

Project Based Learning for Middle School Students

Interactive Qualifying Project



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ABSTRACT

Project Based Learning is a version of active learning that helps improve student learning as well as teaching habits that promote future learning. Project Based Learning studies do tend to focus on either elementary school or high school studies, so the amount of studies on middle schoolers are much rarer. By observing middle school students, this team hopes to fill that gap and concluded that Project Based Learning does positively impact middle school students.

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Chapter 4 - Findings: Katherine Ralph and Alexander Pratt

Chapter 5 - Conclusions and Recommendations: Katherine Ralph

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Appendix A-E Katherine Ralph and Alexander Pratt

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CHAPTER 1: INTRODUCTION

The most common way to teach in the American public education system, lectures and exams, is not the best environment for learning the skills that allow students to be successful in the modern work environment. This system of teaching is contrasted against education focused on projects that students can become more interested in, known as Project Based Learning (PBL) (Solomon 2003). Various versions of PBL have been popular for a long time, with 20th century scholar John Dewey talking about practical and student-centered learning as the best approach to education (Dewey 1902). PBL is characterized by projects that are based in the real world, teach skills such as gathering and analyzing data, and places an emphasis on collaboration. All of these skills are desirable traits, particularly in STEM fields. This type of learning is designed to be able to engage students and provide real world scenarios to demonstrate the importance of the subject, which is critical for convincing students to go along a STEM career path. Children begin deciding to enter STEM fields as early as age 9, so focusing on PBL in a middle school level education is vital to attracting the students towards STEM careers (Dorsen 2006). The focus of this project is to analyze the effects of PBL on the material comprehension and interest levels of middle school students, especially in STEM fields, when compared to more traditional learning methods.

CHAPTER 2: BACKGROUND / LITERATURE REVIEW

2.1 What is PBL?

PBL has a wide variety of features that differentiate it from other methods. First, the lesson plan is based on a project that provides an environment where either in personal or group autonomous work that has a result that can be presented (Jones, Rasmussen, & Moffitt, 1997).

Other parts of PBL, such as a teacher's presence but not involvement, or incorporation of real-world skills into the project, is why this learning method has such an appeal. PBL has many researchers describing different minute aspects that cause PBL to be differentiable from similar protocols. Two approaches to Project Based Learning were the basis for this project. The first approach to PBL that the project was based on was developed in a paper in 1998 which defined PBL as any lesson plan containing the following four criteria:

1. Learning-appropriate goals,
2. Scaffolds that support both student and teacher learning,
3. Frequent opportunities for formative self-assessment and revision
4. Social organizations that promote participation and result in a sense of agency

(Barron 1998.) The other analysis of PBL that the project was based upon was John W. Thomas' 5 points of PBL, which are:

1. Projects at the core of the lesson plan
2. Focused on central concepts
3. Investigate in a constructive manner
4. Student Driven
5. Realistic

(Thomas 2000). These 9 collective points adhere to a framework that the lesson plans were based upon. By combining the two frameworks, the project was able to make sure that the more group focused points of Barron and the tenets of a strong PBL project from Thomas were both balanced against one another. These 9 elements are based on removing the similar yet not identical approaches to learning such as 'active' or 'collaborative' learning. While these

approaches may improve upon standards, this project was singularly focused on PBL and did not take those elements into account.

2.2 History of PBL

There is a history of PBL studies that indicate the efficacy of this system. PBL's roots trace far back to project-based work in architectural programs during the later years of the Renaissance where active learning was introduced to students. As education became more refined, this active learning method left these architectural schools and dispersed to other areas of learning such as various other trade schools. John Dewey refined the learning method even more in the early 20th century with lesson plans based on the principle of learning by doing. In the present, the approaches to learning that teachers use to develop their curriculum have begun moving towards project-oriented styles of learning. Analysis on PBL has shown that the system improves academic achievement, helps students develop a wider range of skills, and generally improves motivation (Harmer 2014)

2.3 Massachusetts Science Standards

The most updated version of the Massachusetts Science and Technology/Engineering Curriculum Framework (MSCF) includes specific criteria for science education in Massachusetts. The particular standards relevant for the development of the PBL experience developed as part of this project include:

MS-LS2-4 Analyze data to provide evidence that disruptions (natural or human-made) to any physical or biological component of an ecosystem can lead to shifts in all its populations.

MS-LS2-5. Evaluate competing design solutions for protecting an ecosystem. Discuss benefits and limitations of each design

These two standards fit into the characterization of the revisions as programs that, “support student engagement, curiosity, analytical thinking, and excitement for learning over the years (Chester 2016). These goals for the revisions match with the principles of PBL, especially when focusing on the student-led organizational structure of PBL promoting student engagement and continued excitement for learning opportunities. Additionally, the MSS places an emphasis on fixing students’ misconceptions about the world. These misconceptions can hold on despite showing knowledge that contradicts what they believe to be true. PBL is most effective at fixing this issue due to student misconceptions becoming more apparent during the project-based process, allowing a surveying teacher to help guide students in the right direction while allowing students to realize the correct choice on their own. This cohesion between teaching standards and optimal student learning practices make the MSCF standards ideal for testing the theories behind PBL. Since the two concepts line up, any consequences, positive or negative, will focus on PBL’s ability to teach students effectively.

2.4 Wetlands

In order to best satisfy the MSCF, the project team decided that the best way to apply PBL to the lesson plan was to focus on a specific environment so that the background the students needed for the project was as minimal as possible. A wetland was chosen primarily due to the student's familiarity with wetlands, considering that the school selected was located in a wetland. Additionally, wetlands are diverse ecosystems that are impacted by a wide variety of ecological disruptions. These disruptions are the focus of the first objective, MS-LS2-4, and responding to these ecosystem disruptions are the main focus of the second objective in the lesson plan. Wetlands suffer from a span of disruptions that are both natural and man-made, allowing students to fully grasp the tenuous nature of the biome. If this experiment was to be done at different schools and different biomes, then the teacher should be encouraged to adapt the lesson plan to their own biome as appropriate. This flexibility is in place so that students can think about these changes in their own communities.

2.5 Audio, Visual, Kinesthetic Learning

Students learn in a variety of ways beyond lectures. There are a wide variety of ways that students can utilize their intelligence in order to learn concepts. The Theory of multiple intelligences was developed in 1983 by Dr. Howard Gardner, professor of education at Harvard University. These different ways of understanding include:

1. Verbal-linguistic
2. Logical-mathematical

3. Kinesthetic
4. Spatial
5. Musical
6. Interpersonal
7. Intrapersonal
8. Naturalistic

Different students will prefer different ways of understanding, so a lesson plan that incorporates multiple styles is beneficial. In order to bring as many ways of learning as possible, both a small lecture to introduce concepts as well as an interactive model were key parts of the lesson plan. The discussion at the start of class helped the more visual-linguistic learners, while the model wetland helped with both the kinesthetic, interpersonal, and naturalistic understanding of the objectives. Graphing the experiment afterwards allowed the logical-mathematically oriented students to see the model's disruptions in a more numeric version. The other versions of learning were considered less of a priority. Spatial, musical, and intrapersonal learning would be good for other projects designed by PBL, but this specific lesson plan focused on student collaboration with a physical model. Adaptations of PBL could easily implement these learning styles into different projects, but in order to keep the project focused, these styles were not a part of the lesson plan.

2.6 The Project

The performance standards chosen for this project are MS-LS2-4 and MS-LS2-5 (see above) chosen from the teacher whose classes were selected for this project. These two

standards can be grouped into one goal; to teach students about disruptions in ecosystems as well as how to solve the problems these disruptions present. The project that the group selected was based on students building models of wetlands and simulating real world disruptions such as flooding or human construction projects. The model wetlands that the students built was based on a concept developed by Rand Water, a South African utility company (reference 6), with small changes made to the model. The original model utilized a 2-liter bottle as well as dirt and sand layered to simulate a wetland, with a sprig of grass placed at the spout to filter the water. The dirt and sand were broken up with stones in between, not just at the top in order to keep the two layers better separated. Additionally, the small amount of vegetation at the tip of the bottle was replaced with moss all throughout the top of the model in order to better filter the water as well as increase the absorbance of the wetland. These changes were made to emphasize the functions of the wetland and to promote the wetlands ability to drain water, so that students would not have to build a new wetland for multiple trials in their experiments. After building the model wetlands, students went about responding to disruptions of their wetlands. Examples of these disruptions include flooding the wetland or simulating a construction project's impact. By highlighting real world issues, the students are positively impacted by PBL and will be more engaged with the learning.

CHAPTER 3: METHODOLOGY

Section 1: Objective

We collaborated with Mary-Ann Demaria, a 7th grade science teacher at a school in Millbury, Massachusetts, to develop an engaging, hands-on project while still meeting the Massachusetts science standards. The challenge was to develop a weeklong project that supported the following Massachusetts STE standards.:

1. **7.MS-LS2-4.** Analyze data to provide evidence that disruptions (natural or human-made) to any physical or biological component of an ecosystem can lead to shifts in all its populations.

Clarification Statement:

- Focus should be on ecosystem characteristics varying over time, including disruptions such as hurricanes, floods, wildfires, oil spills, and construction.

2. **7.MS-LS2-5.** Evaluate competing design solutions for protecting an ecosystem. Discuss benefits and limitations of each design.*

Clarification Statements:

- Examples of design solutions could include water, land, and species protection and the prevention of soil erosion.
- Examples of design solution constraints could include scientific, economic, and social considerations

The objective of our interactive qualifying project (IQP) was to implement a unit that addresses the Massachusetts Science Technology and Engineering Learning

Standards for middle school students through project-based learning (PBL). Research and studies based on PBL in the classroom focuses on four principles of design:

1. Learning-appropriate goals,
2. Scaffolds that support both student and teacher learning,
3. Frequent opportunities for formative self-assessment and revision, and
4. Social organizations that promote participation and result in a sense of agency

(Barron, 1998)

Section 2: Methods of data collection

Data was anonymously collected from the students through a pre and post content knowledge assessment implemented by the teacher. A science, technology, engineering, and mathematics (STEM) attitude assessment was also performed anonymously before and after the implementation of the Project. An Institutional Review Board (IRB) was submitted and approved for this research by WPI. The teacher had 2 classes, Alpha block and Gamma block, that used our PBL unit. Alpha block consisted of 15 students, 0% using an English Language Learners (ELL) plan, and 47% using an Individualized Education Program (IEP). Gamma block consisted of 20 students, 25% using an ELL, and 20% using an IEP. Each class met 4 times a week for 50-minute blocks. Classroom observations were conducted annotating the students' engagement with the curriculum.

Section 3: Lesson plan development

Disruptions of a wetland was the core of the project creating a relevance to the middle school students. Wetlands cover about 590,000 acres of Massachusetts, about 12% of the state's area from the coastline of Cape Cod to the Berkshires (USGS, 1997). Wetlands prevent flooding and storm damage, improve water quality, and prevent land erosion. A wetland in its natural state is great at filtering runoff before the water reaches main bodies of water as well as absorbing excess flow. Once a wetland is disrupted, it can no longer do its job, thus leading to an increase in runoff, such as phosphates, and an increase in erosion, having heavy rainfall to cause flooding in the adjacent vicinities. Since Colonial times, almost one third of Massachusetts' wetlands have been destroyed (MassDEP,2020).

The project was initially designed to assign each member of the group an expert role, a wildlife expert, an environmental engineer, a meteorologist, an atmospheric expert, a microbiologist, and a soil expert. These experts would collaborate to design a solution to a disruption of a wetland given to them by the teacher.

Millbury Memorial Junior/Senior High School uses a 5E lesson plan model (Guhlin, 2019) emphasizing the categories of engagement, exploration, explanation, elaboration, and evaluation. The lesson plan was designed to be at least 5 days long but could be extended to a longer period if time permitted. We adapted our lesson plans to incorporate the teachers previously instituted student engagement tactics. Each class began with what the teacher called a “mindful minute” to allow students to transition from the chaos of the hallways to a focused, ready-to-learn mentality. An “entry ticket” and “exit ticket” was used to introduce the topic of the day and for students to reflect on what they had just learned.

The Units are designed for which ever medium the teacher has available. Millbury Junior/Senior High uses google chrome books in the classroom. Chrome books have been used in previous Units by presenting a “Screencastify” presentation. However, other final presentation mediums can be used. This can include, but not limited to, a pamphlet, a poster board, a power-point, or a video.

The lesson plans were designed to be adaptable for available time in the classroom.

Section 3.1 Unit 1

3.1.1 Planned Unit- Building a Wetland

The objective of day one:

- Understand the components of a wetland and each components purpose
- Understand how to convert volume to mass
- Build a model of a wetland

The teacher would assign the students to teams of 4. These students would be working together and would be presenting the final project together. Students would then split their assigned group into 2, so that they would be working with just 1 partner during the rest of the activities in the week. A short PowerPoint would be presented to the students by the teacher to introduce the topic of a wetland and identify the components of a wetland. Students would take notes in their scientific journals from the PowerPoint presentation. Materials would be provided for the teacher. The model builds would require a dirt station, a sand station, a gravel station, and a moss section. Students would be given 2 handouts, a density activity and model build.

The first hand out would be a density activity. The students would be introduced to the mathematical definition of density and shown an example of how to use the equation. Students would then work with their partner to measure the density of each material: sand, gravel, dirt, and moss. This would be done by measuring 50mL of the material and then weighing the plastic beaker. The data would be annotated in their scientific journals. The densities calculated for this activity would be used when measuring the larger volumes of materials during the model assembly. See Appendix H-1 for the Density activity sheet.

The second handout would be the wetland model assembly. A half of a 2-liter bottle would be pre-cut for the students. These bottles would serve as a base for the wetland. It was important to choose a clear bottle so students can see the variance in layers. The students would measure the materials in the order specified and annotate the volumes in their scientific journals. Pictures of each step would be included to provide a visual aid similar to figure A. The instructions provided to the students can be seen in full under appendix H



Figure A: example pictures of the wetland model build

Once the models were finished, the students would label them with their names and store them for the next unit. If time permitted, students would calculate the weight of each of the previous volumes measured by using the densities found earlier. If not, they would take it home for homework and finish the calculations.

