3rd Grade Engineering and Technology Curriculum

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Abstract

The National Science Foundation (NSF) provided Worcester Polytechnic Institute with a three year grant to assist in the teaching of engineering and technology into the elementary curriculum. IQP students worked in both the Midland Street and Flagg Street Schools. Between the schools there were a total of five classrooms with two IQP students working within each school. Each school and set of IQP students were overseen by a graduate fellow, and the entire third grade team was supervised by a faculty advisor.

Through the tools of questioning, group work, and hands-on learning engineering lessons were designed to be implemented into the classrooms. Over the course of the project year seventeen engineering lessons were created. Of these seventeen lessons ten were implemented, five at Flagg Street School and five at Midland Street School. The main focus of the lessons was to incorporate the five Worcester Public School engineering and technology benchmarks. These benchmarks cover the material students will be tested on in future Massachusetts Comprehensive Assessment System testing. The lessons implemented in both schools covered four out of the five engineering and technology benchmarks. Another goal of this project was to raise the interest and enthusiasm of minorities and females in engineering and technology.

The success of this project was measured by the enthusiasm displayed by both the students and the teachers. This project will be concluded in the next and final year of the grant through an adaptation/sustainability team. This will proved teachers with the knowledge of engineering to continue this program beyond the life of the NSF grant.

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Chapter I: Advancement in Education

Introduction:

Engineering is defined as "the application of scientific and mathematical principles to practical ends such as the design, manufacture, and operation of efficient and economical structures, machines, processes, and systems" (American Heritage Dictionary). Engineering has grown due to the steps society has made in the areas of science and math in order to better society itself. Without engineering, academia and the real world wouldn't be able to support each other. When a new theory is developed in the academic world, engineers receive the task of implementing it into the real world. An amazing idea, such as quantum mechanics, is useless if all that it is used for is theorizing about the atom. If there are flaws in the theory, engineers are the ones who report back to academics about what works, and what does not. Without engineering linking theoretical and practical applications, much of the technology we take for granted today would not be around.

The goal of the Partnerships Implementing Engineering Education (PIEE) project is to develop engineering lessons for grade school students. The foundation of the PIEE project is based on the requirements of the Massachusetts Science and Technology/Engineering Curriculum (MSTECF) that was established to meet the requirements of the Massachusetts Comprehensive Assessment System (MCAS). Starting out children at a young age with engineering will provide continuity and allow future engineers to develop new methods and ideas. This project is also targeted towards the motivation of underrepresented groups in the fields of engineering where they continue to be outnumbered.

The objectives of the PIEE project were laid out in a grant provided by the National Science Foundation (NSF). The grant duration of the NSF grant is three years and is designed to jump start the engineering programs in the Worcester Public Schools (WPS). The first year of the project is oriented towards initiating the project in grades four through six in some of the Worcester Public Schools. The initiation teams develop lessons for engineering, work with the teachers to implement the lessons and evaluate the impact of the lessons. In the second year of the project, there will be initiation teams for second and third grade, and adaptation teams for grades four through six. Adaptation teams work with the curriculum developed by the initiation teams to refine the lessons for future implementation. The third year of the grant has initiation teams for kindergarten and grade one. Also, there will be adaptation teams for second and third grade as well as sustainability teams for grades four through six. Sustainability teams spread the curriculum developed over the first two years of the project to new schools in Worcester. After the funding from the grant runs out, sustainability will be maintained by Worcester Polytechnic Institute (WPI) Interactive Qualifying Project (IQP) teams and the teachers of the Worcester Public School and the Massachusetts Academy.

The remainder of this paper will consist of a discussion of the background research done by the IQP students, the methodology used by the IQP team, and the results of implemented lessons. The background literature is composed of a review of brainstorming and questioning, group work, and learning styles. The methodology discusses team structure, meetings, lessons writing, and implementation. The results and discussion in chapter 4 explains the benchmarks covered through our lessons, the effectiveness of lessons, and suggestions for improvement.

Chapter II: Integrative Fundamentals and Hands On

2 Introduction:

2.1 Brainstorming in the Classroom

Asking questions and brainstorming are two effective classroom techniques that can be used to teach young children. They are effective as teaching implements as well as evaluation methods. These two techniques require a lot of classroom participation and participation is essential to good learning. Participation requires a great deal of communication. It is important to remember that communication is not just the transfer of ideas from the teachers to the students, but also from students to the teacher. This is especially important when examining how well the students understand concepts.

The goal of brainstorming and questioning is to help the students acquire knowledge and understanding. The difference between knowledge and understanding is quite significant. Knowledge is something that can be regurgitated from memory. Understanding is the ability to use this knowledge (Newton, 4). Knowledge and understanding are both developed differently by children. Children learn through connections with the world around them (Kitson and Merry, 9) so that their knowledge builds upon what they already know (Science for All, 22;Gipps, McCallum, and Hargreaves, 133). By combining knowledge with experience, children are able to develop understanding (Science for All, 26; Dean, 53-55). Written tests are often a good indicator of knowledge but do not always show the level of attained understanding (Newton, 4; Science for All, 100). Knowledge is the first step but understanding is the ultimate goal.

Brainstorming and questioning not only help to improve understanding but also evaluate it. Before brainstorming can be used effectively in the classroom there must be ample amounts of background information given on the topic being brainstormed. This information usually comes in the form of lessons. In order to be effective, the students must understand the lesson.

Starting with simple language will build a foundation for their knowledge. During the lesson, careful thought must be put into each explanation. Using complicated words that the students may not be able to fully grasp will not lead them to a good definition of a new concept. Using simple language does not mean that technical terms should be excluded. Technical terms should be explained in language that the children will understand so that they can learn to use the terminology correctly (Bearne, 90). Along with a clear definition, it is necessary to use the terms in proper context (Science for All, 70). Hearing the words in context will lead the students to an understanding of the words and they will be able to do more than just regurgitate a memorized definition. One good structure for teaching something new is to give a definition or rule, show or state an example that makes use of it, and finally restate what was taught (Brown and Wragg, Explaining, 26). Later discussion and activities will build this new knowledge and emerging understanding into a more complex understanding.

It has been shown that when children are allowed to discuss difficult topics amongst themselves, they are able to better formulate their understanding and develop their language and problem solving skills (Gallas, 76; Gipps, Hargreaves, and McCullum, 124; Farrell, 82; Bearne, 79; Science for All, 69). Communication amongst themselves is easier because the students are on the same language and reasoning level (Gipps, Hargreaves, and McCallum, 48, 55, 115). Brainstorming is a great example of an activity that utilizes student discussions. While it is important for the teacher to be an active participant in student brainstorming he or she must not lead the discussions. Brainstorming is a group effort by the children and it is very important to emphasize this. If the teacher becomes too involved in leading the discussion the session could become less productive. Too much leading by the teacher lends the sense that there is a right and wrong answer and a fear of giving a wrong answer hinders participation (Clark 52; Whitebread, 83; Farrell, 83).

It is very important that everyone in the class understands that there is no right or wrong answer in brainstorming. Criticism by other students can be just as detrimental to participation as criticism from the teacher. Just because an idea may not work after being evaluated does not mean that it was not an important idea. Perhaps a seemingly poor idea can be altered or built upon until it becomes a better idea (Clark, 54). The same idea could even trigger another student to have a completely different thought. It is especially important for students not to tear down each other's contributions because it will decrease confidence making the student less likely to offer an idea the next time. Group work should be in an environment where everyone knows that it is all right to make mistakes, and therefore it is good to take risks and try (Gipps, Hargreaves, and McCullum, 43, 149).

That won't work That is stupid The teacher won't like that My idea is better He/She is smarter so… It is too much work You don't know what you're talking about We don't know enough That's not cool enough

Figure 1: Killer Phrases

Charles Clark suggests a list of “killer phrases” to avoid during brainstorming (91-92). Many of these phrases are applicable to corporate society but not the classroom. The figure to the right, shows a list that I created aimed towards children.

Just as one student should not be pointed out for having a less than perfect suggestion, students should not be over praised individually for a good idea. Brainstorming is a group collaboration and new ideas should be considered as group accomplishments (Clark, 59; Whitebread, 83). Students should be encouraged to not stop at a good idea, but rather take that idea and discuss it further to see if it can be made even better. This will reinforce the idea of group accomplishment because everyone will have had a chance to contribute.

As was mentioned before, brainstorming should not be led by the teacher but rather be a spontaneous activity led by the students. However, “the secret to spontaneity, of course, is good planning” (Clark, 71). Before asking students to brainstorm a topic, it is important to be sure that they have enough background information to work with. It is also crucial that they understand their goal. A good way to ensure this is to propose a question or problem for them to work on. The question or problem should not be too vague or broad otherwise each child will be working on a slightly different problem (Clark, 71). Likewise, the problem should be challenging but not impossible (Dean, 60). Before breaking up into individual groups, discuss as a class what the problem is asking (Clark, 72). As each child explains it in his or her own words it will be possible to tell if everyone is on the same track. Having the children explain in their own words will also help them to confirm their understanding (Newton, 6). If it becomes clear that the first question was not well defined, the feedback given by the students should be used to narrow and redefine the problem.

Brainstorming is not inherently easy. It is tempting to give up when there are periods of silence. Instead, offer something to initiate the thought process (Clark 98). Perhaps the students need to be reminded of something they already know in order to reach the solution on their own. Remember that they have the knowledge but not necessarily the understanding. While problem solving activities are a good way to evaluate understanding they do not always increase understanding on their own (Newton 6). By pointing out what information they need to apply, they may be able to progress from knowledge to understanding (Whitebread, 149). It is important that they make that progression to understanding on their own (Kitson and Roger, 18) because they are more likely to remember ideas and concepts that they discovered themselves (Dean, 60).

Another good way to trigger thinking is to have materials available that they can work with (Clark, 84). Discussion alone may not be appropriate for some children. Being able to use their hands to do something or look at something to see how it works may aid them in their understanding.

Discussion after an activity such as brainstorming is often a good idea for multiple reasons. Verbalizing will help the students to reinforce what they know (Bearne, 76, 130; Dean, 168). Discussion will also allow each group to convey their ideas to one another. These discussions allow the teacher the opportunity for informal assessment to see how well the students can communicate the understanding they gained by experience (Shapiro, 35; Science for All, 107-108; Gipps, Hargreaves, and McCullum 63).

2.1.1 Effective Use of Questions

Another common way to evaluate understanding is to ask the students questions. Questions can come in many formats and types. Students could answer questions on a worksheet or a test. Consider questions in classroom discussion and how they can be productive by testing learning and sparking thought (Dean, 65; Gipps, Hargreaves, and McCullum, 61, 73).

There are the six basic question words: who, what, where, when, why, and how (Brown and Wragg, Explaining, 15). Through answering all of these questions, a complete picture of a concept can be drawn. The who, what, where, and when ask for factual feedback (Bearne, 75). Why and how ask for thought (Dean, 65) and rely more on understanding.

Questions, however, can be used for more than evaluation. A lesson could begin with a question. Asking a question that the students do not know the answer to will peak their interest. This kind of question is called a “tease” (Brown and Wragg, Explaining, 9). The tease can be used to motivate the children to want to learn (Brown and Wragg, Explaining, 24). One technique of using a tease would be to get the class’s attention and then discuss pertinent information that perhaps the students would not otherwise find interesting. As the lesson is being taught, the children will be trying to figure out how to answer the original question. Of course, the tease must be returned to at the end to tie up the lesson.

Questions can also be used at the beginning of a lesson to determine how much prior knowledge the students have (Gipps, Hargreaves, and McCullum, 73). These questions should not be in depth or complicated. They are merely looking for known facts. Such questions are considered narrow or closed and are not meant to provoke discussion (Brown and Wragg, Questioning, 20; Whitebread, 71). Perhaps the teacher knows that the students already have background information from a previous lesson. Asking about the previous lessons will remind the students of what they already know (Whitebread, 149; Gipps, Hargreaves, and McCullum, 73). This kind of question is a recall question (Brown and Wragg, Questioning, 21). Recall questions are not always closed questions because they may ask students for reasoning or examples to which there is more than one correct answer. These questions that require thought are called open-ended (Dean, 66; Gipps, Hargreaves, and McCullum, 61) and the thought process that they promote aids learning (Whitebread, 70-71).

It is important to consider the types of question that can be asked. Different types of question look for different types of information and can be broken down by what type of information they ask for. A conceptual question asks for definitions and reasons. An empirical question asks for facts. An empirical question will almost always be a closed question. The last type of question is a value question. These cover worth, merit, or morals (Brown and Wragg, Questioning, 16-17). Including all types of questions in a lesson will lend a sense of completeness.

Consider how these three types of questions could be used in an engineering lesson. The conceptual question would ask what something is and how and why it worked. Remember that how and why questions require thought and often evaluate understanding (Brown and Wragg, Questioning, 17; Dean, 65). The empirical question would ask for specifics such as what type of materials are required. The value question might examine how that aspect of engineering impacts society both positively and negatively.

2.1.2 Correcting Misconceptions

Questions must be used properly to be effective. They should neither confuse the students nor be too easy for them (Brown and Wragg, Questioning 29). If the questions are too easy the students will become uninterested and if they are too difficult they will become frustrated. Both instances can cause the students to dislike the material being taught. The response to a question is also very important. It is important for the children to know that it is all right for them to get the answer wrong (Gipps, Hargreave, and McCullum, 149). The feedback should be positive but constructive when necessary (Dean, 62). A wrong answer should never be treated harshly. On the other hand, it is ineffective to tell every child that he or she had a great answer if the answer was not perhaps entirely correct (Brown and Wragg, Questioning 34). Praise becomes meaningless if over used and will inhibit improvement (Whitebread, 224; Gipps, Hargreaves, and McCullum, 119). Praise answers that are correct and explain why they are correct, but then help students who got the wrong answer so that they too will understand and not be afraid to participate (Dean, 67; Gipps, Hargreaves, and McCullum, 107).

A lot can be done to help a student who gives an answer that is not entirely correct. While it is temping to ask another student for the sake of time it is better to work with the original student to help them reach a better answer. There are two techniques that can be used. The first is prompting. Prompting rephrases the question or breaks it down into smaller, easier parts that lead back to the original question. Prompting can also be reminders of past information that the child may not have thought to apply to the current question (Brown and Wragg, Questioning, 33). The second technique is probing. Probing tries to narrow down the question (Brown and Wragg, Questioning, 33). Perhaps the original question was too broad for the answer being searched for.

These techniques can also be used when none of the students can come up with an answer. It is important to not get discouraged by short spans of silence after a question. Always give the students a big enough pause to think before answering (Brown and Wragg, Questioning; Dean, 66; Whitebread, 73; Kitson and Roger, 151). These techniques may be more time consuming yet it is much more effective to have the students involved and working toward the answer rather than just answering it for them on your own (Brown and Wragg, Questioning, 56; Dean, 60).

Another important thing to consider is that a wrong answer is not always an indication of a lack of knowledge. The teacher should take the time to try and discover where a wrong answer came from so that it can be corrected (Dean, 68; Gipps, Hargreaves, and McCullum, 87; Kitson and Roger, 11; Science for All, 110). A student may have a good understanding of a concept but may not have the ability, perhaps because of vocabulary, to get their point across (Gallas 47; Kitson and Merry, 12). Sometimes the students have misconceptions that cause them to get an incorrect answer (Science for All, 27). The only way to tell if this is the case is to listen to the child carefully. By listening to the children carefully we can better learn how to teach them (Shapiro, 36).

It is often very common for the teacher to do all of the questioning but it is equally important that the students get the opportunity to ask their own questions (Gallas, 77). Questions and discussion from the students will often point out difficulties in understanding the material that may have otherwise gone unnoticed (Shapiro, 34). While it may be unreasonable to expect that there is enough time during classroom discussion for each student to ask all of their questions, students should still be given the opportunity to ask them. Using a journal can help utilize time more efficiently. Each child could keep a journal of what they learned and what questions they still have (Gallas, 79; Science for All, 110). The teacher can then look at the journals and determine what the class understood well and what was still a bit unclear. Any uncertainties could then be clarified in a conclusion lesson.

2.1.3 Implementation

Brainstorming and questioning are easy to incorporate into classrooms and the teachers were doing so before the engineering lessons began in their classrooms. Lessons were never taught with the teacher just standing at the blackboard. Instead, brainstorming and questioning were used to engage the students in the lessons.

Often a lesson would take multiple days to finish. Before continuing with a lesson, recall questions were used to get the class to think about what they learned the day before. As the lesson was continued, the students are asked to think about what they were learning through the use of conceptual questions. Students were allowed to ask questions as well. The most common question in the third grade classroom was why. In preparing lessons it was necessary to anticipate the why questions and be prepared with a clear response. If the response was not clear enough, it would just trigger more why questions.

Brainstorming in the classroom was often used without being called as such. Most group activities required that the students work together to answer a set of questions that guided them in solving a problem. One of the main ideas taught was the engineering design process. The process led the students through brainstorming without ever having to explain what brainstorming was. Having the students work through the engineering design process together also allowed them to work at their own level and get a better grasp on difficult concepts.

Part of grasping difficult topics was being able to use vocabulary in context. Students needed a good background though before they could use words in context amongst themselves. New vocabulary and ideas were introduced in simple language. The engineering design processes is again a perfect example. The engineering design process used by professionals is presented in a more complicated way than what was used in the classroom. By presenting the idea in simpler language they were able to understand it better. The activities done in the classroom required that the process be used in context. After using the design process a few times they understood its purpose and were able to recite it with no problem.

While the students always learned a lot from the lessons it was necessary to wrap the lesson up. This was done best with discussion. The wrap up discussions allowed the teacher to ask questions that would allow them to judge how much had been learned. In some cases the discussions were led by the students and they were allowed to demonstrate what they had learned. This proved to be very effective as the students were eager to show how much they had learned.

2.1.4 Evaluation

While the background research done on questioning and brainstorming was not referenced every time a lesson was written, it was incorporated into lessons. Having the background knowledge and then seeing it applied in the classrooms during the observation stage of the project allowed the concepts to be integrated into the lessons with very little effort.

The ease with which the concepts of brainstorming and questioning were incorporated into the paper probably came in part from their necessity. Teachers must ask questions to test knowledge and peak interest. At the same time, students always have questions. It was hardly ever necessary to prompt questions as the students always had them. Instead it was necessary to prepare for the types of questions they might have. At the same time, children want to interact with each other. Brainstorming allowed them to do so in a constructive way.

While the ideas of section 2.1 did not need to be adhered to directly, they served as a good background for the PIEE project. Doing the research and then observing the behavior in the classroom made it possible for lessons to be written in such a way that they could be implemented in a practically.

2.2 Working In Groups

Group work in school, plays a crucial role in the social development of children. Through group work, children learn to communicate, work together, compromise and deal with conflict; skills that will be needed for the rest of their lives. Discussed below are answers to questions about *why children should learn in small groups*, *how they learn in small groups* and *how to evaluate how groups work together*. But first an explanation of a small group will be briefly discussed.

2.2.1 Defining a Small Group

A small group must consist of at least three persons. Two persons working together is defined as a dyad, where "one person speaks, the other listens and responds, and then the original speaker considers what is being said. No third individual witnesses the event or influences the interaction." (Fujishin, pg.3) This type of partnership does not allow for its members to fully discuss their ideas because no third party challenges the speaker to elaborate or compare the ideas of the first two persons. An optimum number for a group is usually between five and seven. This way the group is not too large so as to discourage an open forum of ideas between its members. With too many people in a group often select members are left out of the discussion for many reasons usually associated with being more timid or just not seeing participating on their part as necessary to further the meeting.

Working towards the same goal is an important albeit obvious requirement of a group. The task must prove to be worthy of attention by all members of the group or problems will arise. It is crucial for members of the group to feel like what they are working towards will be easier accomplished in a group or else the group might fall apart, thus the whole reason for the group will be lost.

Allowing non-verbal communication is an essential way for members of a group to understand the intent of the other members. This is even more important in a primary school atmosphere because it is very easy to discern from body language how a child is feeling about his/her group. At such a young age most elementary school students can not fully express themselves with words yet their peers can understand them if they are able to read the speakers body language.

The last component of a small group is that each member in the group must be able to influence everyone else in the group. However realizing that they are being influenced by each other is not necessary. Remember every remark, criticism, compliment and suggestion effects all members in the group. (Fujishin, pg. 4) (Gipps, pg. 55)

2.2.2 Reasons for Groups

Defining what a group is does not fully explain the importance of them. The reasons for why people form groups is to have a sense of being included in something. Also to have control meaning "provides individuals with the sense that they have some degree of personal influence and power over their environment." (Fujishin, pg.8) Lastly to be liked by someone else as well as to like another person. These three reasons are important to keep in mind when selecting groups because if someone does not feel included, not feel like they have any control or nobody likes them then the purpose for being in the group has not been reached. This is especially true in a primary school atmosphere and if this is the case then either the groups should be rearranged or adult intervention may be necessary. (Dean, pg. 98)

Children also can teach each other while working in groups. Usually children understand each other better than a teacher does just because children use a different set of vocabulary than their adult teachers. Children also tend to have a different way of explaining how things are done. While teachers may think they are explaining something so that the students can understand, sometimes having a student who understands explain it is better because they do not make any assumptions on what people know because they explain everything as easy as possible. (Gipps, pg. 55-56)

2.2.3 Behavior of Groups

All groups develop differently and from their first interactions to the conclusion of their partnership groups will experience many different stages in their development. A generalization of how groups develop over time can be explained in five stages. First the members of the group get to know each other. Then they work together to understand their problem. Next conflict usually arises when the members share their ideas on how to solve the problem. The conflict will end when the group comes to a compromise or some decision is reached as to how the group will solve their problem. Lastly the group will feel stronger and more united because they overcame their conflict to solve the problem. This last stage is called "reinforcement." (Fujishin, pg. 13)

The way in which a group chooses their solution also differs from group to group. There are five primary ways that a solution can be reached in a group during the before mentioned conflict stage. These ways consist of having a leader pick the solution, letting everyone vote and the majority wins, compromising and coming up with a new solution that takes a little bit of each answer and making it into a new one, letting a third party decide, or by everyone choosing maybe not their first choice but the solution that everyone can settle for, this is called a "consensus." (Fujishin, pg. 73-75) Each method has advantages and disadvantages and usually a group will try several of them until the group can agree. This is typically done automatically without discussion.

Problems within groups are usually caused by the very things that make them worth while, here are some that can arise. Once a solution has been reached by a group it is natural to think that your group has the best solution, but what must be stressed is that a group's answer may not always be the best and that they should be open to what other groups decided upon. This problem can also be found on the individual level when coming up with an answer in a group that each person thinks their way is the best way. The same precedent applies as before, each person must realize or be taught to listen to other ideas because they may actually be better. Another problem of group work is that a group will find an answer and believe that is it, but it should be stressed that many tasks have more than one way of being accomplished them and that groups should not limit themselves to only one solution. Another problem associated with groups is conflict, which is actually what makes group work so rewarding. Students must be taught that conflict is not only good but necessary to achieve the best results. (Fujishin, pg. 69-72) This will also provide a good atmosphere to learn to solve problems in a group. Solving problems in groups is something everyone has to deal with throughout their lives and school is as a great a place to learn how as any other.

2.2.4 Short Term Benefits for Students

There are studies that show that students make friends by performing activities together on a regular basis. One such study, *Children learning about friendship in the context of an English reception classroom,* (Avgitidou, pg. 263) was geared toward non-scholastic events but the same holds true in the classroom. Students of the primary school level were found to relate their friends to activities that they did together. For example one student might call another student his friend because when they go to recess they play together. On the other hand, one student might call another student his friend because during math time they work together. This simple relationship can easily be elaborated to include groups just by adding another student to the example. As mentioned in the beginning of this topic on groups, working in groups is an important way for children to develop socially and have fun at the same time. Activities that students associate with other students will ultimately be more productive because the students will enjoy what they are working on and learning at the same time because they are doing so with their friends. This is only possible though if groups are used as part of the lesson plan. (Avgitidou, pg. 263-268)

2.2.5 Short Term Benefits for Teachers

Monitoring or observing is an important part of understanding how children are working in groups. Because young students can get stuck or loose track of what they are trying to accomplish, teachers must know how to detect this and get the children back on task. By leaving kids on their own even when working in groups, students may very easily not get much done. However, having a teacher observing the progress of the group will enable the children to stay on task and be productive. (Wragg, pg. 37)

2.2.6 Evaluating Group Work

Studying groups for yourself is extremely important and being able to know what to look for in a group is critical. IPA, Interaction Process Analysis, is a widely accepted means for studying groups, first introduced by Robert Freed Bales in the 1950s. It works by breaking down everything into the most simple tasks possible. Verbal and non-verbal communications are both considered in this model. There are twelve categories and they are organized as follows.

Area	Positive	Negative
Socio-emotional	1. Shows solidarity	12. Shows antagonism
	2. Releases tension	11. Shows tension
	3. Agrees	10. Disagrees
Task	4. Gives suggestion	7. Asks for orientation
	5. Gives opinion	8. Asks for opinion
	6. Gives information	9. Asks for suggestion

Figure 2: IPA
(Hartley, pg.35)

These categories allow for almost any act within a group to show if it is positively affecting the group or negatively affecting the group. IPA has been used to determine some very important findings. First, larger groups are often controlled by an individual. Second, individual roles in the group usually go hand in hand with classify them as a category. Third, children's groups usually involve more negative socioemotional acts and different groups generally have different patterns. Lastly the pattern a group follows will usually change over time. (Hartley, pg. 36)

With these methods of classifying behaviors in groups it becomes easier to understand where the problems are in groups and where extra help is needed. By using this method for observing groups the observer should be able to assess rather easily if the group is following a negative or positive pattern and in the case of children direct them to more positive means of working.

There are indeed problems associated with this method. Intensity cannot be categorized with this model. Also different observers may not always come to the same conclusion on how a group is interacting because everything that occurs is a judgment call on whether to count it or not and what category it is. Remember, this is not a clear cut system and there are issues with categorizing group interaction but this method along with some others can provide the observer with a general understanding of how a group is working together.

2.2.7 Long Term Benefits of Groups

Working in groups in school is also very important to prepare students for their future. Many researchers believe that team work will be the primary method of working in the future, and that transition has already started. Self-directed teams, SDTs, are gaining popularity in the workplace where groups are in charge of a range of responsibilities which would usually be the job of a single manager. The group is responsible on the whole workload without having a designated leader at least not from outside of the group. (Hartley, pg. 178) SDTs would not be implemented in a primary school atmosphere although by getting students to learn to work with in groups at a young age it will better prepare them for how they will be expected to work when older.

2.2.8 Problems With Groups

How groups affect individuals is also an important aspect that must be observed and thought about. Studies have proven over and over that people in groups influence each other with very profound effects. One such study, the “autokinetic phenomenon,” (Hartley, pg. 72) deals with putting a group of people in a completely dark room with a single dot of light at the far end of the room. After a while the group members will believe that the light is actually moving when it really is not. They will also be able to gauge how far the light has moved. When asked how far the answers are usually very different as other perspectives will vary. But when the test is repeated with the same people the answers tend to become more and more similar as the group comes to a definitive answer as to how far the light actually moves. Even when the group is separated and the individuals are questioned again the answers tend to be the same as the others in the group even though there is no reward for having the same opinion. (Hartley, pg. 72-73) This is something very important to keep in mind when forming groups.

By allowing group work some members may not hold true to what they originally thought just to be in agreement with the rest of the group. This is especially true at younger more impressionable ages. At times it may be better some times to allow individuals to think for themselves instead of being influenced by a group. Although this very same phenomenon is also one thing that makes groups so great for younger people so that those who are really confused can learn from others, as long as they also have time to think of their own answer first. This allows for people to teach themselves in some situations and allows for work to get done faster which is a main reason for using groups in the first place.

2.2.9 Implementation

Using groups as a means of improving learning in the classroom was not difficult to implement. The teacher had the students already arranged in four person groups arranged in a square. In this way, students are always encouraged to use each other as sources of information.

With the introduction of engineering into the classroom, groups will be used throughout the lessons to make the most of the resources available. Lessons will be arranged so that groups work on a project together, gathering input from each student for one output as a group. In some instances that the material is particularly challenging a larger group may be used where the entire class, in the instance of this project sixteen students would compose the entire class. By forming one large group, students could incorporate their own ideas as well as hear other ideas from their classmates. While not particularly small, in a third grade atmosphere larger groups can at times be more beneficial.

Particular attention will be paid to make sure all students have input in their groups. This is important because if students are not contributing, they most likely are not learning. By encouraging students to add their ideas to every project they make that project their own. This shows the difference between cheating and working in groups, something that many students need to understand and learning it sooner than later is only a good thing.

2.2.10 Evaluation and Impact

By tailoring lesson plans to include mostly group exercises the students learned to work together well. Dramatic improvements in cooperation were evident as students learned the important difference between working together and just copying of each other. By having students work on one project together their ideas were combined and they learned the importance of sharing their ideas and how to work as a team. It is now apparent that the students were not fully exposed to group work prior to learning engineering. Students would work in four desk tables but were discouraged from sharing their information. While this has its own value in encouraging independent thought, the gains the students have made from working together is encouraging.

Students have learned to listen to their peers and appreciate their ideas. They have gained an understanding that other students may have a better idea and have learned to value it instead of being jealous which often happens when students do not appreciate each others worth to a group.

2.3 Learning Styles of Elementary Students

In school systems these days' kids are facing bigger challenges than ever before. The curriculum has expanded and become much more complicated, but the time span to teach it still remains the same. So its seems with education today that the goal is not necessarily to make sure the kids learn all the material presented but rather make sure that there is enough time to just cover all the required material. Also, the standard methods of teaching have been gradually changing over the past 50 years. Students used to listen to teachers lecture about a topic. They would then go home, read about the same topic, and complete a homework assignment on it. "Teaching was by rote and drill. Encouragement was by the rod. Obedience (to God, parent and teacher) was the foundation rock for the mansion of learning" (Withers p. vii). It is well known to most people that every child learns differently. So, what if one could harness the method a child learns with, and use that as a tool for teaching? Many students learn under three major categories, which will be explained later in further detail. These main categories are auditory, visual, and kinesthetic. Most children fall into at least one of these categories and many may fall into more than one (Dunn,2). Unfortunately, educators tend to teach in only one style at a time, so when students walk away from a classroom, the question is: How much information have they actually retained?

To aid in material retention, a change in teaching methods was necessary to produce higher retention rates while not necessarily taking up more teaching time. Experts in learning figured out that the best way to study something was not to theorize about it endlessly, but to observe it and how it worked. The experts in education soon caught onto this fact and started implementing it into teaching (Thorndike, p176). It was only natural for teaching methods to evolve to include more hands-on learning. "Imitating the work of the scientists in investigating the natural world, usually in the laboratory, is found in all the new curricula. Whether it is called inquiry, scientific process, or problem-solving, each curricula group espoused the virtues of 'hands-on' experiences to gain greater insights into the basic concepts of science" (Welch, 1979). Why should a student believe something told to them when it had to be physically proved by experts? Seeing the work that goes into proving facts and theories allows a student to understand the importance of what is being taught. Through a combination of teaching to all three learning styles with a focus on kinesthetic learning, more students can be reached, and material retention rates will increase.

2.3.1 Auditory Learners

Auditory learners retain material by listening to themselves, or others. Usually these are the students that will move their lips when they read or even reading aloud to themselves (Murray Learning Styles). Children tend to change to the auditory learning style in the later years of grade school, especially female students (Family Education). Auditory learners need directions to be read aloud to them because they understand expectations better when they are verbalized. These children should be spoken to in a well regulated tone of voice while using non-verbal body language to maintain attention and interest (Family Education). Auditory learners work very well in groups, but are easily distracted by sounds (Murray Learning Styles).

Typically the best way for an auditory learner to communicate the information they have learned is to present a report orally. Predictably, the best way for them to learn, in general, is by a lecture or a forum, where they are allowed to discuss and ask questions (Reading Instructions). Auditory students can be used with much success to tutor other students in the classroom, because when they teach someone they retain the knowledge better themselves (Dunn,2). These students should be encouraged to think out loud. Not doing so will inhibit their ability to grasp some of the concepts they are trying to comprehend. This may mean allowing some students to whisper to themselves in the classroom.

2.3.2 Visual Learners

Visual learners observe concepts through a "Show me and I'll understand method" (Family Education). They prefer to read text, numbers, and use graphics and pictures to learn information (Reading Instructions). This type of learning is usually the style of most 2nd & 3rd graders (Murray Learning Styles). Students who are visual learners benefit from charts or graphs, and need written directions rather than oral ones to understand expectations fully. It is beneficial for them to create assignment logs or to-do lists to keep on task (Family Education). In addition, visual learners are ideal for brainstorming and group work. They usually like to present material they've learned through posters and visual aids. One method of keeping their attention is to perform demonstrations and experiments [Fig 1]. As sounds were a distraction to the auditory learner, visual stimuli can also be a distraction to the visual learner, so visual demonstrations about the topic will focus their thoughts.

2.3.3 Kinesthetic Learners

The majority of children at the kindergarten level start out as a kinesthetic learner. This is a learning style that involves learning by hands-on experience (feeling or touching) (Family Education). These children are usually very active and tend to have a shorter attention span than most. If they are not kept involved and/or amused by an activity then the students will quickly lose interest and their mind will wander (Murray Learning Styles). When engaged in activities, kinesthetic children tend to learn faster than through other learning styles, or at least retain the information for a longer period of time. Usually female children grow out of this stage around 2nd-3rd grade, however many male children will stay a kinesthetic learner for the rest of their life (Family Education).

2.3.4 Advantages of Kinesthetic Lessons

The advantages of kinesthetic learning are numerous and still being discovered by teachers today. The benefits apply not only to students, but teachers and society as a whole. Well developed activities can make learning fun for both the student and the teacher. '"The single most important benefit to me is that although it requires a great deal of preparation time, once a system is developed, hands-on teaching makes teaching fun. If the kids are learning and having fun doing it, then I am having fun at my job, and I am a happier person overall." Jeff G. Brodie, fifth and sixth grade teacher, East Side Elementary, Edinburgh, IN' (Haury and Rillero 1994). Getting teachers to enjoy an activity and look forward to teaching everyday will help them be more productive in the classroom. There are many avenues for teachers to develop hands-on learning activities including summer workshops, summer internships, museum visits, and their fellow teachers. Once a teacher has an idea of what they want to do with their lesson, the best way to develop experience is to try it out on their class (Haury and Rillero 1994).

Kinesthetic learning allows students to delve into material and explore on their own. This has deep rooted meaning for kids. Children start playing shortly after they are born and become deeply engrossed in what they are playing with. "It is a truism of our educational creed that sensory impressions based on object lessons and motor response form the primary basis of thought in dealing with the later materials of knowledge" (McMurray p. 3). Play time is a chance for a child to experiment with one part of his or her world. It develops flexibility in thought. The child can learn the limits and abilities of the world they live in (Whitebread 152). Hands-on learning becomes an extension of play time in the classroom. The difference between playtime and a hands-on learning activity is that the activity focuses the student's experimentation towards a goal. Play time is a time of free thought for the student to learn. Young students are excited by the idea of something new in the classroom. They feel as though they are going to get to play during school time and they approach a classroom activity as if it is playing. They therefore focus on the activity completely. This leads to students retaining material better and comprehending the lesson more than if they learned it through a lecture. At younger ages, students should be encouraged to explore, experiment, and inquire. Some authorities even go so far as to reject the idea of textbooks. "The study of natural history in both the elementary school and the high school should be by direct observational study with the specimens in the hands of each pupil, and that in the work below the high school no text-book should be used" (National Education Association p. 141). The focus should be on the process more than the results. As they learn the process, then a written element can be introduced (Haury and Rillero 1994).

Material retention is one of the main benefits of hands-on teaching techniques (Brown 2001, Disinger 1987, Haury and Rillero 1994, McMurray 1921, Whitebread 2000). Students who retain what they learn can apply it to other subjects more readily. "While information can be remembered if taught through books and lectures, true understanding and the ability to use knowledge in new situations requires learning in which children study concepts in-depth, and over time and learning that is founded in direct experience" (Worth). Applying knowledge previously learned is essential to success as a student progresses through school. Hands-on learning provides a student with a potent way for learning and remembering lessons. Educational research has shown many advantages of using hands- on science programs. Bredderman (1982) reports the results of "a meta-analysis of 15 years of research on activity-based science programs. This synthesis of research was based on approximately 57 studies involving 13, 000 students in 1, 000 classrooms. All of the studies involved comparing activity-based programs (the Elementary Science Study, Science-A Process Approach, or the Science Curriculum Improvement Study) with comparable classrooms using a traditional or textbook approach to science teaching. …Students in activity-based programs performed twenty percentile units higher than the comparison groups. The students in these programs scored higher than the control groups in the following measures (ranked from largest to smallest differences): creativity, attitude, perception, logic development, language development, science content, and mathematics." As the study shows, the effects of a hands-on learning program can be quite dramatic. "Students who were disadvantaged economically or academically gained the most from the activity- based programs” (Haury and Rillero 1994). Lessons discovered by the student become a part of their thinking. They are promptly available for use when solving another problem while something learned from lecture does not necessarily stay with the student as long. “Without this (hands-on) approach students must rely on memory and abstract thought, two methods which restrict learning in most students” Carol J. Stadum (Haury and Rillero). When it comes time to solve a problem, the lessons learned hand-on will help a student more than what he has learned elsewhere.

2.3.5 Benefits for Teachers

Hands-on activities create a base knowledge for the entire class to work with in discussions and activities (Haury and Rillero 1994). All students come to school with different abilities to learn and think. ‘“The benefits of hands-on-learning in my school revolves around those children who are either not as academically "talented" or have not shown "interest" in school. This method tends to stimulate these type [of] students into participating and eventually absorbing information that I believe they would not get from "normal" *show-me - tell-me* methods.” Marv Hougland’ (Haury and Rillero 1994). Group discussions produce better results when everyone in the group is working from the same base knowledge. This will allow students to brainstorm more ideas and discuss their understanding of a concept without having to teach the basics of that concept to each other. Hands on learning “provides students with a similar set of experiences so everyone can participate in discussions on a level playing field regardless of their socio-economic status. In this way, special benefits are not awarded to those who, by virtue of their wealth or background, have a greater number of experiences under their belts" (Knott 1994).

When students are able to get to the bottom of a problem on their own, they feel as if they have accomplished something. The same is true when students learn through a hands-on activity (Haury and Rillero 1994). By working completely from the beginning to the end of an activity, the student understands that they have completed the lesson, and learned all that they can learn from it. Once they have gotten answers to their questions, they feel as though they have a thorough understanding of the subject. Hands on activities "…cause students to rely on the evidence instead of upon authority (encyclopedia, minister, doctor, text, teacher, and parent). Most students live in an authoritarian world with little or no opportunity to practice decision-making because nearly everyone tells students what to do and when to do it. We continually graduate students who do not yet have the ability to set up a simple experiment with controlled variables, collect and interpret evidence, or make correct interpretations based upon that evidence" (Knott 1994). When students complete a task, it builds their confidence. A confident student will tackle more complex problems instead of ignoring them or faking his or her way through them. Also, the student is more likely to start examining the world around them. When exploring, the student will develop their own lesson plan, and go through it until they are satisfied that they understand their own lesson. This develops students who can teach themselves. A self taught student has a distinct advantage over his and her counterparts. They can learn outside of the classroom, where they experience real world problems.

2.3.6 Benefits for Students

A student who begins to explore the world on his or her own has taken a great step in their education. “The justification for hands-on learning is that it allows students to build understanding that is functional and to develop the ability to inquire themselves, in other words, to become independent learners” (Worth 1994). The advent of better technology in the home has made it hard for students to experiment in their own home. People who change their own oil and fix their own lawnmower are a dying breed (Stanford News Service 1992). This is unfortunate because students are lacking in basic mechanical education. By starting students early on with this sort of learning, and giving them the tools to learn on their own, they can handle the influx of technology into the home. If a child can experiment at home where they are in a comfortable environment, there is a great potential for them to learn.

2.3.7 Implementing Hands-On Learning

Hands-on learning can be quite complicated for some teachers to implement. The costs of acquiring material or arranging field trips might be too much for a small school system or one that has a limited budget. This does not mean the teacher cannot hold hands on lessons. Teachers have gotten around this by becoming innovative and using materials from their homes, their student’s homes and from the school itself. Districts can avoid this by purchasing supplies in large quantities to save money, or by centralizing their on hands location, and having students travel to it for a lesson (Haury and Rillero 1994). Also, a hands-on activity can be as simple as walking outside for a lesson. This provides additional education at no cost to the school system.

Introducing students in elementary school to science and engineering provides teachers with a great opportunity to advance their students education. Field Trips are an amazing opportunity for students to experience something hands-on. A museum trip to see dinosaur fossils will provide a much better educational experience than reading a book about how archaeologist dig up dinosaur bones and fossils. Science museums are specifically designed with hands-on experiments for students of all ages. The organization of elementary schools allows for classes to go on field trips all day (Disinger 1987). In junior high and high schools, the regimented structure of class schedules inhibits these types of activities. Also, elementary teachers have a more general course plan to follow. This allows them to integrate the lessons of a field trip into many different topics of learning (Disinger 1987). Researchers concluded that a science museum, by providing exhibits which generate enthusiasm for and interest in learning science, can serve as a valuable adjunct to formal, in-school instruction (Disinger 1987). Trips to museums can be beneficial, especially if the museum has a classroom lesson program. If teachers begin exposing students to hands-on lessons at an early age, the benefits will stick with the student for the rest of his or her education.

2.3.8 Disadvantages of Hands-on Learning

Hands-on education can prove to be a distraction for students. The idea that activity time is play time can go overboard and lead to a loss of control in the classroom (Disinger 1987). Any sort of novelty, like a new place or new teacher can cause a classroom to go off on tangents uncontrollable by the teacher. The key to preventing this is to keep students focused on the lesson at hand. Hands-on activities must be planned out thoroughly to control the students. Teachers must try to plan for the questions that will bombard them from their class. This will allow them to guide the conclusions of the class towards the goal of the lesson.

As mentioned earlier, the development of hands-on activities can be a daunting task for teachers, especially those who have never used this approach before. Deciding what to teach in an activity can be the toughest part. A careful examination of the lesson plan can help a teacher through this. The instructor should go through each subject to be taught, and try to think of an idea for each part of the curriculum. Other teachers and online texts are a great source of ideas for this. The teacher should then go through the process of designing the lesson. Figure 1 from Rillero, Brownstein, and Feldkamp-Kemp provides an excellent basis for designing hands-on lessons, which can be a new experience for some teachers. The final step is for a teacher to actually implement the activity. Over time, the teacher will discover the problems generated by hands on activities and begin to work out solutions. The only way to perfect this style of teaching is to use it frequently.

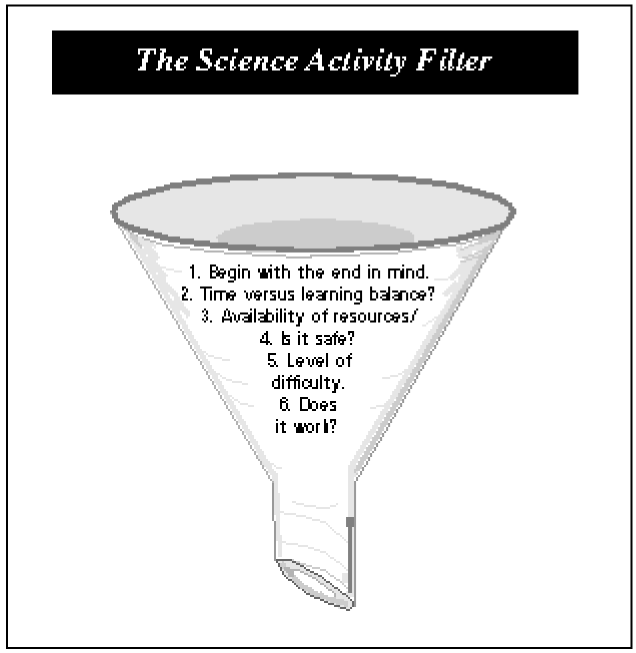

Figure 3: The Science Activity Filter
(Rillero, Brownstein, Feldkamp-kemp)

2.3.9 Conclusion

It is necessary to teach kids hands-on so that they can teach themselves, and solve real world problems. Children who learn through preplanned hands on activities gain an advantage over their peers in the future. They also gain an understanding of a lesson like that of those who originally developed the ideas being taught. This is crucial for students to not only learn what is being taught, but to trust it as reliable also.

L.D. Sharp believed, "Those things which can best be taught outdoors should there be taught" (Disinger 1987). It is imperative that teachers use visual, auditory and kinesthetic methods in their classrooms. One study showed that out of every 10 students in a 6th grade classroom, two were auditory learners, four were visual learners and four were kinesthetic learners. It is also estimated in this case study that 90% of all teachings are auditory. This means that 80% of the students are being taught through a method they are not fully comfortable with the majority of the time (Murray Learning Styles). In order to support current students in their educational undertakings, teachers must adapt to the students needs. This sometimes means overcoming the traditional teaching style they were taught with. It is estimated that children spend up to 15% of their time in a classroom daydreaming (Gardiner,1). It is very important to layer your curriculum with many styles of teaching to retain the attention of all your students.

"Often in the mass media, however, the assumption is that teachers are in two fiercely opposed camps: 'traditional' and 'progressive'. Most teachers recognize that it is common practice to vary one's strategies and styles according to circumstances, so that a teacher may give information directly on one occasion and encourage children to explore a topic on another" (Brown 2001). Some lessons are better taught by lecture while others can serve a student more if he or she learned them themselves through a discovery process. This may not be enough for today's student though. The increased curriculum load forces teacher to cover more topics in less time. Individual lessons should contain a multi-faceted style that will cover all styles of learning to help insure higher material retention rates. Hands-on teaching is a fundamental technique in a teacher's repertoire. Not only does it address kinesthetic learners, but also auditory and visual learners as well because there will inherently be some lecturing involved in any activity. Any sort of kinesthetic activity will have to be supported through text, diagrams and lecture. Modern lesson planning requires a teacher to be flexible in their methods and styles in order to reach every student and cover the curriculum thoroughly. The fundamental challenge to teachers is balancing kinesthetic learning with auditory and visual learning. Fortunately, many students are capable of learning through more than one learning style, making a well rounded lesson plan even more effective.

2.3.10 Implementation

Hands on and kinesthetic techniques were used in a large amount of our lessons. It was an important method to convey ideas that were tough for students to visualize. Students were generally introduced to ideas through lecture or written worksheets, but to complete a lesson, a hands-on example was used. This would tie together what the student had learned in the first part of the lesson.

In a lesson about sound, the goal was to demonstrate to the students how sound was invisible, but could be visualized in the form of a wave. This was accomplished through two hands on demonstrations. The first was a string held by two people, who then shook it to create waves. This demonstrated the idea of waves traveling to students. To drive home the idea of sound waves, students constructed string and cup phones. While talking back and forth, they would pinch off the string. This stopped the transmission of sound, and showed them how sound waves traveled down the string.

Without a kinesthetic teaching method, the concept of sound waves would have been extremely hard to convey to the students.

Many of our lessons used hands on demonstrations. During a lesson about tools, students were allowed to handle examples of hand tools. A computer was brought in and opened up to show students what the inside of it looked like during a lesson about computers. This interested the students thoroughly. Hands on lessons were vital to capturing the interest of students and conveying difficult ideas to them.

2.3.11 Evaluation

The style of learning played a key role in the development and implementation of the lesson plans. Each students needs were different, so the lessons had to be prepared to meet each student's individual learning style.

The design of the lesson plans allowed the students to learn the same concepts from several different angles. This allowed them to fully grasp the concepts. While one student may only learn through a single method, others may need all three methods to fully understand what is being taught. The main emphasis of most of the lessons written was based on hands-on learning. This is because most students in this age bracket learn from hands-on experience. However, since the only way to fully learn something is by doing it over and over again. The same concepts were repeated to the students using all three of the main methods.

The PIEE project greatly revolves around the learning styles of students. One would not try to teach a 3rd grade student by standing in front a chalk board and lecturing all class. The same as one would not teach a PhD student by giving them clay and having them make a model of the heart. The lessons were generated to fit their age bracket and meet the needs of the students acquiring the material.

Chapter III: Methodology

3.1 Team Structure

The third grade PIEE was composed of seven people: one member of the WPI faculty, two graduate students, and four undergraduate students. Midland and Flagg Street schools each have one graduate fellow and two undergraduate students assigned to them. Both of these groups were overseen by a single WPI faculty advisor. In each school were two classrooms. At Midland Street School, the two IQP students worked in separate classrooms and the graduate fellow oversaw both rooms, whereas at Flagg Street School both IQP students worked in one classroom with the graduate fellow teaching in the second classroom.

3.2 Meetings

The third grade PIEE team would meet a mandatory time once a week. Individual meetings were arranged as necessary amongst the IQP students or at the separate schools with the teachers. Each week one IQP student was responsible for leading the meeting. An agenda of the important discussion topics would be compiled and emailed out before each weeks meeting. This was the leader’s responsibility as well as letting the team know where each meeting would be held.

Discussions at each meeting would vary depending on events going on at the time; however each term had a general structure. The first meeting of each term consisted of organizing for the upcoming term and discussing deadlines. The second meeting and forth meeting were spent discussing basic outlines of the lesson plans we were working on. This then led the team to offer comments and suggestions for each other. The third and fifth meetings were when we would submit our lesson plans and also formally present them to the group in a mock schoolhouse setting. The last meetings of the terms were commonly spent wrapping up unfinished business and discussing the upcoming term.

3.3 Lesson Writing

The lesson writing process began with topic discussions. Each graduate fellow constructed a list of the upcoming lesson being taught at each school. Then each IQP student took on at least two lesson plans per B and C term. Next we reviewed the benchmarks for Worcester Public Schools Grade Three to see what skills were required to be taught for engineering and technology.

Once it was known which benchmarks should be included in the lesson, it was necessary to adapt the lesson idea to fulfill as many of these as possible. To guide the IQP students through the creation of the lesson, the Engineering Design Process, shown here, was used. The Engineering Design Process not only provided a basis for our lessons, but provided a common format for the students receiving the lesson. Ensuring the students understood the process of designing and testing an idea was one of the goals for this year. Once there was an idea for a lesson, we used a template, examples of which can be found in the appendices of this report, to create a lesson plan. The plan was then reviewed by both the teachers, graduate fellows and our faculty advisor, and critiqued. After the lessons were critiqued they were edited with new content to meet the needs of the teachers, and the requirements of the fellows. Then finally the lessons were submitted to be put in a portfolio for the teachers to choose from.

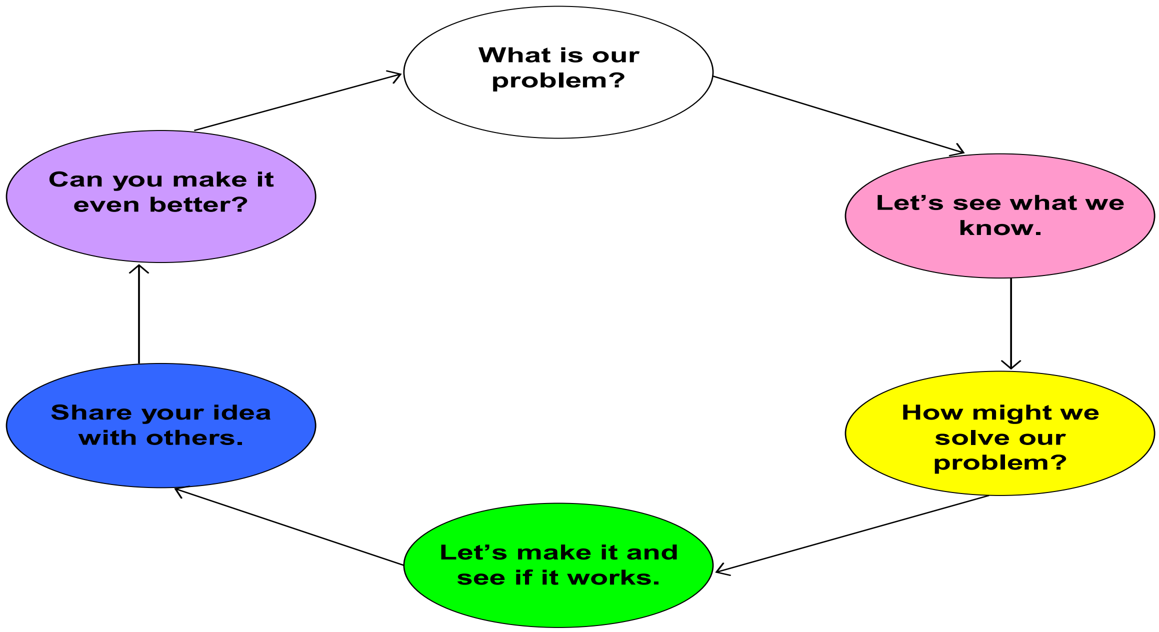

Figure 4: The Engineering Design Process

3.4 Implementation

A list of available lessons was provided to the teachers, who would then select which lesson plans they wanted to use. This would usually entail the IQP students going into the classroom to teach their lesson plans. Most IQP students taught their own lesson plans at the school they were working at. If a lesson was implemented at the other school, then the lesson creator would meet with the other IQP students to go over the basics of the lessons and answer any questions. After the implementation was complete the student who wrote the lesson would revise any changes that they felt necessary for further implementation and type up an implementation record about the lesson, which can be found in section four of this paper.

Chapter 4: Results and Discussion

4.1 Impact

The Worcester Public School developed a system of benchmarks designed to highlight important parts of the curriculum. These benchmarks are designed to help teachers know what to emphasize in the classroom so that students are prepared for MCAS testing. The PIEE project focused on the technology and engineering benchmarks. They are listed as follows:

(1.) Identify materials used to accomplish a design task based on property, e.g., weight, strength, hardness, and flexibility.

(2.) Identify and explain the appropriate materials and tools (e.g., hammer, screwdriver, pliers, tape measure, screws nails, and other mechanical fasteners) to construct a given prototype safely.

(3.) Identify a problem that reflects the need for shelter, storage, or convenience.

(4.) Describe different ways in which a problem can be represented, e.g., sketches, diagrams, graphic organizers, and lists.

(5.) Develop a knowledge and understanding of the metric measurement system.

While writing lesson plans, the IQP students used the benchmarks as guidelines. Between the benchmark guidelines and the curriculum provided by the teachers, the IQP students were able to generate quality lessons that were of great education value.

Of the technology benchmarks, all of them were used in the lessons written by the IQP group. In the lessons implemented by the IQP students, the first four benchmarks were all integrated into the classroom multiple times. The fifth benchmark is taught by the teachers during math lessons where the metric system is emphasized and compared to the English system.

The IQP students incorporated benchmarks from other areas, such as life sciences, inquiry skills and history. The benchmarks covered by each lesson are listed in a table on the following page. The inventor of the month lessons covered history benchmarks while the temperature probes and graphs lesson covered almost all of the inquiry skill benchmarks. Though this was not necessary for the engineering lessons, the IQP students felt it was important to build bridges between the areas of curriculum. This allowed students to apply engineering outside of their engineering lessons, increasing the benefits and impact of the lessons.

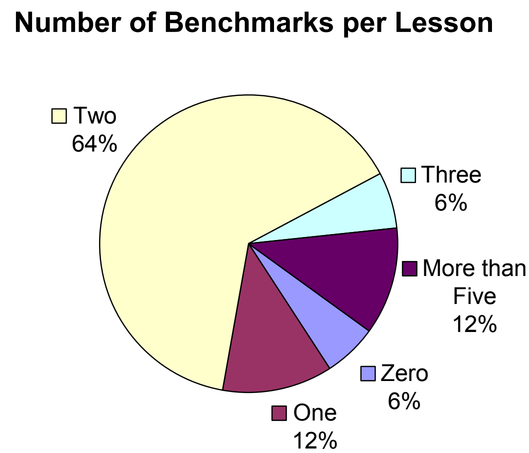

Figure 5: Benchmarks per Lesson

The students appeared to love the engineering lessons that were implemented, even if they didn't always go as planned. When IQP students visited on days without engineering lessons, the students were disappointed that there was no lesson that day. When lessons were being taught, the students had plenty of questions or comments to spur discussion in the classroom. By the end of the project it seemed that event he students who previously were very shy were beginning to enter into discussions. This alone is a major success to the IQP students.

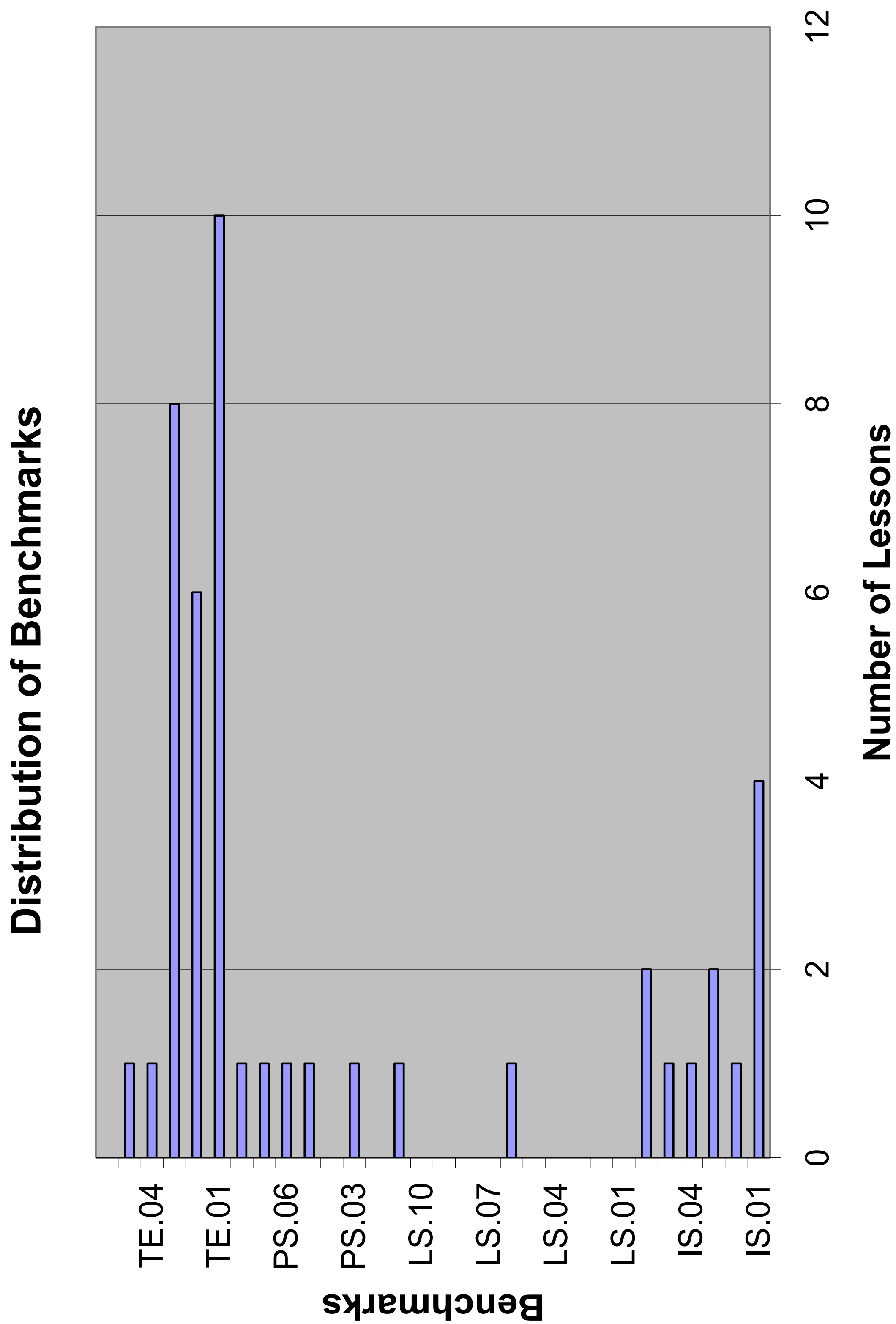

Figure 6: Distribution of Benchmarks

	Boating Tools	Building a Biome	Butterflies	Engineers Work Together	IOTM: Alexander Graham Bell	IOTM: George Washington Carver	IOTM: Robert Goddard	IOTM: Eli Whitney	IOTM: Steve Wozniak	Life Cycles	Lunar Bases	Nuts, Bolts, and Screws	Maple Sugaring	Phases of the Moon	Sound: See the Vibration	Temperature Probes	Water Cycle
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03.SC.PS.06																	?
03.SC.PS.07																	?
03.SC.PS.08															?		
03.SC.TE.01	?	?	?		?	?	?	?			?				?		?
03.SC.TE.02		?		?	?	?						?					?
03.SC.TE.03	?		?	?	?		?	?			?		?				
03.SC.TE.04				?		?	?		?		?			?		?	
03.SC.TE.05																?	

Figure 7: Benchmarks and Lessons

4.2 Teacher Feedback

One of the fundamental parts of the PIEE project implementation was working with the teachers. The students were not the only focus of the engineering lessons. The teachers' backgrounds on engineering varied greatly. As part of the PIEE program, the lessons were written with the idea in mind that teachers with little engineering background could implement them. For this, the advice of the teachers at Midland Street and Flagg Street schools was enlisted. They were invaluable in providing ideas and experiences to help shape lessons. The relationship between the teachers and IQP students had to be solid for the project to be successful. The IQP students started out working in the classroom on non-engineering lessons to learn the ropes of working with the teacher and the students. Throughout the project, the IQP students continued to work in the classroom outside the field of engineering. The teachers greatly appreciated this as well as the work put in by the graduate fellow and IQP students towards the engineering lessons.

A survey was developed and given to the teachers at each school to evaluate the PIEE project in their classroom. The following questions were asked:

1. Did the students enjoy the engineering lessons?
2. Did the students benefit from the engineering lessons?
3. Did the students benefit in other areas such as math, science, etc.
4. Would you have the PIEE project back next year?
5. Were the IQP students helpful outside the engineering lessons?
6. Was there enough communication between the IQP students and the teacher?

Overall, the teachers were very impressed by the project. The survey asked the teachers to agree with the prior questions on a scale of one to five, five being total agreement, one being total disagreement. The following graph shows the average response from the teachers.

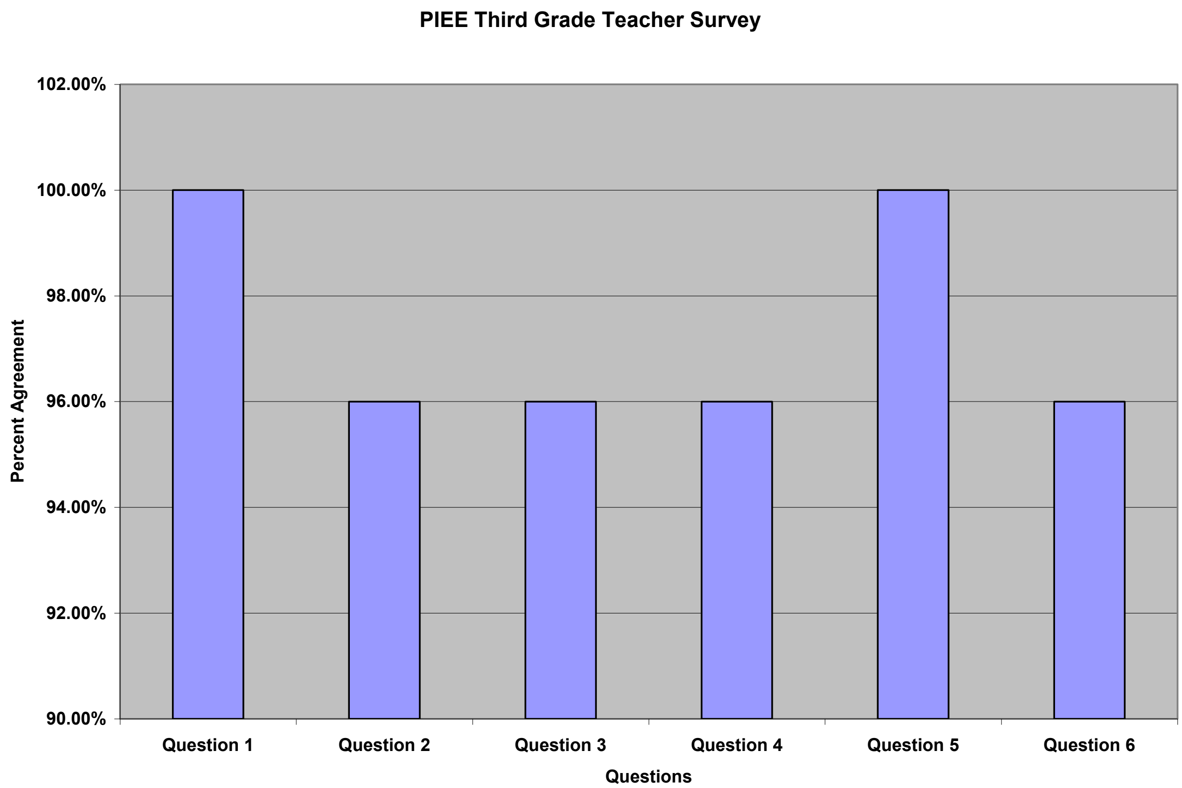

Figure 8: Teacher Response Survey

As shown in the graph above, the PIEE project was an outstanding success in the eyes of the teachers. They enjoyed having the IQP students in the classroom. The students also looked forward to the IQP students coming into the classroom, whether it be for engineering activities or just to help out in other areas of study.

The teachers liked the way their students looked forward to the engineering lessons and took hold of the concepts presented to them. “Many of the lessons integrated what we are learning in math, science, social studies and even connected to some of our reading material" said a third grade Midland Street teacher. