The students are designing a method of real-world impacts on the environment in which they live in. Each project will have students' personal touches that will speak for their own interests, issues, and concerns on ways to minimize human impact on land and water pollution in their environment.

Element Four: Student Voice and Choice

Each pair of students or individual student has their own voice as to the ways in which they will educate others in their community in order to minimize human impact on land and water pollution. This means that students will be able to call these projects as their own as they will be able to present their method to the public. Students also have a choice as to which way they would like to present their method such as: create a Weebly website, digital flyer, newspaper article to be published in the local newspaper, photo-story, Public Service

Announcement (PSA) or to write a persuasive letter asking for support with the land or water pollution human impact issue to be sent to their local city hall.

Element Five: Reflection

The fifth element for *Gold Standard PBL* consists of teacher and student collaboration. This element is done throughout the entire project design process as students are constantly filling out a project work report (See Appendix D) each time they are working on their project. In this project work report students are discussing their goals, accomplishments, next steps, and concerns, problems, or questions. Students can collaborate with other pairs of students or the teacher in order to help relieve any concerns, problems, or questions during the design process. The teacher will also have a schedule of checkpoints (Appendix E) in which she will have a teacher made checklist of when she does check with the pairs or independent students in order to see where they are in their design process. Students will have a practice presentation in front of their peers which will help them determine any modifications needed before the public production (Element Seven). Lastly, students at the end of the public product will have a “My Thoughts” which is an independent form stating the factors that they thought went well, those that did not go well, and the modifications that they might have for future PBL units (Appendix G).

Element Six: Critique and Revision

Element six is another element that can be done at any time in order to build students’ discussion knowledge. If a student would like teacher assistance on a certain topic on an environment/community other than theirs, the teacher can provide mini lessons, posters, whole or group discussions. The teacher will also incorporate a mini lesson with visuals and role play examples on the ways to give and take constructive peer feedback. This is very important and will be discussed when students are signing the partner and independent agreements. The teacher will also provide formative evaluations by giving feedback and time for students to address their own evaluations as they are working on the process of their project design.

Element Seven: Public Product

Lastly, students will be presenting their final method on the ways to minimize human impact on land or water pollution in their own environment to a live audience. The teacher would be hosting an after school open house during which I will invite school district members and administration, city board members, and open to the students' family members, friends, and their community members. The students will be able to display and educate the audience using their Weebly website, digital flyer, newspaper article to be published in the local newspaper, photo-story, Public Service Announcement (PSA) or persuasive letter asking for support with the land or water pollution human impact issue. During this time, students will be able to take their concerns and pitch their ideas as to the ways in which they can help their communities land and water environment.

Validity

One of the limitations faced by this curriculum project would be addressing English Language Learners' specific needs such as translating the materials students would be using. Students might also need a translated guided notes page for guest speaker presentations depending on the English proficiency level of the ELL. Teachers should assist and provide additional materials in order to help support all students in their classroom.

Another limitation faced by this curriculum would be if a high leveled middle school teacher would like to take this curriculum project and have a 7th or 8th grade class complete this NGSS Earth and Human Activity as a PBL unit. With the students who are older than 6th grade, they might have more background knowledge on possible topics to be investigated or would need other procedures to complete method to monitoring the land or water pollution in their environment. The teacher implementing this curriculum project would need to provide additional supports or more challenging criteria for this unit.

The last limitation faced by this curriculum would be for a school district that does not have access to a specific land and body of water combination in order to visit on site or collaborate with guest speakers. Teachers could then change the driving question to: *How can you design a method to help minimize air or land pollution in our environment?* If the environment around your school district does not have access to a body of water, it is important to implement the driving question into one that your students can make personal connections to their environment around them. An example would be if the environment around the school district had a lot of industrial buildings or was a city environment with little natural environment.

Conclusions

After completing Chapter Three of this curriculum project, I believe that my project matches the problem outlined in Chapter One. My initial question was – does the use of PBL affect student learning in science? By focusing on academic learning outcomes, students are able to develop outcomes that will extend beyond the classroom setting. This curriculum project has students creating a method for a real world problem in the environment in which the student lives. The students will be able to take this part of their 6th grade science class with them throughout their higher education and in the career they pursue later on in their adult lives. The interests of connecting the NGSS MS:ESS3-3 with the *Gold Standard PBL* elements will help teachers teaching this standard in grades 6- 8by creating a hands on, community involved and student led project design process. In the next chapter, the outcomes and revision process of creating the NGSS Earth and Human Activity PBL curriculum project will be addressed.

Results and Interpretations

The following chapter contains the outline for the unit aligned with the curriculum for a 6th grade science unit that incorporates Project-Based Learning (PBL). The following outline contains lesson plans for each of the seven Gold Standards to PBL. This is followed by the supplementary materials that coincide with the curriculum lessons.

Unit: Minimizing Human Impact

Students will be designing a method independently or with a partner in order to help minimize human impact on the environment around them by answering the following inquiry question: *How can you design a method to help minimize water or land pollution in our environment?* The outline for this unit will follow the Buck Institute (2015) *Gold Standards PBL* to help guide students and make sure they are following the correct PBL guidelines as addressed in the Scope and Sequence section in Chapter 3.

Next Generation Science Standard

MS-ESS3-3 *Apply scientific principles to design a method for monitoring or minimizing a human impact on the environment.*

Intended Learning Outcomes:

- Students will be able to create a method for minimizing water or land pollution in his/her community environment.
- Students will be able to provide constructive peer feedback to his or her partner to create a successful collaboration process.
- Students will be able to display their method using a Weebly website, digital flyer, newspaper article, photo-story, Public Service Announcement, or in a persuasive letter during the open house public production event.

Grading Policy

Students will receive multiple grades throughout their design process:

Assignment being Graded	Description of Assignment	Total Points
Project Work Report (Appendix C)	Each day the students meet to work on their design project, they will fill out a project work report during the last 5 minutes of each class. The teacher will take the first few minutes of each class to go around the room and check to make sure the project report was completed. The students will receive 5 points for each day the students have completed the report.	5 points each day x 20 days = 100 total points
Final Project Design Rubric (Appendix F)	Students will be graded during their class presentation and their presentation at the public production open house event. Students will be	50 points during class presentation + 50 points during public production presentation = 100 total points.

	graded on the following criteria: display/creativity, presentation, voice level/speed, knowledge on method, and knowledge of the environment in the community.	Students will earn up to 10 points in each criteria for each presentation.
“My Thoughts” (Appendix G)	Students will independently complete a “My thoughts about the project” short response to answer the following questions: What factors went well, what factors did not go will, what modifications should the teacher have for the future PBL units, and what suggestions would you give to next year’s 6th grade students?	25 points x 4 questions = 100 total points, students should answer all four questions in complete sentences.

Suggested Timeline

Students will complete this PBL design process at their own pace; the suggested timeline is four school weeks/20, 40-minute class days. In this four-week time period, students will gather evidence to help answer the challenging problem/question.

Brief Summary of each Buck Institute *Gold Standards for PBL*

Standard 1: Challenging Problem/Question

How can you design a method to help minimize water or land pollution in our environment?

Standard 2: Sustained Inquiry

Students will investigate/seek new information on water or land pollution in their environment by coming up with a list of places or people they could talk to in their community to help design their method to minimize water or land pollution.

Standard 3: Authenticity

Each student working independently or with a partner will create their own perspective and specific designs within their projects. The students will create a method to help the environment that he or she lives in, their own personal touches, interests, actions, and concerns will be voiced in their method to minimize human impact on the water or land pollution in their environment.

Standard 4: Student Voice & Choice

Students will be able to construct their design method in several ways including:

- Weebly website
- Digital Flyer
- Newspaper Article
- Photo Story

- Public Service Announcement (PSA)
- Persuasive Letter

Standard 5: Reflection

The students and teacher will work together in order to make sure that all aspects of the project have answered the challenging problem/question. The students will complete a *Project Work Report* each time they are working on their project. The teacher will also have checkpoints and meet with each group or independent student every other day. At the end of the project after the open house, students will complete a "My thoughts about the project" form, which will be turned in for the teacher to review.

Standard 6: Critique & Revision

The teacher should provide mini lessons to small groups of students or the whole class in order to assist students on their design process. Some examples of mini lessons can be found in Appendix A. Students will have a practice presentation day, during which the students in their class will provide constructive peer feedback to help the presenter before the final presentation public production. The teacher can also have displays of posters and should begin this unit with a short lesson on constructive peer feedback using modeling strategies.

Standard 7: Public Production

The final piece to the *Gold Standards PBL* includes the production piece, during which students will come together in an open house presented by the teacher. The teacher will invite an audience of school district members and administration, city board members, students' family members, friends and any community members. A flyer will be sent home to students' parents, posted around the school, an email will be sent to school district employees, and parent communication via email or other technology devices will be sent. The students will present their designs to help minimize water or land pollution in their environment as the audience conducts a gallery walk and listens to each individual student or pairs of students.

Weekly Timeline

Week 1 Timeline	
Day 1	- Introduce Challenge Problem/Question: *How can you design a method to help minimize water or land pollution in our environment?* - Create roles of partners and display them on a poster. - Read and sign the partner agreement. - Read and sign the independent agreement. - Create a list of information students would like to learn more about on a poster board. - Read project work report and fill out day 1 during last 5 minutes.
Day 2	- With your partner or independently decide if you would like to create a method to minimize water **or** land pollution. - Pick a design to present your method to help minimize water or land pollution. • Weebly website • Digital Flyer • Newspaper article – to be published • Photo-story • Public Service Announcement – to be sent to City Hall

	- Persuasive Letter – to be sent asking for support with the water or land pollution human impact issues. - Students begin researching people they would like to have as guest speakers along with places they would like to visit to help guide their design process. -Last 5 minutes complete the project work report.
Day 3 ½ school day field trip.	-Class Field Trip to 2 – 3 places in their environment that shows water and land pollution. Examples include: Point Gratiot Beach, Cedar Beach, The Boardwalk, or Wright Park Beach. -Students should fill out their project work report along with taking notes during the field trip of their observations.
Day 4	Begin brainstorming ideas for you design method independently or with your partner.
Day 5	- Guest Speaker question/answers. - From the student's guest speaker list, have three presenters that can talk about water pollution in their environment and three presenters that can talk about land pollution. - Students will break up into two groups (water and land) and will have 10 minutes to listen to the three presenters and 3 minutes for questions. - Each group of students will hear from all three presenters.

Mini-lessons can be taught by teacher on specific topics asked by students throughout weeks 2-3. Some of these mini-lessons include: The Great Pacific Garbage Patch or oil spill pollution and clean up processes.

Week 2 Timeline	
Day 6	- Work on your design method independently/with partner. - Last 5 minutes complete the project work report. - Teacher checkpoint with Individual students/partner #1-6
Day 7	- Work on your design method independently/with partner. - Last 5 minutes complete the project work report. - Teacher checkpoint with individual students/partner #7-12
Day 8	- Work on your design method independently/with partner. - Last 5 minutes complete the project work report. - Teacher checkpoint with Individual students/partner #1-6
Day 9	- Work on your design method independently/with partner. - Last 5 minutes complete the project work report. - Teacher checkpoint with individual students/partner #7-12
Day 10	- Work on your design method independently/with partner. - Last 5 minutes complete the project work report. - Teacher checkpoint with Individual students/partner #1-6

Week 3 Timeline	
Day 11	- Work on your design method independently/with partner. - Last 5 minutes complete the project work report. - Teacher checkpoint with individual students/partner #7-12
Day 12	- Work on your design method independently/with partner. - Last 5 minutes complete the project work report. - Teacher checkpoint with Individual students/partner #1-6
Day 13	- Work on your design method independently/with partner. - Last 5 minutes complete the project work report. - Teacher checkpoint with individual students/partner #7-12
Day 14	- Work on your design method independently/with partner. - Last 5 minutes complete the project work report. - Teacher checkpoint with Individual students/partner #1-6
Day 15	- Work on your design method independently/with partner. - Last 5 minutes complete the project work report. - Teacher checkpoint with individual students/partner #7-12

Week 4 Timeline	
Day 16	- Prepare with your partner or independently for presentations tomorrow. - Students should put finishing touches on projects if needed.
Day 17	In class presentations peers five constructive feedback on index cards.
Day 18	Class time to go over constructive peer feedback and edit or revise any parts of your design method.
Day 19	Public Product Presentations – Open House
Day 20	"My Thoughts About The Project" Form completed in class by answering all four questions (25 points each)

Conclusions

The purpose of this curriculum project was the create a unit aligned to the Next Generation Science Standard MS-ESS3-3 and connect Project Based Learning strategies to create a hands-on, student-centered learning approach to teaching a science unit. The completed curriculum will address the challenge problem/question of *How can you design a method to help minimize water or land pollution in our environment?* The teacher will follow the *Gold Standards PBL* from the Buck Institute (2015) in order to make sure that students are successful and follow proper PBL outlines in completing their method of minimizing water or land pollution. This curriculum can be implemented to any 6th grade science teacher using the next generation science standards. Some teachers may need to adjust which type of pollution needs to be minimized in the challenge problem/question depending on the location of their school district. The author hopes that the curriculum can help implement a student-centered hands-on unit to engage and help build student awareness on the water or land pollution in the environment around them.

The next and final chapter will discuss the evaluation and interpretation of the implications of the results that emerged from this curriculum project, along with a discussion of similarities and differences between the results of my curricular work and the work of other scholars.

Discussion and Conclusion

Introduction

Previously in Chapter 4, the curriculum project was aligned to the Next Generation Science Standards (NGSS) and followed the *Gold Standards PBL* seven standards of Project Based Learning (PBL) created by the Buck Institute (Buck Institute, 2015). In Chapter 5, the discussion will explain the significance, limitations, and future investigations that incorporate with this curriculum project. The purpose of this curriculum project was to create a science unit that is aligned to student creativity and collaboration in order to create a method to minimize water or land pollution in the environment around them using the PBL teaching model.

The curriculum project was designed by selecting a NGSS and aligning the standard with the Buck Institution *Gold Standards PBL.* The PBL strategy was aligned with the NGSS MS-ESS3-3 that allows students to have a say in the content and skills that they are learning and to create something out of it. I aligned the standard and *Gold Standards PBL* in order to create an easy outline for teachers to modify and to adapt into their own 6th grade science classrooms. By using the 7 Gold Standards PBL, the curriculum will allow teachers and students to understand the significance of using the PBL strategy. Students will answer the driving question – *How can you design a method to minimize water or land pollution in your environment?* Students will become the researchers and design methods that will help the environment that they live in to become a cleaner and safer community.

Significance

As many teachers are transitioning to PBL approaches in their classrooms, it is important to understand that it is acceptable to take a step back from your normal teaching strategies. PBL is something that takes time, collaboration, and planning in order to implement the project in the classroom. The Buck Institute (2015) stated: "When transitioning to PBL, one of the biggest hurdles for many teachers is the need to give up some degree of control over the classroom, and trust in their students. But even though they are more often the 'guide on the side' than the 'sage on the stage' this most certainly does not mean that teachers don't 'teach' in a PBL classroom. Many traditional practices remain but are reframed in the context of a project" (p. 2). Teachers are changing their teaching styles in order to engage their students more and allow students to have a say in the content and skills that they are learning.

The teacher using this curriculum begins with a design and plan, aligns the project to the standards of their school district, creates a culture that allows students to work independently and grow with one another. The teacher also manages the activities that the students might have difficulty when finding sources on, the teacher scaffolds student learning by creating a variety of tools and lessons to help students reach their end goals. Teachers assess students' learning in multiple different ways such as check-ins, formative and summative assessments and by observations. Lastly, the teacher engages and coaches' students with their creativity and learning outcomes as students might need additional support in encouragement, team building, redirection, and celebrations.

The attitudes of students' achievement in their educational academic Science, Technology, Engineering, and Mathematic (STEM) classes should promote a positive impact that will encourage students later on in life. High, Thomas, and Redmond (2010) explained findings on positive impacts of student attitudes after participating in STEM PBL: "found that after completing such projects students reported increases in math and science confidence, engineering career interest, and awareness of the nature of engineering, in addition to improved cognitions related to making efforts in math and science coursework" as cited in Alfred Hall's

(2016) study on *A Study of Student Engagement in Project- Based Learning Across Multiple Approaches to STEM Education Programs* (p. 310). By following the *Gold Standards PBL* 7 standards, teachers will allow students to become more vocal in their learning and creativity during this curriculum project.

The *Gold Standards PBL* helps to build a comprehensive PBL research-informed strategy that helps improve practices for teachers. The Buck Institute (2015) elaborated: “Student learning goals for projects include standards-based content as well as skills such as critical thinking, problem solving, communication, self-management, project management, and collaboration” (p. 1). For the curriculum project that I have created, the students will be able to use all the skills stated above to help answer the driving question of *How can you design a method to minimize water or land pollution in your environment?*

The students will use critical thinking to predict and analyze what pollution is happening in the water or land in their environment. The students will be using problem solving skill sin order to help design a method to minimize the water or land pollution. The students will be communicating with their partners, the teacher, and with professionals who will come in as guest speakers. The students will use self-management in order to figure out the part of the design method that should be worked on at times and the students will have to fill out their daily project work report. Students will have to decide about the type of presentation that they want to deliver their final design method in by creating one of the following approaches: Weebly website, digital flyer, newspaper article, photo story, Public Service Announcement (PSA) or a persuasive letter. Lastly, the students will have to collaborate with their partners, other students in the classroom, professionals that come in as guest speakers, and the teachers(s) in the classroom. These are all critical skills that students can use in the classroom and later in their future careers when they get older. Students who are introduced to PBL over many years especially in the elementary grade level will help create a stronger future in the career fields later in life.

Student's engagement in PBL will help students later on in their educational careers and daily life decisions. A study by Kou-Hung Tseng (2013) stated: "A better understanding of student attitude and the relationship between course choice and future career choice would lead to instructional and curricular changes that may support and enhance students' learning of difficult subjects such as science, technology, engineering, and mathematics" (p. 89). Later on in Tseng's study, the results indicated that "The majority of students indicated that science could be applied to solve real world problems and to increase effectiveness in daily lives" (p. 98). As an end result, students who partake in their educational decisions will increase their decision in career fields later in life by reusing prior knowledge learned in the classroom.

Limitations

The following three paragraphs will explain the three limitations that teachers might face if trying to implement this curriculum project to their school district science classroom setting:

The first limitation of this curriculum project would be if the classroom that the teacher is teaching in, has students who are English Language Learners (ELLs). ELLs can be provided with a variety of supports depending on their proficiency level. The students might need translations, visuals, or oral communication during parts of the PBL lessons. The school district should have ENL/ELL teachers that can help with translating parts of the lessons or materials for the students. The teacher using the curriculum project in his or her classroom should already have strategies in place in order to help his or her ELLs to be successful students for all academic subjects.

The second limitation of this curriculum project would be the Challenge Problem/Question: *How can you design a method to minimize water or land pollution in your* *environment?* Not all school districts have a water source around their communities. The water source in this curriculum project is Lake Erie by other water sources can include rivers, streams, or ponds in the community. If water sources are not accessible the teacher can change the Challenge Problem/Question by adding air and land pollution instream of water and land pollution. By adding air pollution, students would need more background knowledge on the causes air pollution compared with land pollution. The teacher would need to incorporate small mini lessons before beginning this unit on the different ways that our Earth has pollution.

The last limitation for this curriculum project would be the grade level that the teacher is teaching with this PBL lesson. The NGSS have Middle School standards for grades 6 – 8, which means that the standards are not aligned to any specific grade, the standards must be taught within those three years. This curriculum project is specifically designed for 6th grade science students. If a teacher who teaches 7th or 8th grade would like to incorporate this curriculum in their science classrooms, the teacher might need to add additional resources to the curriculum project in order to align with the higher leveled students that, he or she is teaching.

Future Investigations

With the limited time available to create the curriculum project, the following criteria in the paragraphs below will be created later in order to help future teachers using this curriculum project in their own 6th grade science classrooms.

The first objective that I would investigate would be the NGSS. As the standard that I chose to use for this curriculum project is on standard of many that are incorporated in the MS-ESS 3: Human Impact science unit, I would incorporate the other standards to create a larger unit that will address all the MS-ESS3 standards. This way the teacher using the curriculum project would have a flow of all the other standards incorporated in this unit and would not have to research other lessons or information to use for the *Human Impact* unit.

The second objective that I would investigate in the future would be creating virtual field trips to many places around the community that could be incorporated into this curriculum project in the school district did not have funding or time available for a field trip. Some examples of these activities I would create include virtual field trips of Point Gratiot, The Board Walk, Wright Park Beach, and Memorial Park, all in Dunkirk, NY, in order to show the land and water pollution in the community. These virtual field trips would be created into a Weebly account, where the teacher would be able to post to the students google classroom accounts or share with the students the web link to view.

The last objective that I would investigate in the future would be creating time to independently set up interviews with professionals in the community. Some examples of guest speakers that I would set up interviews with would include: The Lake Erie Coastal Management, North County Transfer Station for Recycling and Landfill, City Grounds Crew, Steel Plant Productions director, and the City water/sanitation plant. During these interviews, I would ask if I could video record or voice record the sessions; in this way, the answers from the professionals can be shown to the students at a later time. This could be an alternate solution if time was limited or if guest speakers were unable to come in, then a teacher could use the video or recording for his or her class.

Conclusions

After completing the final chapter of this curriculum project, I want to make sure that teachers are able to adapt a compensable curriculum project that aligns to the Next Generation Science Standard: MS: ESS3-3: *Apply scientific principles to design a method for monitoring* *and minimizing a human impact on the environment* and with the *Gold Standards PBL* from the Buck Institute (2015). By creating this curriculum project, 6th grade science teachers using the NGSS will be able to create a classroom atmosphere that is full of collaboration, self-management, and project management, problem solving skills, critical thinking, and communication. All 6 of these skills that are incorporated in this science curriculum project will help students not only have their classroom environment, but they will also be able to take these skills with them later in life.

With this student-centered and hands-on unit, the students will become engaged as engineers in the ways to minimize water or land pollution in their environment. Students will not only become engineers; they will also become presenters during the public production at the end of the unit. Students will be surrounded by school district leaders, family members, friends, peers, and community leaders in neighbors when presenting their design methods as to helping to minimize the water or land pollution that their community is facing.

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Appendices

Appendix A: Examples of Student List of Topics and Mini Lessons.

Teacher Resource – Below you will find examples of topics your students might suggest as mini lessons or examples that the teacher might teach before this unit.

- The Great Pacific Garbage Patch Causes & Effects
- The Great Pacific Garbage Patch Cleanup Process
- Nurdles Causes & Effects
- Water and Land Oil Spills Pollution Causes & Effects
- Water and Land Oil Spill Cleanup Process
- Human Impact on Beaches and Water Sources
- Human Impact on Various Land Types or locations: grasslands, valleys, large cities,
- Laws on pollution/recycling around the World.
- Biodegradable vs Non-Biodegradable Materials
- Ecosystem Restoration Projects
- Global Warming
- Hometown Ecology
- Human Population and Resource Consumption

Appendix B: Roles of Each Student

The roles for each student participating in the PBL unit can be created by the students in your classroom. If the students have difficulty coming up with roles, you can provide them with the list below.

- **Recorder –** (students can take turns every other day/week)
  - Takes notes each meeting time to make sure important information is documented.
- **Organizer –** (one student should be the organizer)
  - Neatly keeps all papers and materials needed for the project.
- **Editor –** (both students should be the editor for one another)
  - Edits the work of your partner
- **Timekeeper –** (students can take turns every other day/week)
  - Makes sure everyone is on track and has enough time to complete the task goal in the class period given.

Appendix C: Partner/Independent Student Agreement Form

Independent Student Agreement Form
I promise to: ____ ____ ____ ____ ____ ____ __
Date: ______________
Student Signature: **Print name:** ____________________ **Sign name:** ____________________

Partner Agreement Form
We promise to: ____ ____ ____ ____ ____ ____ __
Date: ______________
Student Signatures: Print name: ________________ Print name: ____________________ Sign name: ________________ Sign name: ____________________

Appendix D: Project Work Report

Independent Project Work Report	
Project Name:	
Student Name:	
Starting Date:	
Take the last 5 minutes of every class period to finish completing out the chart below by typing in your responses for each section.	
Goals: What I want to accomplish during this project.	1.
	2.
	3.
Accomplished: What I completed during this work day.	Day 1: Day 2: Day 3: Day 4: Day 5: Day 6: Day 7:
Steps: The steps I would like to complete next class.	Day 1: Day 2: Day 3: Day 4: Day 5: Day 6: Day 7:
Problems/Concerns: What are the most important problems or concerns I am facing?	Day 1: Day 2: Day 3: Day 4: Day 5: Day 6: Day 7:
Questions: Any Questions I have for my teacher or outside professionals.	Day 1: Day 2: Day 3: Day 4: Day 5: Day 6: Day 7:

Partner Project Work Report	
Project Name:	
Student Name:	
Student Name:	
Starting Date:	
Take the last 5 minutes of every class period to finish completing out the chart below by typing in your responses for each section with your partner.	
Goals: What we want to accomplish during this project.	1.
	2.
	3.
Accomplished: What we completed during this work day.	Day 1: Day 2: Day 3: Day 4: Day 5: Day 6: Day 7:
Steps: The steps we would like to complete next class.	Day 1: Day 2: Day 3: Day 4: Day 5: Day 6: Day 7:
Problems/Concerns: What are the most important problems or concerns we are facing?	Day 1: Day 2: Day 3: Day 4: Day 5: Day 6: Day 7:
Questions: Any Questions we have for our teacher or outside professionals.	Day 1: Day 2: Day 3: Day 4: Day 5: Day 6: Day 7:

Appendix E: Teacher Checkpoint

Pair/Independent Student names	Circle days the teacher has meet with student(s)	Goal Number that had been met and date accomplished		Questions/mini lessons student(s) need to help complete their design model
Student 1	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20			
Student 2	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20			
Student 3 and 4	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20			
Student 5 and 6	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20			
Student 7	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20			

Appendix F: Final Design Project Rubric

Classroom Presentation: Minimize Land or Water Pollution

Student Name: ____________________________ **Design Name:** ____________________

Category	Exemplary 10-9 points		Accomplished 8-6 points		Developing 6-4 points			Beginning 3-0 points				Score
Display & Creativity	10	9	8	7	6	5	4	3	2	1	0	
Presentation	10	9	8	7	6	5	4	3	2	1	0	
Voice level & Speed	10	9	8	7	6	5	4	3	2	1	0	
Knowledge of Method	10	9	8	7	6	5	4	3	2	1	0	
Knowledge of Environment in Community	10	9	8	7	6	5	4	3	2	1	0	
Total Score												

Grade: ____/50 = _____%

Comments:

Open House: Minimize Land or Water Pollution Student Name: ______________________ Design Name: ________________												
Category	Exemplary 10-9 points		Accomplished 8-6 points		Developing 6-4 points			Beginning 3-0 points				Score
Display & Creativity	10	9	8	7	6	5	4	3	2	1	0	
Presentation	10	9	8	7	6	5	4	3	2	1	0	
Voice level & Speed	10	9	8	7	6	5	4	3	2	1	0	
Knowledge of Method	10	9	8	7	6	5	4	3	2	1	0	
Knowledge of Environment in Community	10	9	8	7	6	5	4	3	2	1	0	
Total Score												

Grade: ____/50 = _____%

Comments:

Combination of both scores

Classroom Presentation Score	Open House Presentation Score	Total Score Combination

Appendix G: "My Thoughts" Written Response

My Thoughts…

Directions: You do not need to put your name on this paper. Your answers will be anonymous please answer each question honestly.

After you have completed your Project on how to minimize water or land pollution in the environment around you answer the following questions.	
What factors went well during your project design process?	
What factors did not go well during your project design process?	
What modifications (changes) should your teacher make for future PBL units?	
What suggestions do you have for future 6th grade students who will complete this project?	