3.1.2 Implementation of Unit 1

The pre-knowledge assessment and the STEM attitude surveys were performed anonymously with google forms. The teacher aggregated the data anonymously and delivered the data to us. A PowerPoint was used to assist the teacher in discussing with the class what a wetland was and how it worked. This method was used to engage the students before they built the models. The teacher placed the students in teams of 4. The groups were to build 2 models (2 people each building one model). Plastic beakers were used for measurement tools. Each group was given a printout of the directions of the model build. The teacher explained the activity beforehand and emphasized the specific measurements for each material and the importance of following the directions for the sake of order of materials for the build. The density lab was not performed due to lack of time.

Gamma block was the first class. Students were excited to have a new person in the room and participated whenever asked engaging questions. Such as what is a wetland? Students answered this by referring to the everglades in Florida. Once that was said, this triggered other students to answer things such as bogs, or a really wet piece of land, flat, etc. The next slide introduced three benefits of a wetland. Students had scientific notebooks in

which they were supposed to take notes, such as the amount of material needed for each step in the model build. Figure 1 shows the students assembling the models at different stations.



Figure 1: Students assembling models

Alpha block lost 15 minutes of the first unit due to a medical emergency lockdown. They rushed through the presentation portion to ensure adequate time to complete the model build.

3.1.3 Observations

In future lesson plans, the pre-knowledge assessment and the STEM attitude survey can be given to the teacher beforehand and be done on a previous day. This took more time than previously allotted. During the brief discussion at the start of class, not many students knew wetlands existed in Massachusetts

There were a lot of distractions during the transition from one activity to another. For example, once the students were finished with both assessments, they were asked to quietly place the chrome books back to their stations and return to their seats for further instructions. Students would take their time putting away the chrome books and would have to be told multiple times to settle down and listen for further instructions. The teacher explained the activity beforehand and emphasized the specific measurements for each material and the importance of following the directions for the sake of order of materials for the build.

Students still started assembling the models in the wrong order and had to be guided by the teacher to read the instructions. Three adults assisted in guiding the students. Some of the students wouldn't take their time to measure what was specified. Other students were playing with the materials, such as submerging their hand into the sand basin. Once the students were through the first two stations, the flow was more fluent. In future setup, it would be beneficial to have two separate sand stations to prevent a bottleneck effect on the model completions.

3.1.4 Teacher alteration

The teacher made an alteration in the lesson plan for day 1. Instead of the density lab, she created a flow chart activity lab called "Our wetlands, our world" (California Coastal Commissions). In the same groups from day 1, stations were made of different habitat card descriptions. The students had to use the flowchart provided to figure out the type of wetland it was describing.

This was a useful addition to the lesson plan. It exposed the students to the multiple types of wetlands that exist.

3.2 Unit 2

3.2.1 Planned Unit- Disruptions of an ecosystem

The objective of day two:

- Cause disruption of model with given scenarios
- Collect quantitative and qualitative data
- Collaborate with team members to design a solution for disruption

Prior to any of the scenarios, the models would have to be saturated with water to mimic a wetland. Students would perform the scenarios in the following order: construction, flooding, mining, and vegetation loss.

Scenario 1 would be a construction disruption. Wetlands can absorb a large quantity of water, thus preventing flooding in nearby areas. Construction disrupts the wetland and thus affects its absorption capabilities. Students would demonstrate this by placing a square piece of plastic to represent concrete in their model. The pieces of plastic would be pre-cut in 6cm by 6cm squares prior to class. Each model would require 4 pieces of plastic. Following the handout given to the student, they would remove the vegetation where the plastic would be placed and pour 100 mL of water over the sheet of plastic timing how long it took for the water to reach the nozzle. The students would use a control by timing 100mL of water poured over an undisturbed ecosystem. Next, removing moss the size of the plastic next to the first piece, and repeating the experiment, taking note of the time it took each time a piece of plastic was added. The handout would include a table where the students would annotate the

number of houses and the time it took for water to exit the nozzle. The data collected would be used for the following days unit. In this scenario, students would learn about collecting quantitative data.

Scenario 2 would be a flooding scenario. Students would measure and pour 300 mL of water directly over the model and observe the absorption rate of the water. They would annotate in their scientific journals for the following:

- Where does the water go?
- Does it spill over the edges of the model?
- In a real-world flood over a wetland, how would a wetland be affected?
- Discuss with your group the different possibilities. How could you help restore the wetland after the flood?

Scenario 2 would teach the students about collecting qualitative data.

Scenario 3 would be mining sand in the wetland. Students were to remove a large chunk of sand by the nozzle. They would pour water onto the model and observe the new flow path. They would annotate in their scientific journals for the following:

- Describe the waters interaction with the hole. (is more sand taken away with the water?)
- Can you think of other scenarios that cause erosion to an ecosystem?
- What are some preventative things that can be done to minimize the erosion in an ecosystem?
- Could the wetland be fully restored with the mine still there?

Scenario 3 would teach the students about collecting qualitative data.

Scenario 4 would be loss of vegetation due to a high traffic footpath. One of the benefits of a wetland is filtration. With the vegetation removed from the ecosystem, the quality of filtration is significantly worse than the undisturbed ecosystem. Students would mix dirt and water and pour over the unaffected model, collecting an output sample. students would then remove all of the moss to mimic a high foot traffic path and repeated the dirt water mixture over the model and collected an output sample. Students would compare the unaffected wetland filtration to the affected wetland filtration capabilities. This scenario would be another lesson of qualitative data collection.

Students would hold a short discussion with their team of possible solutions for the scenarios.

If all 4 scenarios were completed early by the students, additional work would be assigned that could either be performed in class or at home per the preference of the teacher. The additional work would include the students measuring the surface area of their model. Clear instructions and an example would be provided for them to follow. This would be used to find the percentage loss of land per house. Ideally, they could use these values for graphing in the next unit.

3.2.2 Implementation of unit 2

Day 2 had complications outside of the classroom control. The day started as a late day due to snow, followed by a medical emergency which locked down the classrooms. Gamma block had only 25 minutes in class. The teacher modified the

lesson to do a class demonstration with one model of each of the scenarios so that the students would be prepared the following day as shown in figure 2.

After the first class performed the scenarios, it was noted that it was very difficult to restore the model to its previous nature after the mining scenario was completed. The mining scenario was thus moved to the last scenario for Gamma block class



Figure 2: Demonstration of Scenario 1

Scenario 1: Each student collected data with their partner. With the model saturated, it was difficult for some of the students to know which water drops to stop the timer. They were told to stop the timer when a steady stream emerged out of the nozzle. Further clarification should be added to the instructions for future use. The teacher collected each of the groups data to have a set of class data.

Scenario 2: Students didn't have any issues with this scenario.

Scenario 3: The ratio of sand that was removed from the models varied. Some students removed just enough to expand the opening of the nozzle. Other students removed almost half of the sand, making it impossible for them to put the sand and dirt back without mixing.

3.2.3 Teacher alteration

The overall project was implemented in December in Massachusetts. Due to heavy snowstorms, Millbury middle school was closed for 2 snow days. For Day 2, the teacher created lab stations of habitat cards describing what type of wetland it was describing. The students used a flow chart provided and with team collaboration, selected the correct choice. (our wetland, our world activity). The unit of wetland disturbance was performed the following day.

3.3 Unit 3

3.3.1 Planned Unit- Graphing the data

The objective of day three:

- Define what is a graph
- Identify the parts of a line graph, a bar graph, and a pie graph
- Examine various graphs and interpret the information

- Determine which type of graph is appropriate for representing a given set of data presented
- Graph the data collected from unit 2
- Complete the activity of selecting the appropriate graph for the given data and justify reasoning
- Analyze data to provide evidence that disruptions to any physical or biological component to an ecosystem can lead to shifts in all its populations

A short PowerPoint presentation would be presented by the teacher. It would define what a graph was, the important aspects of a graph, the various types of graphs, and tips on making a good graph. It would also include an example of a poorly executed graph and a well-made graph.

Students would be expected to graph the data collected from unit 2. The first graph they would make would be from unit 2, scenario 1, the construction disruption. The data collected would be the number of houses versus the time it took for water to exit the nozzle. This would be graphed in the student's scientific journals. Students would decide the appropriate graphing method. These graphs would be used in their final presentations.

Finally, the students would complete an activity sheet. The activity sheet would include 3 questions. The first question would ask to select the graph that best matches the information. The paragraph would contain the average rainfall in Millbury, Massachusetts. 2 line graphs would be provided. Students would provide supporting reasons as to why they chose the answer chosen. The 2nd question would include pie

charts. A breakdown of the wetland types in Massachusetts is described in the paragraph. Students would once again select the appropriate answer and justify which graph best supports the data. Finally, the 3rd question would include a bar graph. Students would have to rank 4 states in order from greatest loss of wetland acreage to least loss of wetland acreage over the years.

For homework, or if students finished early, students were to find a wetland near their house and see how it plays a role in their life. A website would be provided for them to visit that showcased all of the wetlands in Massachusetts.

3.3.2 Implementation of unit 3

When graphing the data of unit 2, the students used excel or google graphs to execute the task. The quality of work across the students varied. Some students followed the directions and graphed their data and the class data as shown in figure 3.1.

Other students only graphed their data, and some students provided no graphs.

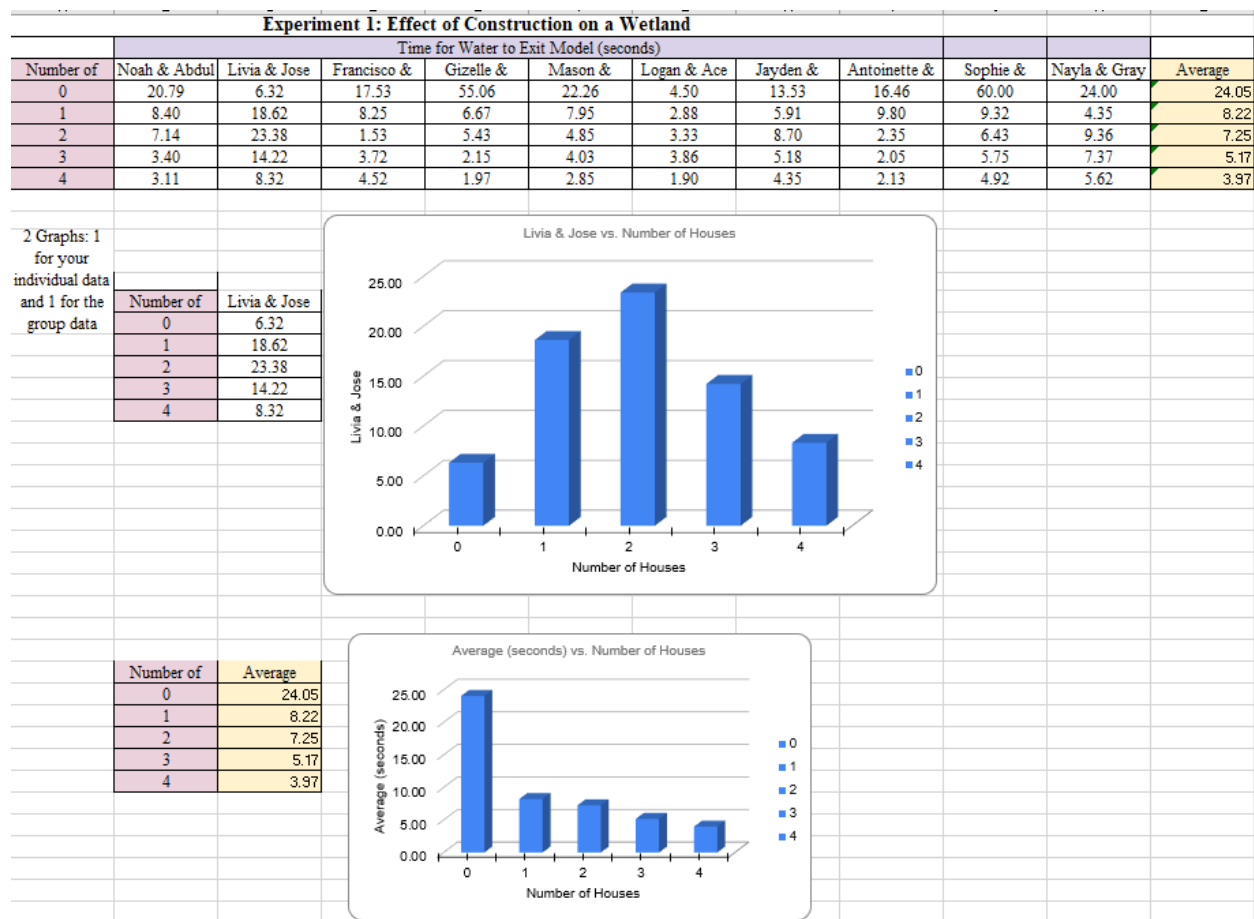


Figure 3.1: example of unit 2 graphed data

The same quality range applied for the activity sheet as well. Students were asked to justify why they chose the answer they did. Some students were very descriptive justifying their answer as shown in figure 3.2. Other students were vague in their reasoning as shown in figure 3.3.

Day 3 Graphing Activity

Write answers to all the questions below. Justify your answers.

The answer to number one is A. The reason that it is A is because in the paragraph it says that March is the wettest month in millbury with 4.6 inches of rain. The point the was plotted for March on graph A is on 4.6 inches but for March on graph B the rainfall is at 2 inches.

The second question says that Palustrine wetlands make up most of Massachusetts. A graph shows that Lacustrine and Riverine wetlands take up most of the land, this is not the right one. The B graph shows that Palustrine wetlands are the most common and matches up with the paragraph.

The one who lost the most wetlands is Florida. The state who lost less than Florida is California then Arizona. The state that didn't loss any was Alaska.

Figure 3.2: descriptive answer for activity 3

Day 3 Graphing Activity

Write answers to all the questions below. Justify your answers.

1. The reason I picked it is because its letter A because it represents the paragraph well.
2. The reason I pick letter B is because when I look at the chart I see a resemblance in the graph and the paragraph.
3. Florida, california, alaska, arizona

Figure 3.3: vague answer for activity 3

The homework activity was not completed due to lack of time. This was where students were to use the website provided to see what wetlands existed near their homes.

3.3.3 Observations

No observers were present for this day.

3.4 Unit 4

3.2.1 Planned Unit- Making the presentations

The objective of day 4:

- Students will discuss wetlands near their homes to identify local wetlands and their purpose
- Students will collaborate to create a presentation that portrays solutions to the scenarios provided.

Students would work in the groups assigned from unit 1. Together, they would create a medium (a poster, a PowerPoint, etc.) to include a title, pictures of their model with captions, the graphs from unit 3 with an explanation of the data, and a discussion of the results from unit 2. A rubric would be provided displaying the expectations of the projects. The rubric was based on 4 sections: information, Solution, Teamwork, and Respect of each other. A point system was designed 1 point to 4 points, 4 being exceeds expectations and 1 being unsatisfactory of said section.

3.2.2 Implementation of Unit 4

Students created Screencastify presentations using a PowerPoint style. Time constraints for this classroom and snow days affected the depth of which students would have to thoroughly complete the project. The final project still consisted of group collaboration and a scenario while still using the ideas of the expert roles.

CHAPTER 4: RESULTS AND ANALYSIS

4.1 Theory to Practice

Project based learning allows for a broad range of learning styles for middle school students. This style of learning accommodates and challenges each student to his or her potential. With the small survey group (n=40) and a short time constraint of 5 days, it is difficult to draw to a conclusion of the impact of project-based learning on middle school students. However, after discussing with the teacher of prior implementations of the units satisfying the Massachusetts science standards, the teacher has confirmed her impression of the effects of PBL on the students. Using qualitative measures as an observer of the class, we noticed that the students were excited and eager to learn what they would be doing for the units. The responses of the students could have been influenced by outside guests in their classroom, in fact, most likely this is to be the case. An observer was present for the implementation of unit 1 and unit 2, these were the assemblies of the wetland models and the disruptions inflicted upon them. Based on observations alone, the students worked well with the teams assigned to them. As in most classrooms, there were students who were more eager to play with the materials than to use them appropriately. However, with slight guidance, they were back on task. Frequently, the teacher reiterated the importance of reading the instructions when building the models. The students were eager to start their assemblies with little regard to how they should approach the task. However, at the end of the class, all groups successfully completed assemblies.

The final presentations from the groups varied on a quality product. As seen in Appendix E, the final projects ranged from only presenting a portion of the data to presenting personal data from their group and comparing to the class data. Similarly,

the solutions for the disruptions of wetlands also ranged from “just don’t do it”, to a viable solution for the disruptions specified in unit two. From Appendix E, the group did an excellent job describing the empirical data collected. They included both the class data and the group data. The solution they chose to mitigate flooding in a wetland would be to add more sand. The second groups data presented only the groups data. However, they did an excellent job correlating the relationship between the components of a wetland and how to mitigate disturbing it. They suggested building houses on stilts to minimize the disruption.

4.2 Surveys

Pre and post knowledge assessments were performed through google surveys to get a baseline of what the students understood before and after the PBL unit. Similarly, a pre and post STEM attitude survey was performed anonymously before and after the PBL unit.

4.2.1 Pre and Post Test assessment

A pre knowledge assessment was implemented prior to engaging in the unit plans. The same questions were asked in a post knowledge assessment after the final presentations.

The following questions were asked to the students:

1. What is a wetland?	<p>a. A treeless area beyond the timberline in high-latitude regions, having a permanently frozen subsoil and supporting low-growing vegetation, such as lichens, mosses, and shrubs.</p> <p>b. A low area saturated with water.</p> <p>c. An arid land with usually sparse vegetation</p> <p>d. A growth of trees and other plants covering a large area.</p>
2. Wetlands can make water cleaner to drink	<p>a. True</p> <p>b. False</p>
c. Wetland areas can be damaged by:	<p>a. Local water runoff</p> <p>b. Mining</p> <p>c. Natural disasters</p> <p>d. All of the above</p>
4. The x axis is on the bottom of most graphs	<p>a. True</p> <p>b. False</p>
5. Select the following that are benefits of a wetland (can be more than one answer):	<p>a. Improved water quality</p> <p>b. Flood protection</p> <p>c. Increased runoff</p> <p>d. Preventing shoreline erosion</p>

Pre-survey versus Post- survey correct responses

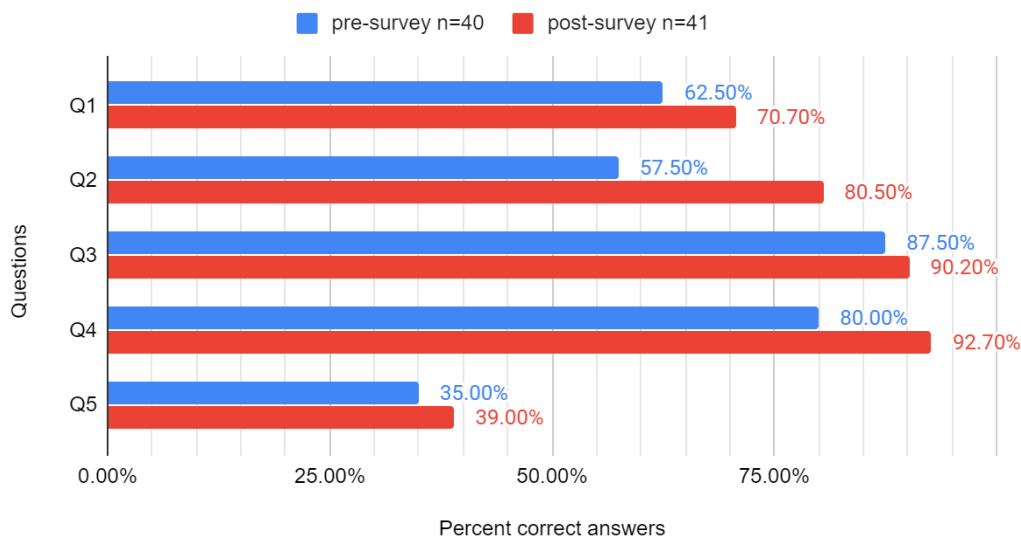


Figure 5: pre and post knowledge assessment

Each question shows an improvement of the correct responses post unit. An

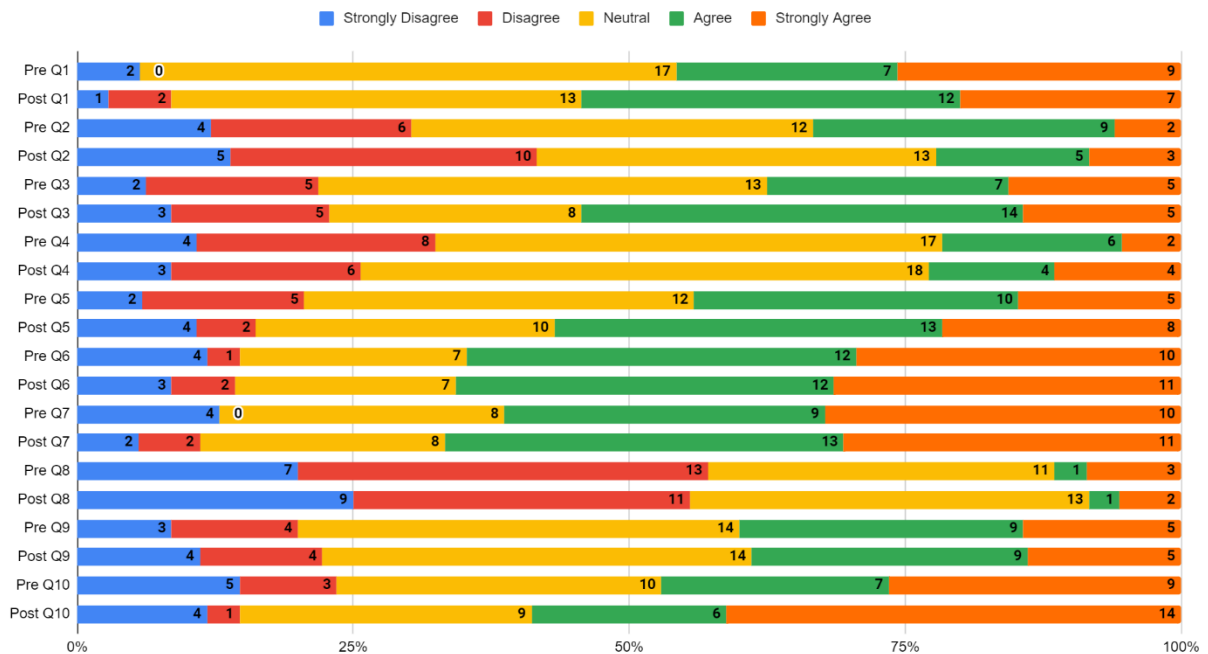
4.2.2 STEM attitude survey results

A pre-attitude STEM survey was given to the students prior to the implementation of the unit. After the 5-day unit lesson plans, a post-attitude STEM survey was given to the students containing the same questions listed below. A full survey can be found in Appendix B.

Science:

- Q1 Science is exciting.
- Q2 Science is my favorite subject
- Q3 I am sure of myself when I do science
- Q4 I would consider a career in science
- Q5 I expect to use science when I get out of school
- Q6 I care about learning about science
- Q7 Science is an important subject
- Q8 Science is my worst subject
- Q9 I look forward to science class
- Q10 The skills I am learning in science could be important to my future career

Pre and Post Science Attitude Survey



Engineering and Technology:

Q1 Engineering sounds exciting

Q2 I know what engineering is

Q3 Technology is exciting

Q4 I want to learn about engineering in high school and/or college

Q5 I am interested in what makes machines work

Q6 I like (or would like) to build/fix things

Q7 I am curious about how electronics work

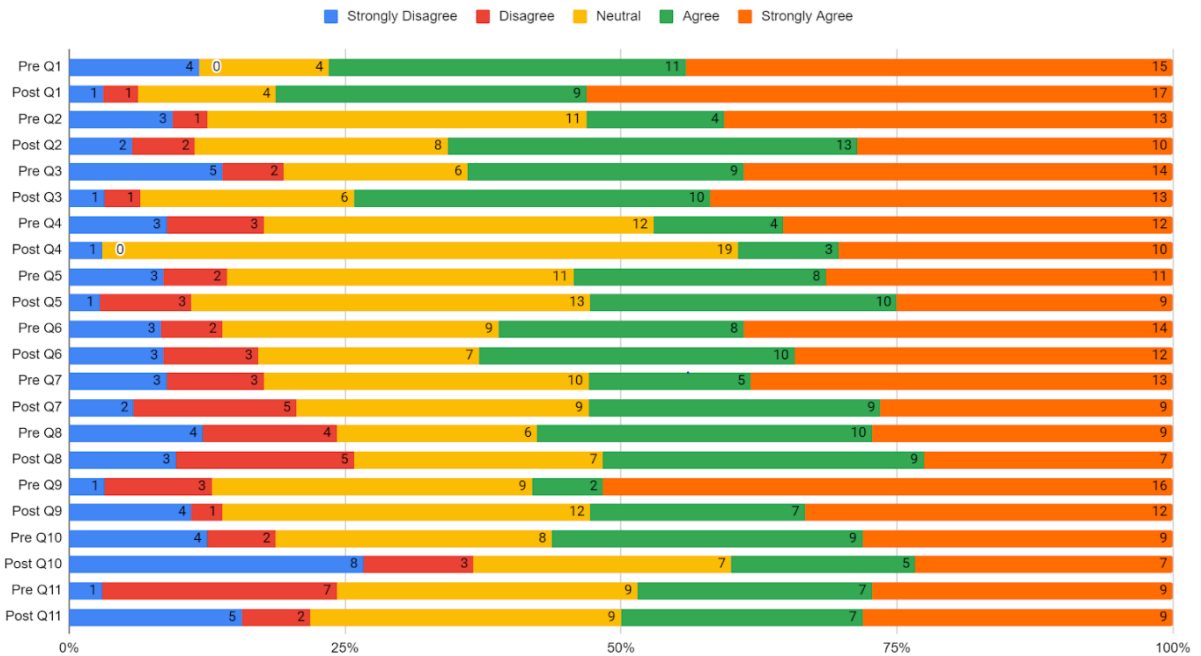
Q8 Physics interests me

Q9 I would like to use creativity and innovation in my future work

Q10 Computer science sounds interesting

Q11 I would consider a career in an engineering field

Pre and Post Attitude Surveys Engineering



Math:

Q1 Math is exciting.

Q2 Math is my favorite subject

Q3 I am sure of myself when I do Math

Q4 I would consider a career that uses a substantial amount of math

Q5 I expect to use math when I get out of school

Q6 I care about learning about math

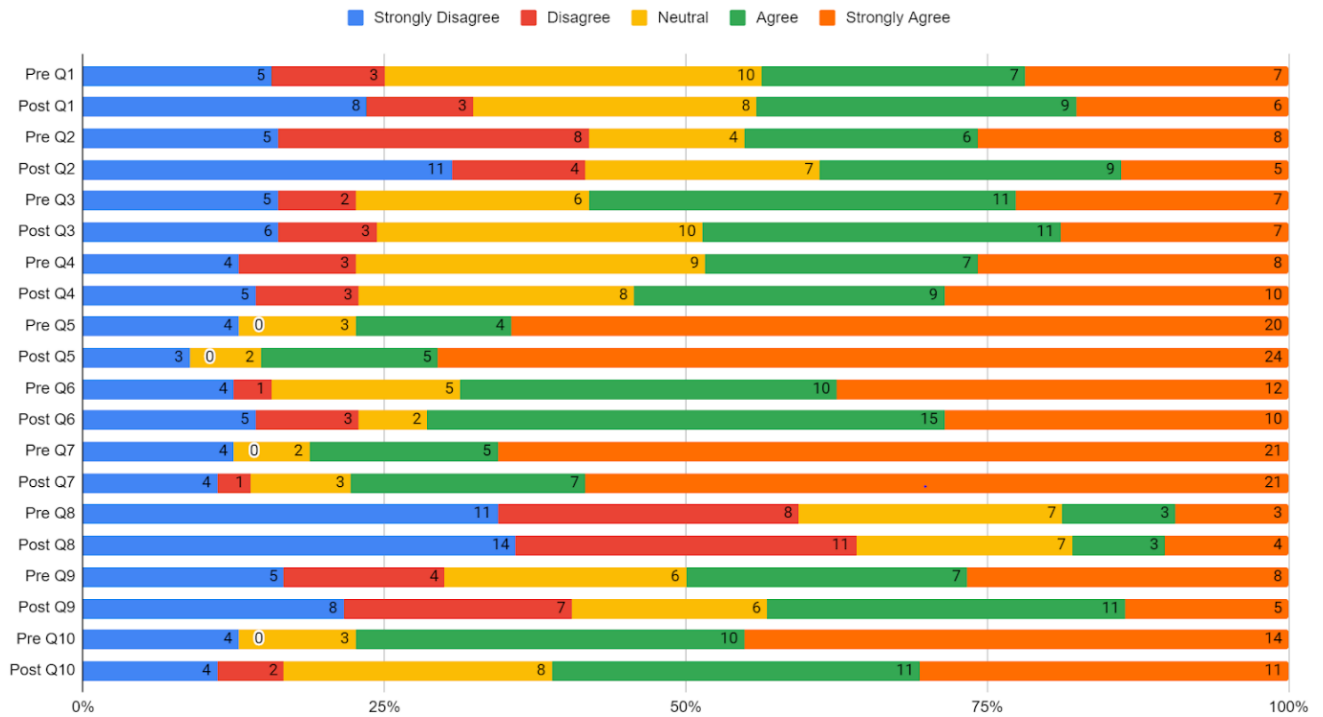
Q7 Math is an important subject

Q8 Math is my worst subject

Q9 I look forward to Math class

Q10 It is important to use math in science classes.

Pre and Post Attitude Surveys Math



4.3 Interview

After the 5-day Unit, an interview was performed with the teacher. In this interview, we sought for the teacher's feedback. We asked about past approaches to the unit to satisfy MS-LS-2-4 and MS-LS-2-5 and typically classroom atmosphere. In previous implementations, the teacher deployed an erosion project. The teacher would use gutters filled with sand to study the effects of erosion. However, the teacher thought the project we brought forth was better at satisfying the Massachusetts science standards. The teacher typically has a hands-on approach in her current classroom style, so adapting to our project-based learning style in her classroom

deemed not too difficult. She was asked about her suggestions to adaptations if it were to be implemented again. Her answer was clarifying qualitative data and quantitative data, especially relating to unit 2. A weakness in our lesson plan was the project end product not being what was expected. She thought this was due to time constraints and rushing. Further, to provide further supporting information for future implementations, it was suggested by the teacher to add more connections to wetlands, such as videos of various examples of wetlands. Due to the heavy snowstorms disrupting the implementations of the units, the teacher thought if the units were performed at a different time, they would have been able to perform all of the desired activities. Unfortunately, the time for the website and the density activity were lost. We asked about previous time allotted for these standards in past classes, it was stated that at least a week was given as well. To understand the student-to-student relationship, we asked that with small groups, does she feel students carried an equal amount of work as their peers. The teacher's response was, "Absolutely not equal. Some students will depend on others to pick up their slack." However, she stated that she would absolutely utilize this lesson plan in future classes and would, in the future, look forward to working with WPI again. For the full interview, see Appendix F.

4.4 Discussion

4.4.1 Analysis and Interpretation

In order to gauge the student's comprehension of the material, pre and post lesson quizzes were used to analyze if the students were able to learn the material (*Fig 5*). The questions asked were chosen because they highlight the key points that the project wanted to cover. These points include the students understanding what a wetland is and their role in the

ecosystem as well as understanding the basics of graphs and analyzing data. The students post-survey answers were higher by 9.5% on average. This indicates that the students were able to learn the lesson objectives,

Additionally, attitude surveys for science, math, and engineering were sent out before and after meeting the class to analyze student engagement with the material. These attitude surveys helped to highlight the student's impressions of the stem field. In the science attitude survey, a large majority of answers were either neutral or agree. Similarly, the engineering, technology and math survey results were average.

4.4.2 Validity of Interpretation

Overall, our team feels the project was executed well under the circumstances faced. Some contributing factors were the multiple snow day interfering with the time constraints. The snowstorms caused the units to be performed days apart. Along with this, the teacher had to adapt her lesson plans with the snow interference to accommodate all lectures. Some class times were split between the units we provided and other units she had scheduled. The lack of available time caused the class unable to perform the task of looking up their house to see what wetlands exist near their home. We feel this exercise was important to allow the students to see a connection that wetlands existing near their homes as well and the importance to mitigating our impact to wetlands.

The pre-surveys were given prior to implementing the lesson plans. However, the post survey attitude survey wasn't given to the students until after their winter break. The STEM attitude survey our team gave the students was very long. We had a category for science, technology and engineering, and math. In future executions of this research, it would be recommended to either give the surveys to the teacher so the students may perform them in their own time or to provide shorter attitude surveys to the students.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.1.1 EFFECTIVENESS IN TEACHING

The overall project satisfied the standards of LS-MS-2.4 and LS-MS-2.5. It is difficult to compare any change in participation of students from previous units as we were not there to observe prior lesson plans. However, from the interview with the teacher, it was stated that although the groups were small, there were those same students who still depended on their peers to “pick up their slack”. From an outside perspective, the students were fully engaged and excited to participate and learn from the project-based learning curriculum. The students responded well in adapting to changes made in the day’s lessons. Some of the vocabulary used to describe a wetland and its benefits were difficult for some of the students to understand. Further clarification from the teacher was added so that all students understood fully. More time could be spent on approaches to mitigate wetland disturbances to show students what is currently being done. Articles were provided for the students to look through, however, with all the disruptions in the class time already, there was no time left. The teacher stated she would use our units for future implementation of LS-MS-2-4 and LS-MS-2-5.

5.1.2 ACCESSIBILITY OF RECREATION

One overarching goal of the project was to allow it to be recreated with ease to be used anywhere. Overall, our team spent about \$25 on supplies. The \$25 went toward purchasing aluminum tins, moss, 2 50-pound bags of gravel, and 2 50-pound bags of sand. The 2-liter bottles we used in our project was generously donated by O'Hara's liquor store in Worcester, Massachusetts. Though, these bottles can also easily be brought in by the students. The plastic we used to imitate concrete was plastic pellet stove bags cut up from home. However, any other material can be used that is not absorbent. The lesson plans can be adapted to the time constraint the teacher has.

5.1.3 Future Implementation

As with any prototype, adaptations to the original lesson plan will most likely occur. For our project to be used by future middle school science teachers, our team would add more time for a full 5-day lesson plan. As mentioned previously, we need to add more examples of wetlands and possibly videos. Our unit did not cover animal migrations in wetlands; however, this adaptation could easily be added as another day extension. More concrete examples of ways to mitigate disruptions of a wetland would be beneficial for the students to make a connection.

Also, we would alter our design to embrace the engineering design process when the students are developing solutions for the disruptions.

5.1.4 Final Remarks

It is hard to conclude whether project-based learning differs from traditional learning based on our surveys alone. However, based on the teacher's feedback and our self-made observations, we can say that the students enjoyed coming to class and were eager to learn. Project based learning challenges students to think in a non-traditional way and allows them to use their creativity to find a solution for said issue. It accommodates for different style learners, whether it be kinesthetically or audibly. Through project-based learning, students are challenged to collaborate with their peers and tackle real-life challenges based on issues in the outside world.

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APPENDIX A: PRE AND POST KNOWLEDGE ASSESSMENT

1. What is a wetland?
 - a. A treeless area beyond the timberline in high-latitude regions, having a permanently frozen subsoil and supporting low-growing vegetation, such as lichens, mosses, and shrubs.
 - b. **A low area saturated with water.**
 - c. An arid land with usually sparse vegetation
 - d. A growth of trees and other plants covering a large area.
2. Wetlands can make water cleaner to drink
 - a. **True**
 - b. False
3. Wetland areas can be damaged by:
 - a. Local water runoff
 - b. Mining
 - c. Natural disasters
 - d. **All of the above**
4. The x axis is on the bottom of most graphs
 - a. **True**
 - b. False
5. Select the following that are benefits of a wetland (can be more than one answer):
 - a. **Improved water quality**
 - b. **Flood protection**

c. Increased runoff

d. Preventing shoreline erosion

APPENDIX B: STEM ATTITUDE SURVEY

B. Attitude Survey

Stem Attitude Survey

There are no "right" or "wrong" answers. The only correct responses are those that are true for YOU.

SCIENCE

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Science is exciting.					
Science is my favorite subject.					
I am sure of myself when I do science.					
I would consider a career in science.					
I expect to use science when I get out of school.					
I care about learning about science.					
Science is an important subject.					
Science is my worst subject.					
I look forward to science class.					
The skills I'm learning in science could be important to my future career.					

MATH

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Math is exciting.					
Math is my favorite subject.					
I am sure of myself when I do math.					
I would consider a career that uses a substantial amount of math.					
I expect to use math when I get out of school.					
I care about learning math.					
Math is an important subject.					

Math is my worst subject.					
I look forward to math class.					
It is important to use math in science classes.					

ENGINEERING and TECHNOLOGY

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Engineering sounds exciting.					
I know what engineering is.					
Engineering is important to the world.					
Technology is exciting.					
I want to learn about engineering in high school and/or college.					
I am interested in what makes machines work.					
I like (or would) like to build/fix things.					
I am curious about how electronics work.					
Physics interests me.					
I would like to use creativity and innovation in my future work.					
Computer science sounds interesting.					
I would consider a career in an engineering field.					

APPENDIX C STUDENT DATA EXAMPLES

Anonymous A:

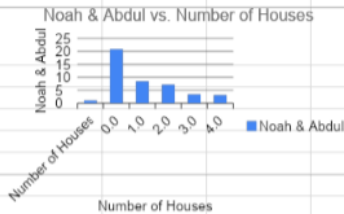
Experiment 1: Effect of Construction on a Wetland											
Number of Houses	Time for Water to Exit Model (seconds)										Average (seconds)
	Noah & Abdul	Livia & Jose	Francisco & Mouhamet	Gizelle & Mark	Mason & Xavier	Logan & Ace	Jayden & Madison	Antoinette & Dylan & Anthony	Sophie & Brady	Nayla & Gray	
0	20.79	6.32	17.53	55.06	22.26	4.50	13.53	16.46	60.00	24.00	
1	8.40	18.62	8.25	6.67	7.95	2.88	5.91	9.80	9.32	4.35	
2	7.14	23.38	1.53	5.43	4.85	3.33	8.70	2.35	6.43	9.36	
3	3.40	14.22	3.72	2.15	4.03	3.86	5.18	2.05	5.75	7.37	
4	3.11	8.32	4.52	1.97	2.85	1.90	4.35	2.13	4.92	5.62	
2 Graphs: 1 for your individual data and 1 for the group data											

Anonymous B:

Experiment 1: Effect of Construction on a Wetland											
Number of Houses	Time for Water to Exit Model (seconds)										Average (seconds)
	Noah & Abdul	Livia & Jose	Francisco & Mouhamet	Gizelle & Mark	Mason & Xavier	Logan & Ace	Jayden & Madison	Antoinette & Dylan & Anthony	Sophie & Brady	Nayla & Gray	
0	20.79	6.32	17.53	55.06	22.26	4.50	13.53	16.46	60.00	24.00	24.05
1	8.40	18.62	8.25	6.67	7.95	2.88	5.91	9.80	9.32	4.35	8.22
2	7.14	23.38	1.53	5.43	4.85	3.33	8.70	2.35	6.43	9.36	7.25
3	3.40	14.22	3.72	2.15	4.03	3.86	5.18	2.05	5.75	7.37	5.17
4	3.11	8.32	4.52	1.97	2.85	1.90	4.35	2.13	4.92	5.62	3.97
2 Graphs: 1 for your individual data and 1 for the group data											
<div> <div> <div>Number of Houses</div> <div>Livia & Jose</div> </div> <div> <div>0</div> <div>6.32</div> </div> <div> <div>1</div> <div>18.62</div> </div> <div> <div>2</div> <div>23.38</div> </div> <div> <div>3</div> <div>14.22</div> </div> <div> <div>4</div> <div>8.32</div> </div> </div> <div> <div>Livia & Jose vs. Number of Houses</div> </div>											
<div> <div> <div>Number of Houses</div> <div>Average (seconds)</div> </div> <div> <div>0</div> <div>24.05</div> </div> <div> <div>1</div> <div>8.22</div> </div> <div> <div>2</div> <div>7.25</div> </div> <div> <div>3</div> <div>5.17</div> </div> <div> <div>4</div> <div>3.97</div> </div> </div> <div> <div>Average (seconds) vs. Number of Houses</div> </div>											

Anonymous C:

Experiment 1: Effect of Construction on a Wetland									#DIV/0!		
Number of Houses	Time for Water to Exit Model (seconds)										
	Noah & Abdul	Livia & Jose	Francoise & Mouhannet	Gizelle & Mark	Mason & Xavier	Logan & Ace	Jayden & Madaou	Antoinette & Dylan & Anthony	Sophie & Brady	Nayla & Gray	Average (seconds)
0	20.79	6.32	17.53	55.06	22.26	4.50	13.53	16.46	60.00	24.00	24.08
1	8.40	18.62	8.25	6.67	7.95	2.88	5.91	9.80	9.32	4.35	8.22
2	7.14	23.38	1.53	5.43	4.85	3.33	8.70	2.35	6.43	9.36	7.28
3	3.40	14.22	3.72	2.15	4.03	3.86	5.18	2.05	5.75	7.37	5.17
4	3.11	8.32	4.52	1.97	2.85	1.90	4.35	2.13	4.92	5.62	3.97
2 Graphs: 1 for your individual data and 1 for the group data											
Number of Houses		Noah & Abdul									
0		20.79									
1		8.40									
2		7.14									
3		3.40									
4		3.11									
Number of Houses		Average (seconds)									
0		24.08									
1		8.22									
2		7.28									
3		5.17									
4		3.97									



Appendix D Activity sheet 3 student Answers

Activity 3 Anonymous A

Day 3 Graphing Activity

Write answers to all the questions below. Justify your answers.

1. The reason I picked it is because Its letter A because it represents the paragraph well.
2. The reason I pick letter B is because when I look at the chart I see a resemblance in the graph and the paragraph.
3. Florida, california, alaska, arizona

Activity Anonymous B

Day 3 Graphing Activity

Write answers to all the questions below. Justify your answers.

The answer to number one is A. The reason that it is A is because in the paragraph it says that March is the wettest month in millbury with 4.6 inches of rain. The point the was plotted for March on graph A is on 4.6 inches but for March on graph B the rainfall is at 2 inches.

The second question says that Palustrine wetlands make up most of Massachusetts. A graph shows that Lacustrine and Riverine wetlands take up most of the land, this is not the right one. The B graph shows that Palustrine wetlands are the most common and matches up with the paragraph.

The one who lost the most wetlands is Florida. The state who lost less than Florida is California then Arizona. The state that didn't loss any was Alaska.

APPENDIX E FINAL PROJECT EXAMPLE

Project Example Group A



Results of Experiment 1

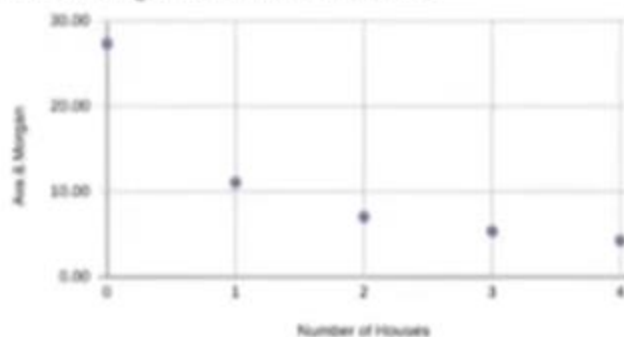
In experiment one we had to place 4 houses on our wet land one by one and see how the water flow was affected. When we didn't have any houses it took 27.30 seconds for the water to come out of the nozzle. After we moved some moss and put on a house(a small piece of wax paper). When we put the house the water came out of the nozzle in 11.06 seconds. Next we put another house and it only took 7.02 seconds for it to pour out. By the third house it started coming out faster. This time it took 5.33 seconds. We noticed the more houses the less time it took for the water to come out of the nozzle. Lastly the fourth house took 4.23 seconds.

Our graphs

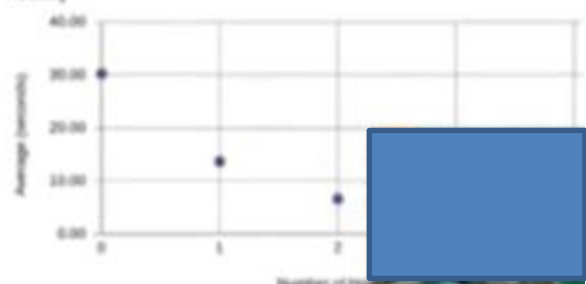
Our data was pretty consistent and the time it took to have the water leave the model decreased when we moved the moss to create room for houses.

When we average the data it went down a lot smoother. This is because everyone got different test results.

Ava & Morgan vs. Number of Houses



Average (seconds) vs. Number of Houses (class data)



Results of Experiment 2 & 3

Experiment 2 was on flooding and how the wetland stopped it. The water came out the nozzle. It spilled over the edges of the model. If there was a flood in the real world the wetland would get over flooded.

Experiment 3 was on mining in the wetland. The sand was wet like mud. The mud was slimy and it very hard to get out.

Results of Experiment 4



The two cups in the photo are both mixtures of soil and water. The light brown water is filtered than the other cup.

Because one had more filtration and the other had



Describe a Solution to the Various Disturbances with Justification

If i could stop a flooding in a wetland i would hope for more sand so the sand could soak up the water and the water will shrink. The scenario would be in the flooding one. The sand would protect the wetland a lot more.

Project Example B

Wetlands Project

By: Madison, Jayden, Ace, and Logan

Results of Experiment 1

Number of Houses	Time For Water To Exit (seconds)
0 (control)	13.53
1 house	5.91
2 houses	8.70
3 houses	5.18
4 houses	4.35

Results of Experiment 2

In this experiment we tested if vegetation(moss) would affect how the water flooded. We tested this by pouring 300mL of water in each model with no vegetation and only houses and the water just overflowed and fell over the edges. We think if we had more vegetation than the vegetation might help absorb some of the water from the flood.



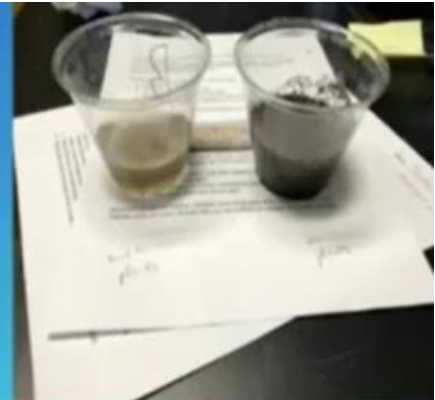
Results of Experiment 3

The wetland could not be restored with the mine still there. The mine greatly hindered the filter operation. The mining takes out precious filtration systems that help with flooding and the overall well being of the wetland. The mining also causes erosion from the water at a beach.



Results of Experiment 4

The cup on the left has cleaner water than the cup on the right because the cup on the left had moss in the project and the cup on right didn't. The cup on the left had moss in their project and the one on the right didn't the moss filtered the water out with the project on the left so, it made the water cleaner. The cup on the right had no moss in it to filter it out so the sand dirt and other things made it dirtier.



Describe a Solution to the Various Disturbances with Justification

A solution could be that maybe you could build houses, but without disturbing the vegetation. Another example could be building houses that have stilts on the bottom of it, this won't disturb the vegetation, and the house won't get flooded, and destroyed.



APPENDIX F: INTERVIEW QUESTIONS WITH 7TH GRADE MIDDLE SCHOOL SCIENCE TEACHER

Questions to ask MaryAnn

For days not present, how were the lesson plans deployed? What alterations were made?

Never got to the wetland website to see where marshes were, not enough time. The density lab was not completed either, but will use this in later lesson plans.

What were past approaches in teaching MS-LS-2-4 and MS-LS-2-5?

Erosion project, similar; gutters look affect angle of incline, the one we made was much better and connected it to wetlands

What are some differences in your typical classroom style versus what was implemented?

The classroom style is hands-on

Would you consider utilizing this lesson plan in future classes?

Absolutely

What changes would you suggest to make if you were going to implement it again?

Give the students more support with what data to collect, 2 and 3 qualitative. Specify qualitative vs quantitative, how much fallening

What were some weaknesses about the lesson plan? Some unsuccessful parts?

Project end product were not what expected, time constraints and rushing

In your opinion, did these lesson plans cover the standards appropriately?

Yes

How effective, overall, do you think the lesson plans were in teaching the standards?

A little bit, videos of wetlands, more connections to wetlands

Do you feel the timing of the project around the holidays made a difference, along with the multiple snow days? In regards to the students focus

I understand some of the lesson plans had to be cut short due to lack of time, if it were done a different time, do you think that part would have benefited the students?

How much time is typically spent on these standards in past classes?

Erosion lab at least a week,, guided inquiry and open inquiry

How well would the lesson plans have been understood if one of us were not there to guide?

a. Plastic, pieces of plastic, this portion could have been clarified more clearly.

Was disciplining students more-less-the same during the lesson plans?

Much better ,

With the small groups, do you feel the students carried an equal amount of work and learning as their peers? Absolutely not, distraction, not equal. Some students will depend on others to pick up their slack .

Would you consider working with WPI again for future projects?

Yes, most definitely

Is there anything else you wish to add, remarks, feedback, maybe to future teachers using these lesson plans, tips?

It was a great experience, the whole process.

APPENDIX G LESSON PLANS

Teacher: MaryAnn DeMaria
Date: Day1
Duration: 50 minutes
Subject/ grade level: Science/ 7th grade
Materials: <ul style="list-style-type: none">• Scientific journals• 2-liter bottles• Coarse grain sand• Dirt• Moss• Gravel• Beaker (250mL)• ruler
NC SCOS Essential Standards and Clarifying Objectives: MS-LS2-4, MS-LS-5 <p>Analyze data to provide evidence that disruptions (natural or human-made) to any physical or biological component of an ecosystem can lead to shifts in all its populations.</p> <p>Evaluate competing design solutions for protecting an ecosystem. Discuss the benefits and limitations of each design.</p>
Lesson objective(s): <ul style="list-style-type: none">• Students will be assigned groups project• Students will be able to understand the components of a wetland and each component's purpose.• Students will understand how to convert volume to mass• Build a model of a wetland
Differentiation strategies to meet diverse learner needs: <ul style="list-style-type: none">• Provide examples of scientific journal entries• Provide visual aid of final model• Extra time for completion of model
ENGAGEMENT <p>Students will be given their roles for the end of week presentation. The overall scenario will be a hurricane affecting the wetland.</p>

Pre-lab questions:

- What is a wetland? Do any students have an example of where a wetland is in their areas
- Name some benefits of wetlands (group discussion)
- In what order do you think the materials should go when building the model? Explain.

EXPLORATION

Measuring Lab: 2 wetland models will be built. A model with all of the components will represent an undisturbed wetland. The other model will represent a disruption in the wetland. Students will be weighing a certain amount of each material and annotating the amounts in their scientific journal. These models will be used for the rest of the week to model disruptions.

ELABORATION

•Students will be developing their lab skills of measuring length

Label the bottle with moss as model 1. Label the bottle without the moss as model 2.

EVALUATION

Post-lab questions:

- What is the importance of measuring the same amount of sand for each model?

Wetland models will be used for the rest of the week as tools to model disruptions on a small scale.

Teacher: MaryAnn DeMaria

Date: Day 2

Subject/ grade level: Science/ 7th grade

Materials:

- Scientific journal
- Plastic tub (big enough to hold model) (used for retaining water)
- Graduated cylinder/beaker
- Wetland models
- Water
- Dirt
- plastic sheets (Cut into 6cm by 6cm square)

NC SCOS Essential Standards and Clarifying Objectives: **MS-LS2-4, MS-LS-5**

Analyze data to provide evidence that disruptions (natural or human-made) to any physical or biological component of an ecosystem can lead to shifts in all its populations.

Evaluate competing design solutions for protecting an ecosystem. Discuss benefits and limitations of each design.

Lesson objective(s):

- Students will be able to visualize a disruption of their model wetland and will collaborate with one another to resolve the damage caused by disruption.
- Scenarios: Construction, flood, mining, house runoff

Differentiation strategies to meet diverse learner needs:

- Group work
- Directions
- Visuals
- Example of scientific journal entry for each scenario

ENGAGEMENT

Teacher will hand out a scenario to each group.

Scenario 1 is a construction company building on top of a wetland. Students will collaborate to build where it is least impactful. A 6cmx6cm in sheet of plastic will represent the construction site. 1.Students will pour 100mL of water onto model and observe the water path, writing their observations of the quantity of water coming out of the mouth of the bottle collected by the graduated cylinder under the mouth of the bottle.

2. Students will continue to add Legos and/or sheets of plastic until a noticeable difference in water runoff is distinguished.

3.Ensure students log the amount of water collected with each addition of housing. (data will be graphed the following lesson plan)

Scenario 2 is a flood in the area. Students will add 300mL of water to their wetland. How fast is the water absorbing? does the water overflow over the model edges?

Scenario 3 is a sand mining company. A large hole will be placed toward the opening mouth of the wetland model. Students will pour 100mL of water onto the model and observe the water path. Describe the waters interaction with the hole. (is more sand taken away with the water?)

Scenario4 high traffic footpath in the wetland has cause partial loss of vegetation. Students will be performing a filtration lab.

In the immediate groups, 2-3 people per model. One group will get the model with the moss. The other participants of the group will get the model without the moss or vegetation.

You are now ready to perform the experiment!

Experiment:

1. In a graduated cylinder, measure 100mL of water
2. Pour water into beaker

3. Gather about 2 tablespoons of dirt
4. Pour dirt into the same beaker as the water
5. Stir the dirt and water so that the dirt dissolves in the water
 - a. Annotate in journal the appearance of the dirt and water solution.
6. Pour the water and dirt solution onto the gravel at the back of model 1.
 - a. Observe the path of water. Did it go straight through the gravel and sink through the sand? Did the water go to the outskirts of the bottle's edges?
7. Repeat step 1 through step 8 until water begins to pour out the mouth of the bottle.
8. Annotate the color of the liquid.
9. Compare the sample from before it entered the model to the sample post model.
 - . What visual differences do you see?

Once both groups are finished, compare clarity of samples of the final liquid post model. Discuss clarity, color, and measurements. Discuss why you see a difference between the model samples.

EXPLORATION

- scenario 1 demonstrates the loss of wetland absorption by replacing the wetland surface with concrete (the plastic in the model)
- Scenario 2 demonstrates overflow and the importance of the absorption capabilities of a wetland.
- Scenario 3 demonstrates erosion of a wetland
- Scenario 4 demonstrates loss of vegetation and why the plants are important by providing filtration and slowing down water streams.

ELABORATION

- students will use their expert roles in each of the scenarios to discuss the impact on the wetland, how they will resolve the disruption on the wetland, and what can be done in future cases to either prevent or mitigate the impact on the ecosystem.

EVALUATION

- Students will be able to visualize a disruption of their model wetland and will collaborate with one another to resolve the damage caused by disruption.

Teacher: MaryAnn DeMaria

Date: 12/5/2019
Subject/ grade level: 7th grade, Science
Materials: <ul style="list-style-type: none"> • Scientific Journals • Student data from day 2 • A straight edge (ruler)
NC SCOS Essential Standards and Clarifying Objectives: MS-LS2-4, MS-LS-5 Analyze data to provide evidence that disruptions (natural or human-made) to any physical or biological component of an ecosystem can lead to shifts in all its populations. Evaluate competing design solutions for protecting an ecosystem. Discuss the benefits and limitations of each design.
Lesson objective(s): Identify graphs and their matching written information to each other Create graphs that describe the student's data from Day 2.
Differentiation strategies to meet diverse learner needs: -Extra time to complete objectives(50%more) -Examples of what we are looking for -Check list of graphic organizers -Chunking of information (break down tasks into smaller chunks) -Copy of notes -Directions, preview read aloud -Word banks -Visuals -Scaffolding (framework supports of lesson plan) -Teacher facilitated group
ENGAGEMENT <ul style="list-style-type: none"> • Describe how the teacher will capture students' interest. By using the student's personal data, the students will be interested in the results. <ul style="list-style-type: none"> • What kind of questions should students ask themselves after the engagement?
EXPLORATION <ul style="list-style-type: none"> • Describe what hands-on/minds-on activities students will be doing. After a discussion about graphs (x and y axes, line vs bar), the student's will take their data and reform it into a graph <ul style="list-style-type: none"> • List "big idea" conceptual questions the teacher will use to encourage and/or focus students' exploration When should bar graphs be used over line graphs? Why would the X-axis have the dependent variable?

ELABORATION

- Describe how students will develop a more sophisticated understanding of the concept.
- What vocabulary will be introduced and how will it connect to students' observations?
X/ Y axis, Bar/Line Graph, Dependent/Independent Variable
All of these will be utilized with visual aids and creating their own graphs
- How is this knowledge applied in our daily lives?
Graphs are the most common way to format data both in academic and common usages.

EVALUATION

- How will students demonstrate that they have achieved the lesson objective?
Graphs will be generated that accurately reflect the student's data

Exit Ticket: Students will turn in their graphs they made that day

Homework: Find a wetland nearby their house at

<http://maps.massgis.state.ma.us/images/dep/omv/wetviewer.htm> to look into how wetland play a role in their life.

Teacher: MaryAnn DeMaria

Date: 12/6/2019

Subject/ grade level: 7th grade, Science

Materials: Poster Board, Markers, computers (screencastify program)

NC SCOS Essential Standards and Clarifying Objectives: **MS-LS2-4, MS-LS-5**

Analyze data to provide evidence that disruptions (natural or human-made) to any physical or biological component of an ecosystem can lead to shifts in all its populations.

Evaluate competing design solutions for protecting an ecosystem. Discuss the benefits and limitations of each design.

Starting Action: The Mindful minute

Lesson objective(s):

Students will discuss wetlands near their homes in order to identify local wetlands and their purpose

Students will collaborate to create a poster that portrays solutions to the scenario provided.

Differentiation strategies to meet diverse learner needs:

- Extra time to complete (50%more)
- Examples of what we are looking for

- Check list of graphic organizers
- Chunking of information (break down tasks into smaller chunks)
- Copy of notes
- Directions, preview read aloud
- Word banks
- Visuals
- Scaffolding (framework supports of lesson plan)
- Teacher facilitated group

ENGAGEMENT

- Describe how the teacher will capture students' interest.
- The Mindful Minute will help direct the student's focus towards the teacher

EXPLORATION

- Describe what hands-on/minds-on activities students will be doing.
- Students will be discussing local wetlands and their impacts on the local area
Students will be collaborating with other students to put together a presentation for the scenario tasked to the group for presentation on the next class period.
- List "big idea" conceptual questions the teacher will use to encourage and/or focus students' exploration
- What would the local area look like without any wetlands?
Does anyone live inside a wetland?

ELABORATION

- Describe how students will develop a more sophisticated understanding of the concept.

Students will engage with each other to create a final presentation of data collected from unit 2 and design a solution as a team to mitigate the scenarios from unit 2.

EVALUATION

- How will students demonstrate that they have achieved the lesson objective?
- Students will develop an understanding of the role that wetlands play in their local area

Students will create a poster that presents their idea on how to solve the issue

Teacher: MaryAnn DeMaria

Date:

Subject/ grade level: 7th grade, Science

Materials:

NC SCOS Essential Standards and Clarifying Objectives:
Lesson objective(s):
Differentiation strategies to meet diverse learner needs:
ENGAGEMENT <ul style="list-style-type: none"> Describe how the teacher will capture students' interest. What kind of questions should the students ask themselves after the engagement?
EXPLORATION <ul style="list-style-type: none"> Describe what hands-on/minds-on activities students will be doing. List "big idea" conceptual questions the teacher will use to encourage and/or focus students' exploration
ELABORATION <ul style="list-style-type: none"> Describe how students will develop a more sophisticated understanding of the concept. What vocabulary will be introduced and how will it connect to students' observations? How is this knowledge applied in our daily lives?
EVALUATION <ul style="list-style-type: none"> How will students demonstrate that they have achieved the lesson objective? This should be embedded throughout the lesson as well as at the end of the lesson

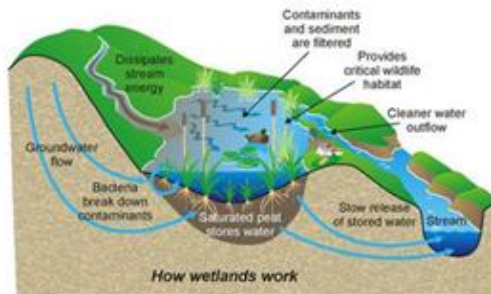
APPENDIX H: PRESENTATIONS FOR EACH DAY

Day one supporting slides

Wetlands

What is a wetland?

- Lowland
- Lots of water (saturated soil)



Why are they important?

Stops Flooding

Improves Water Quality

Helps to stop erosion



Project

In groups of 5, build a wetland model and investigate different ways the model can be damaged.

Make sure to log everything in your journal



How to build your models

1. Gather the materials
2. In the 500mL beaker, measure 400mL of dirt
3. Annotate the measurements in your scientific journal
4. Pour the 400 mL of dirt in the bottle and spread dirt out evenly
5. In the 500mL beaker, measure 500mL of sand
6. Annotate the measurement in your scientific journal
7. Pour the 500mL of sand on top of the dirt and spread out evenly
8. In the 500mL beaker, measure 250mL of gravel
9. Annotate the measurement in the scientific journal
10. In the 500mL beaker, measure 300mL of sand
11. Annotate the measurement in your scientific journal
12. Pour the sand over the gravel and spread out evenly
13. In the 500mL beaker, measure about 500mL of moss
14. Annotate the measurement in your scientific journal
15. Place the pieces evenly on top of the sand, ensure to place a piece of moss in the nozzle of the bottle

H-1 Day one activity sheets (Density and model build)

Building the model- Volume to mass Activity

Materials Needed:

- 500 mL beaker
- 50mL graduated cylinder
- Dirt
- Gravel
- Sand
- Moss
- Bottle cut in half
- Scientific journal
- scale

Calculating the mass from volume:

Density is the measure of mass per unit of volume

$$D = \frac{m}{V}$$

, Units (g/mL)

D= density
m= mass
V= Volume

1. Gather the 50mL graduated cylinder
2. Tare the scale and weigh the empty 50mL graduated cylinder
3. Write the weight of the graduated cylinder to the nearest tenths in your scientific notebook
4. Place 50mL of sand in the graduated cylinder
5. Tare the scale
6. Weigh the 50mL of sand on the scale
7. Write the weight of the sand to the nearest tenths in your scientific notebook.
8. Empty the sand from the graduated cylinder
9. Place 50mL of dirt in the graduated cylinder
10. Tare the scale if not reading 0.00
11. Weigh the 50mL of dirt on the scale

12. Write the weight of the dirt to the nearest tenths in your scientific notebook
13. Empty the dirt from the graduated cylinder
14. Place 50mL of gravel in the graduated cylinder
15. Tare the scale if not reading 0.00
16. Weigh the 50mL of gravel on the scale
17. Write the weight of the dirt to the nearest tenths in your scientific notebook
18. Empty the gravel from the graduated cylinder
19. Place 50mL of moss in the graduated cylinder
20. Tare the scale if not reading 0.00
21. Weigh the 50mL of moss on the scale
22. Write the weight of the moss to the nearest tenths in your scientific notebook.

Calculate the density for each of the materials: Moss, gravel, sand, and dirt.

We will be using these densities to calculate the weight of the materials for the building of the model.

Example of measured weight:

50mL of sand weighs 137.5 grams- weight of cylinder 57.4 grams

50mL gravel 115g

50mL dirt 112.3g

50mL moss 91.4 g

Building the model:

Instructions:

1. Gather the materials
2. In the 500mL beaker, measure 400mL of dirt
3. Annotate the measurements in your scientific journal
4. Pour the 400 mL of dirt in the bottle and spread dirt out evenly.



5. In the 500mL beaker, measure 500mL of sand
6. Annotate the measurement in your scientific journal
7. Pour the 500mL of sand on top of the dirt and spread out evenly.



8. In the 500mL beaker, measure 250mL of gravel.

9. Annotate the measurement in the scientific journal

10. Pour the 250mL of gravel on top of the sand and spread out evenly.



11. In the 500mL beaker, measure 300mL of sand

12. Annotate the measurement in your scientific journal

13. Pour the sand over the gravel and spread out evenly.



14. In the 500mL beaker, measure about 400mL of moss

15. Annotate the measurement in your scientific journal

16. Place the pieces evenly on top of the sand, ensure to place a piece of moss in the nozzle of the bottle.



Calculate the weights using the density you calculated earlier for each of the materials and the volumes measured when constructing your model.

Density activity sheet: Scientific Journal Entry Example

Name_____

Date_____

Density activity example of scientific journal

Density is the measure of mass per unit of volume

$$\rho = \frac{m}{V}, \text{ Units (g/mL)}$$

ρ = density

m = mass

V = Volume

Mass of empty 50mL graduated cylinder (grams): 57.4 grams

(You will be needing the mass of the empty graduated cylinder to subtract the value from the scale when measuring each of the materials)

Mass of 50mL sand: 137.5 grams - 57.4 grams = 80.1 grams

Mass of 50mL gravel: 115 grams - 57.4 grams = 57.6 grams

Mass of 50mL dirt: 112.3 grams - 57.4 grams = 54.9 grams

Mass of 50mL moss: 91.4 grams - 57.4 grams = 34 grams

Calculating the density of each material:

Sand: $\text{density} = m/V = 80.1 \text{ grams}/50\text{mL} = 1.602 \text{ g/mL}$

Gravel: $\text{density} = m/V = 57.6 \text{ grams}/50\text{mL} = 1.152 \text{ g/mL}$

Dirt: $\text{density} = m/V = 54.9 \text{ grams}/50\text{mL} = 1.098 \text{ g/mL}$

Moss: $\text{density} = m/V = 34 \text{ grams}/50\text{mL} = .68 \text{ g/mL}$

(After building your model, you can use the densities you just calculated of each material to find the mass of each material utilizing the density equation.) Pay attention to the different volumes used for each material.

Mass of dirt: $m = \text{density} \times \text{Volume} = 1.098 \text{ g/mL} \times 400 \text{ mL} = 439.2 \text{ g}$

Mass of Sand:

Mass of gravel:

Mass of Sand

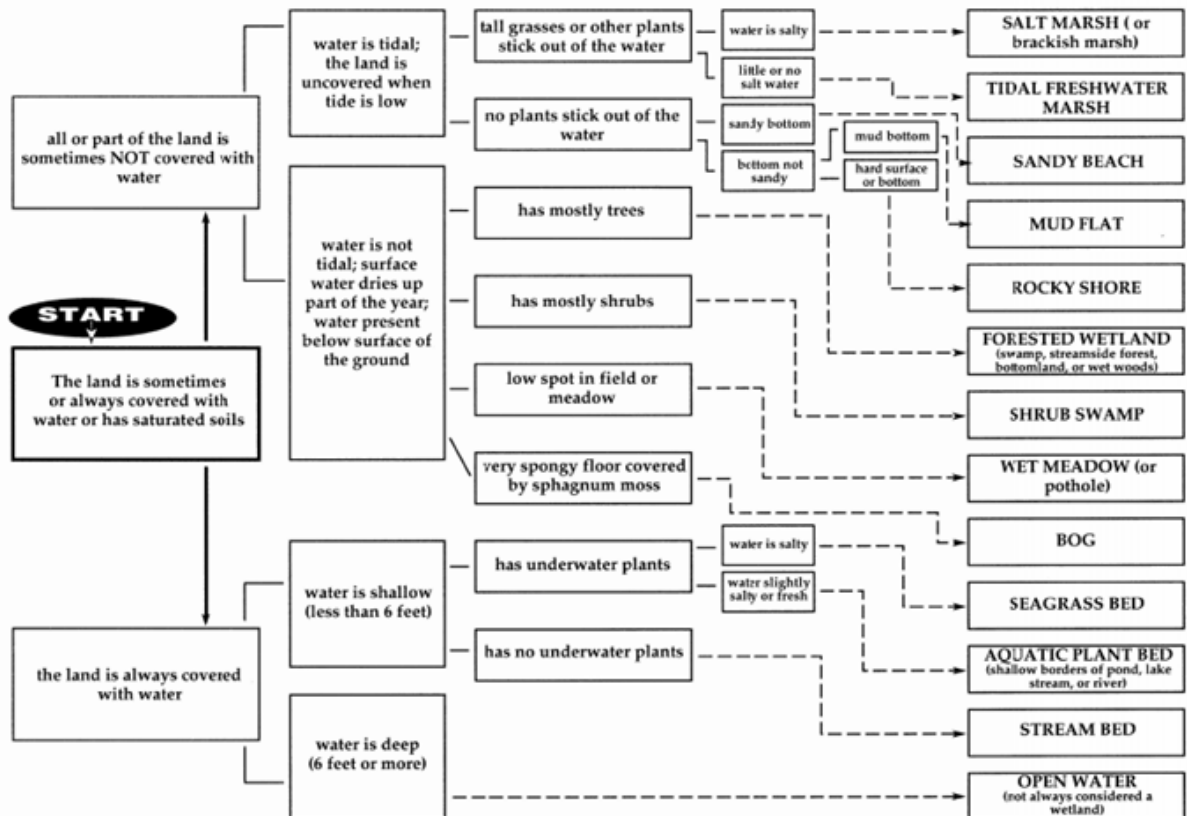
Mass of moss

Mass of sand total:

Day 1.5 Our Wetland, Our World Activity Sheet

Wetland Habitats Flow Chart

Carefully read each of the habitat cards, then use this flow chart to identify each habitat. Start at the left side of the page at the first box. There are two boxes connected to that box—choose the one that matches the description on the card. Then move on to the next set of boxes, following the lines, and make another choice. Continue until you reach the name of the habitat described on the card. Can you identify all ten habitats?



Habitat Cards

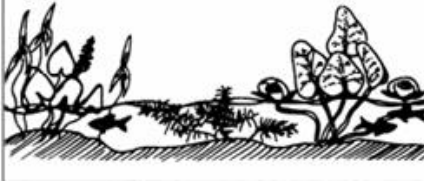
1. During storms, the waves push grains of sand into ever-changing patterns. During low tide the animals that live among the sand grains feel the summer heat or the winter cold. Shore birds search along the water's edge for these animals and for bits of food that wash in from the water. No plants grow here.



2. Scrubby, low-growing thickets of shrubs grow here, in places that may have started out as wet meadows. You might find these places near the coast, or where lakes, streams, rivers, marshes, and forested swamps overflow. They are not always covered with water. This type of wetland offers good habitat for fish, reptiles, amphibians, and many other animals.



3. In the shallow borders of ponds, lakes, rivers, and streams, where there is good light and the water has little salt, under-water plants and plants with floating leaves grow. Some of these plants are valuable food for many kinds of water-fowl including ducks, geese, and swans. All make places for little fish and other animals to live and feed. These plants slow water movement and protect the soil on shores and banks from erosion.

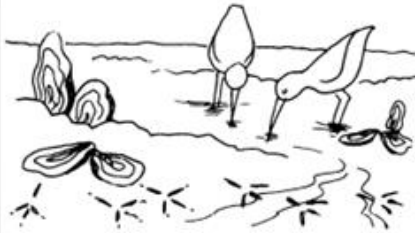


4. Depressions in the ground may fill with rain and ground water and stay wet for several days or weeks. Landowners often mow or plow around these spots to avoid getting tractor wheels stuck in the soft ground. On spring evenings, these puddles seem alive with the high-pitched calls of spring peepers (tiny frogs) looking for mates among the rushes and sedges that grow here. In the heat of the summer, these places usually dry up.



Habitat Cards

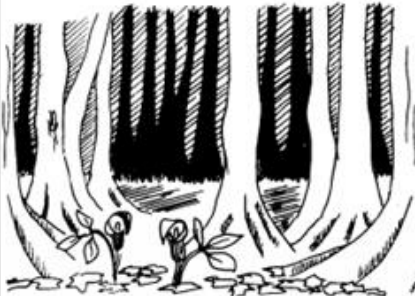
5. Fine particles of dirt make mud when they settle out of the water. Where the water is very shallow, the muddy bottom is uncovered at low tide. While this area may not look like home to many animals, and few or no plants grow here, lots of creatures live down in the mud. Watch for hungry shore birds searching for them in the mud.



6. Tall grasses and other kinds of plants grow up out of the water. The water contains little or no salt, but the push of incoming tides is strong enough to raise the water level in the river. The ground is sometimes flooded and sometimes dry or exposed. The plants provide food and places to hide for many kinds of animals including fish, invertebrates, muskrats, and lots of birds.



7. Where trees grow in low-lying areas, the ground may hold water for part of the year. In the spring, many beautiful wildflowers grow here, and frogs and salamanders find wet places to lay their eggs.



8. In salty bays or at the ocean's edge, two kinds of plants may grow under the shallow water. They can only live where it is shallow because they are rooted on the bottom and need light to make food. The plants are eaten by many animals, and many of them find safe places to live among the plants. These plants protect the shore and reduce the muddiness of the water by slowing the waves.



Habitat Cards

9. Old lakebeds and other low areas that fill with rainwater sometimes accumulate layers of partially decayed plants called peat. At first glance these places might look dry, but their moss-covered floors actually hold a good deal of fresh water just below the surface. The ground here feels very spongy. Some shrubs and evergreen trees also grow above the sphagnum moss. In these unusual conditions, many unique, beautiful, and rare plants and animals can be found.



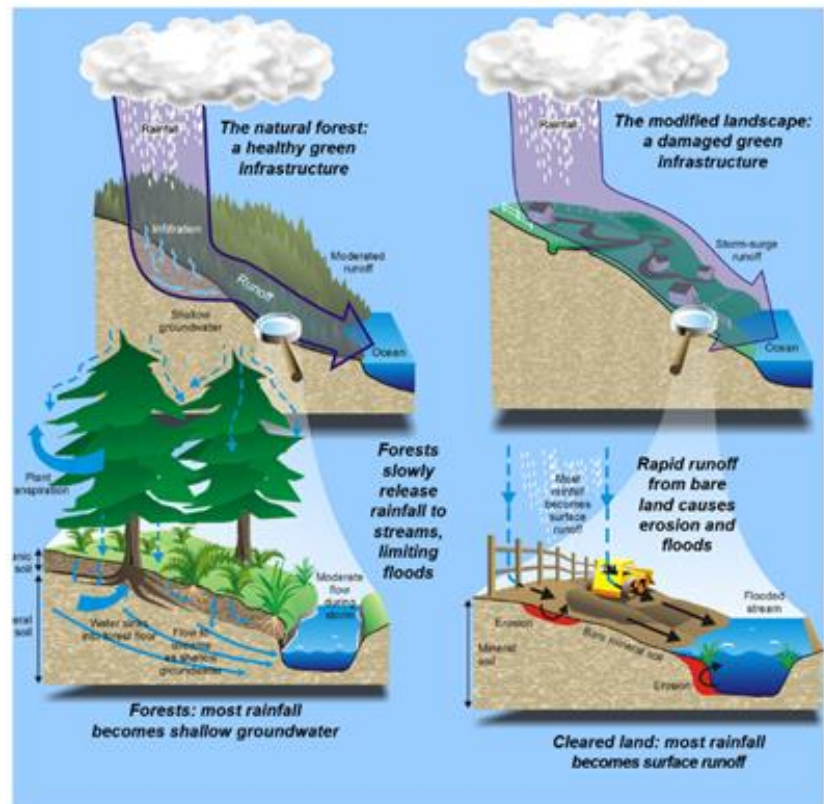
10. Along the shore where the water is salty, tall grasses grow up out of the water. Tides move in and out, but some places are flooded only during storms and very high tides. When the tough plants here die, they break down in the water to form little particles called detritus. Many animals eat detritus by filtering it out of the water.



DAY 2 SUPPORTING SLIDES

Disruption of an Ecosystem

A wetland in its natural state is great at filtering runoff before the water reaches main bodies of water as well as absorbing excess flow. Once a wetland is disrupted, it can no longer do its job, thus leading to an increase in runoff, such as phosphates, and an increase in erosion, causing heavy rainfall to cause flooding in the adjacent vacinities.



Major Causes of Wetland Loss and Degradation

Human Actions

- Drainage
- Dredging and stream channelization
- Deposition of fill material
- Diking and damming
- Tilling for crop production
- Levees
- Logging
- Sand mining
- Construction
- Runoff
- Air and water pollutants
- Changing nutrient levels
- Releasing toxic chemicals
- Introducing non-native species
- Grazing by domestic animals

Natural Threats

- Erosion
- Subsidence
- Sea level rise
- Droughts
- Hurricanes and other storms

<https://www.mass.gov/service-details/massachusetts-wetlands>

Today, we will be using our models to demonstrate some of these disruptions:

- Construction
- Flooding
- Erosion
- Vegetation loss

Day 2 Scenario Statements

Scenario one: Construction Disruption

Name: _____

Scenario 1 Construction Disruption

Materials:

1. Stopwatch (a phone will be sufficient)
2. Wetland model
3. Scientific journals
4. 500 mL of water
5. Beaker (100mL)
6. Four 6 cm by 6 cm pieces of plastic

A construction company begins building a neighborhood on top of your wetland. A 6cm by 6cm piece of plastic will represent the absorption capabilities of concrete. A total of 4 pieces of plastic will be added to your wetland model as such:

First House:



Second House:



Third House:



Fourth House:



Instructions:

1. Measure 100mL of water in the 100mL beaker
2. With the stopwatch ready, pour the 100 mL of water into the far end of the model and start the stopwatch.
3. Observe the path of the water. Take note of the water traveling down. When you see the water you poured begin exiting the nozzle, stop the stopwatch.
4. Record the time in the table below.
5. Remove the moss at the back of the model and place a 6x6 sheet of plastic in the spot

Name: _____

6. Measure 100mL of water in the 100mL beaker
7. With the stopwatch ready, pour the 100 mL of water over the piece of plastic and start the stopwatch.
8. Observe the path of the water. Take note of the water traveling down. When you see the water you poured begin exiting the nozzle, stop the stopwatch.
9. Record the time in the table below
10. Remove the excess water from the model.
11. Add another piece of plastic directly in front of the first house, removing moss where the plastic will sit.
12. Repeat steps 1-7 until 4 houses have been completed.
13. After data on all 4 houses has been collected, discuss with your group different ways that the impact on the wetland could be reduced as well as how to restore the wetland's full capabilities

Effect of Construction on Wetland Water Flow

Number of Houses	Time for Water to Exit (seconds)
0 (control)	
1	
2	
3	
4	

Homework/ extra time:

Measure the surface area of your model. You can use a rough estimation of a rectangle.
Measure the length of the model in centimeters. Measure the Width of the model. Now multiply the width times the length to get the surface area of the model.

Each housing site was represented by a 6cm by 6cm piece of plastic. The total surface area of the plastic is 36cm^2 . So, one house will take away 36cm^2 of surface area of the wetland, 2 houses take away 72cm^2 and so forth.

Calculate the percentage loss of land per house.

For example: 1 house = 36cm^2 total surface area of model = 176cm^2

Percent available = $\frac{\text{total surface area of model} - \text{house surface area}}{\text{Total surface area of model}} \times 100$

Scenario two and Scenario three

Scenario 2: Flooding

A Flash flood has affected your wetland.

Pour 300 mL of water over your wetland at once. Observe the absorption rate of water.

- Where does the water go?
- Does it spill over the edges of the model?
- In a real world flood over a wetland, how would a wetland be affected?
- Discuss with your group the different possibilities. How could you help restore the wetland after the flood?

Scenario 3: Mining in the Wetland

A mining company has dug a large hole at the nozzle of your wetland. A large hole will be placed toward the opening mouth of the wetland model.

Pour 100mL of water onto the model and observe the water path.

Dig out a large hole near the mouth of the wetland model.

Pour 100mL of water onto the model and observe the water path.

- Describe the waters interaction with the hole. (is more sand taken away with the water?)
- Can you think of other scenarios that cause erosion to an ecosystem?
- What are some preventative things that can be done to minimize the erosion in an ecosystem?
- Could the wetland be fully restored with the mine still there?

1

Scenario four

Scenario 4

High traffic foot-path in the wetland has caused partial loss of vegetation. Students will be performing a filtration lab.

In the immediate groups, 2-3 people per model. One group will get the model with the moss.

The other participants of the group will get the model without the moss or vegetation.

You are now ready to perform the experiment!

Experiment:

1. In a graduated cylinder, measure 100mL of water
2. Pour water into beaker
3. Gather about 2 tablespoons of dirt
4. Pour dirt into the same beaker as the water
5. Stir the dirt and water so that the dirt dissolves in the water
 - a. Annotate in journal the appearance of the dirt and water solution.
6. Pour the water and dirt solution onto the gravel at the back of the model 1 (away from the nozzle).
 - a. Observe the path of water. Did it go straight through the gravel and sink through the sand? Did the water go to the outskirts of the bottles edges?
7. Repeat step 1 through step 6 until water begins to pour out the mouth of the bottle.
8. Annotate the color of the liquid.
9. Compare the sample from before it entered the model to the sample post model.
 - a. What visual differences do you see?

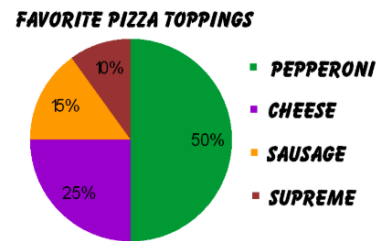
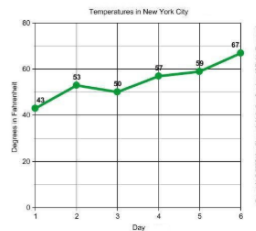
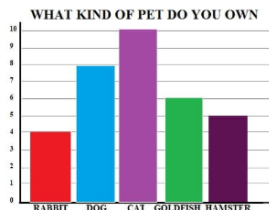
Once both groups are finished, compare the clarity of samples of the final liquid post model.

Discuss clarity and color. Discuss why you see a difference between the model samples.

Day three Supporting Slides

What is a graph?

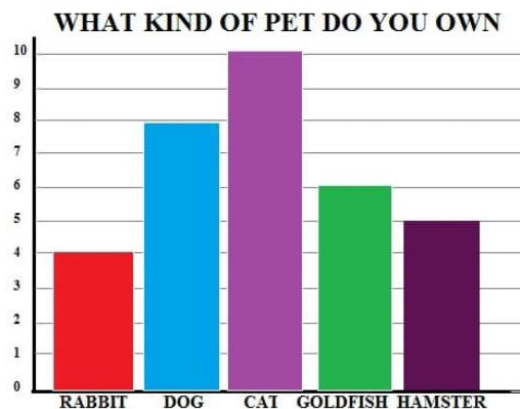
A graph is a diagram that represents a connection between two or more things by a number of distinctive dots, lines, bars, etc.



What are the important parts of a graph?

A title to briefly describe your data

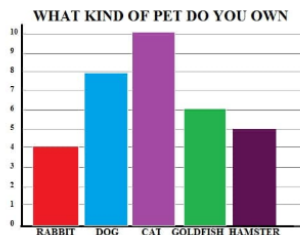
The Y axis: Where the dependent variable is shown



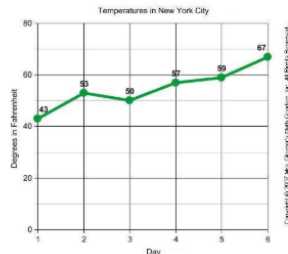
The data: Where the two variables are put together

The X axis: Where the independent variable is shown

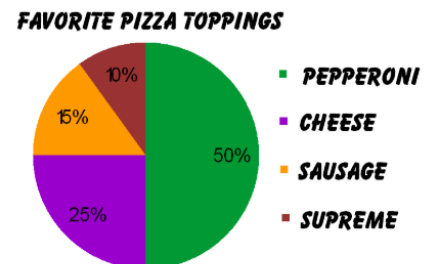
What types of graphs are there?



Bar graphs are good at measuring data where two sets aren't connected



Line graphs are good at measuring data where the two sets are connected

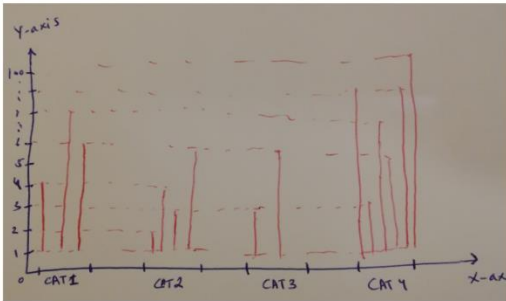


Pie graphs are good at measuring data that is in percents

Tips on making a graph

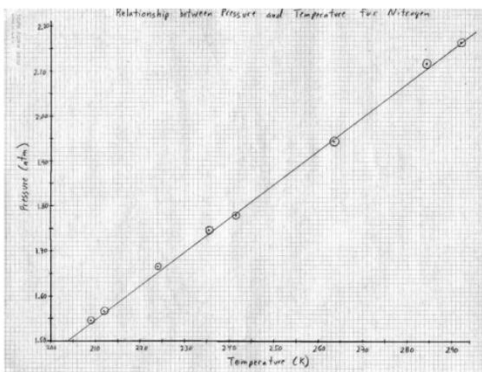
1. Title your graph. Ensure the title appropriately displays what information you want to depict.
2. Label your x and y axis. The x-axis should be your independent variable. The y-axis is your dependent variable.
3. Pick an appropriate range of numbers for your axis.
4. Have even spaces between your numbers. (using graph paper would be beneficial for this). If no graph paper is available, a ruler will be valuable.

A poor example of a graph



- There is no title
- The axes are not appropriately labeled
- The numbers are not spaced evenly
- The lines are not straight

An example of a well made graph



- Appropriate title
- Both axes are labeled
- Even spacing between numbers
- Ruler used to connect points

What is this graph showing?

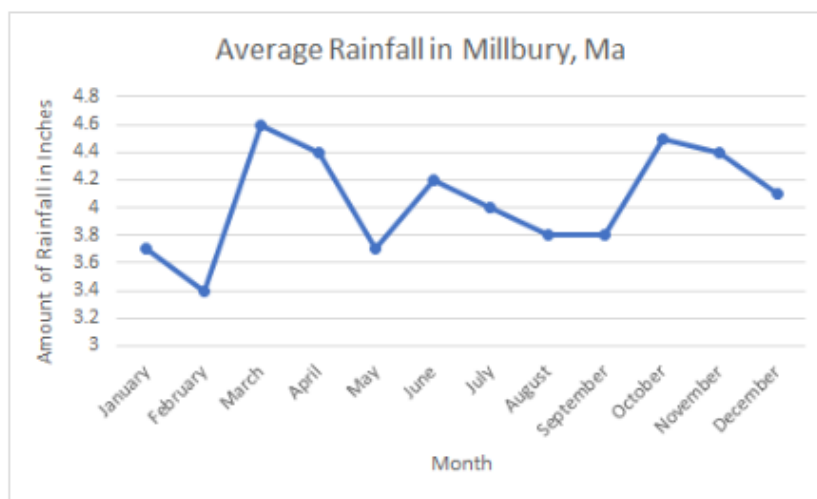
Day three Activity

Day 3 Activity

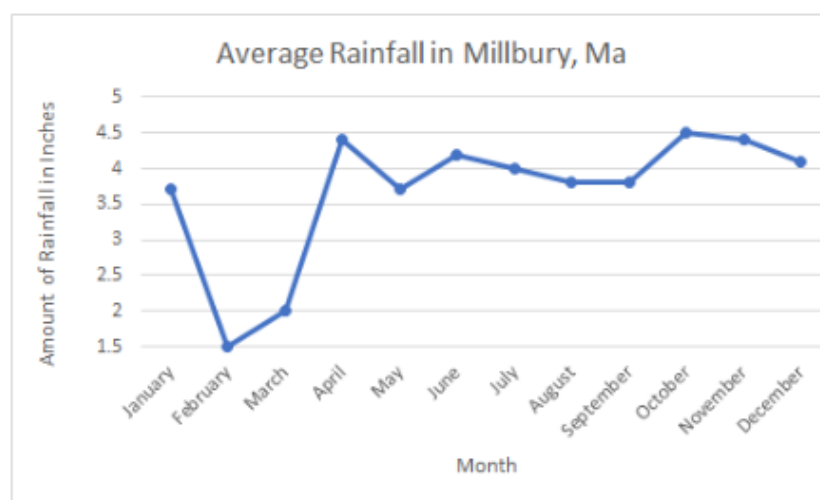
Instructions: Select the graph that best matches the paragraph

1. March is the wettest month in Millbury with 4.6 inches of rain, and the driest month is February with 3.4 inches. The wettest season is Summer with 26% of yearly precipitation and 23% occurs in Spring, which is the driest season. The annual rainfall of 48.6 inches in Millbury means that it is wetter than most places in Massachusetts.

A)

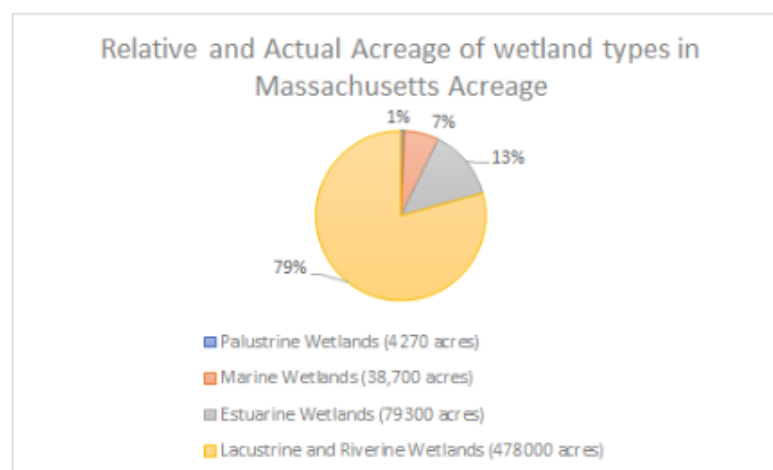


B)

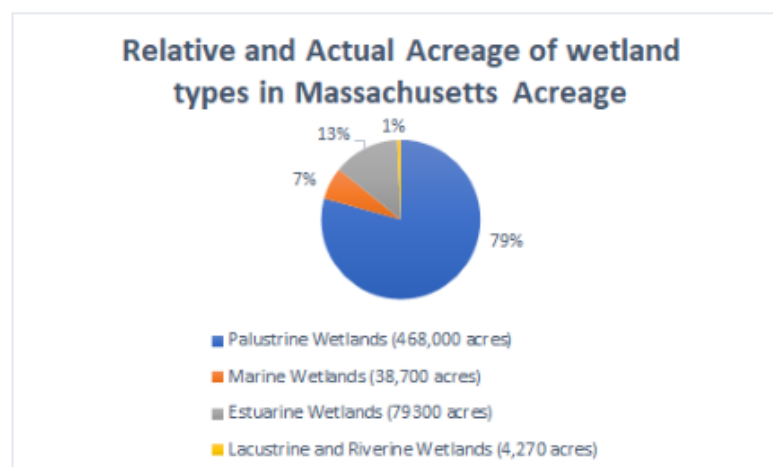


2. Palustrine wetlands are the most common wetland type in Massachusetts, followed by estuarine and marine wetlands ; all together, they constitute about 99 percent, by area, of the State's wetlands. The combined area of lacustrine and riverine wetlands makes up the remaining less than 1 percent of wetland acreage.

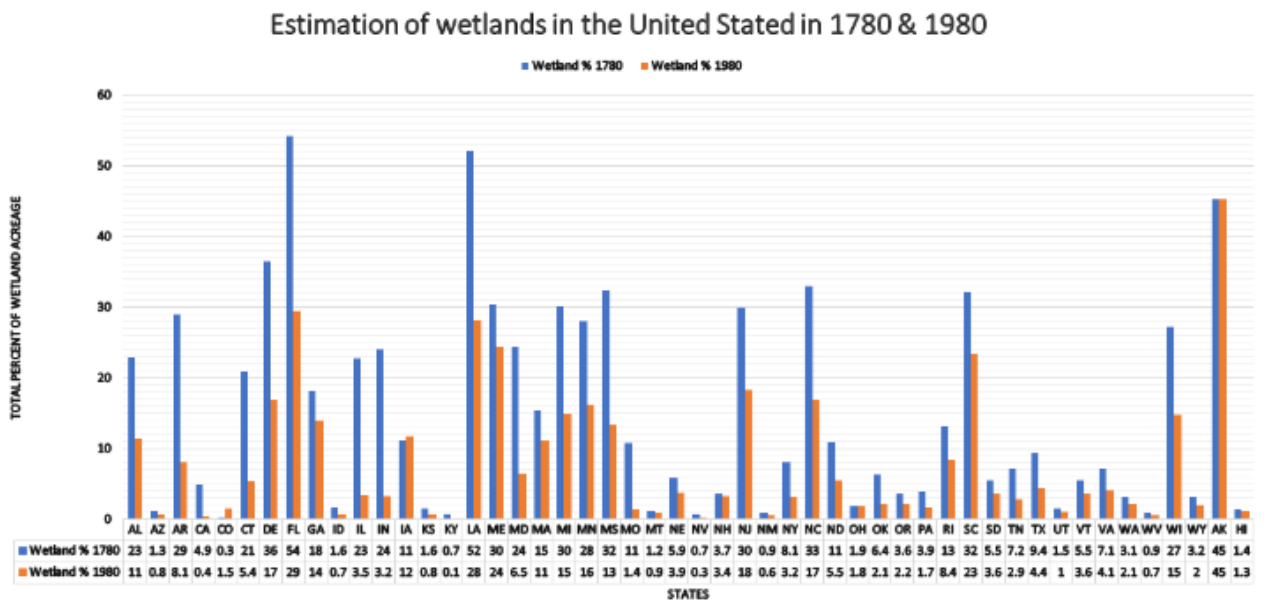
A)



B)



3. From the graph below: A rough estimation of wetland acreage per state was collected in a 200 year span, from 1780 and then again in 1980. In the 1980's wetlands constitute only 5 percent of the land surface in the lower 48 states: 12 percent of Alaska and Hawaii are included. The State of Alaska has the vast majority of wetland acres. An estimated 170 million acres are believed to exist in Alaska alone. This represents approximately 45 percent of the State's total surface area. Among the lower 48 States, Florida, Louisiana, Minnesota, and Texas are the 4 States with the greatest wetland acreage. Other states with considerable wetlands include Alabama, Georgia, Maine, Michigan, Mississippi, North Carolina, South Carolina, and Wisconsin.



Rank Florida, Arizona, Alaska, and California in order from Greatest loss of wetland acreage to least loss of wetland acreage between 1780 and 1980.

For Example: Between Georgia and South Carolina: 1. SC 2. GA

1. _____ 2. _____ 3. _____

4. _____

List of State Abbreviations

Alabama - AL	Montana - MT
Alaska - AK	Nebraska - NE
Arizona - AZ	Nevada - NV
Arkansas - AR	New Hampshire - NH
California - CA	New Jersey - NJ
Colorado - CO	New Mexico - NM
Connecticut - CT	New York - NY
Delaware - DE	North Carolina - NC
Florida - FL	North Dakota - ND
Georgia - GA	Ohio - OH
Hawaii - HI	Oklahoma - OK
Idaho - ID	Oregon - OR
Illinois - IL	Pennsylvania - PA
Indiana - IN	Rhode Island - RI
Iowa - IA	South Carolina - SC
Kansas - KS	South Dakota - SD
Kentucky - KY	Tennessee - TN
Louisiana - LA	Texas - TX
Maine - ME	Utah - UT
Maryland - MD	Vermont - VT
Massachusetts - MA	Virginia - VA
Michigan - MI	Washington - WA
Minnesota - MN	West Virginia - WV
Mississippi - MS	Wisconsin - WI
Missouri - MO	Wyoming - WY

www.timvandevall.com | States and Abbreviations List created by Tim van de Vall
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Day three Activity sheet Answer Key

1. A 2. B 3. Florida, California, Arizona, Alaska

Day Four Supporting Slides

What should you have on your poster?

- A title
- Pictures of your model with captions that describe the picture
- Graphs of your data with conclusions from the data
- A solution that can be backed up by the data that you took

Rubric for Final Project

	4	3	2	1
Information	Student data was clearly demonstrated with graphs and pictures. These visuals have captions that clearly describe the data	Student data was demonstrated with graphs and pictures. These visuals have captions that describe the data	Student data was partially demonstrated with pictures or graphs. These visuals are partially described	There was no data on the poster
Solution	Student solutions demonstrate a full understanding of the concepts	Student solutions demonstrate an partial understanding of the concepts	Student solutions do not demonstrate an understanding of the concepts	Students did not have a solution
Teamwork	Students were able to work together and provide equal amounts of work and discussion to the project.	Most students were able to work together and provide equal amounts of work and discussion to the project	Some students were able to work together and provide equal <u>ammounts</u> of work and discussion to the project	Students did not work together
Respect	Students were attentive during other presentations and gave <u>conructive feedback afterwords</u>	Students were attentive during other presentations	Students were mostly attentive during other presentations	Students were not attentive during other presentations

DAY BY DAY BREAKDOWN: TEACHER GUIDELINES

Disruptions of a Wetland Day to Day Schedule

Day1: building of the model

- Open the presentation slides (about 10-15 minutes)
 - What is a wetland
 - How a wetland works
 - The importance of a wetland
- Open the density activity sheet. Students will use this as a model for the scientific notebooks
- Open the Day 1 Model build, students will use these instructions to build the model and calculate the mass of each material

Day2: disruptions of the model

- Open the Day 2 Presentation slides (about 5-7 minutes)
 - Before going to slide 3, ask the class if they can name some type of a disruption to a wetland (open ended)
- Slide 4 introduces what they will be doing today
- There are documents for each different scenario

Day3: graphing data from the disruptions

- Open the Day 3 presentation slides
 - In scientific notebooks, graph the data from day 2
- Open the day 3 activity sheet, an answer key is provided in the folder

Day4: making of the posters

Day 5: presentation day!

Real world articles containing consequences for violating wetland code.

310 CMR 10.00: Wetlands Protection Act Regulations is a 246-page document defining the regulations in protecting Massachusetts ecosystems. If these regulations are violated by a company or group, then a large sum of money, also known as a fine is penalized to the company or group.

Millbury, Massachusetts Climate x Company penalized \$8K for Wetl x +

← → ↻

millburysutton.com/article/20150108/NEWS/301089434?template=ampart

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Company penalized \$8K for Wetland Violations impacting Millbury

Posted Jan 8, 2015 at 12:01 AM

The Massachusetts Department of Environmental Protection has assessed an \$8,000 penalty on Arboretum Village, LLC of Holden to address damage caused by violations of the Wetlands Protection Act that occurred at Arboretum Village Estates, a subdivision off Sarah Drive in Worcester.

MassDEP inspected the site in June 2013 and observed the discharge of silt-laden runoff to wetland resource areas and the Blackstone River in Millbury due to inadequate erosion and sedimentation controls at a portion of the subdivision that was under construction.

MassDEP ordered the owner to stop the discharge of silt and sediment, install erosion control measures to stabilize soils and retain a wetland specialist to prepare a comprehensive erosion and sedimentation plan, a slope stabilization plan and a wetland restoration plan, if needed.

That order was later appealed by the owner.

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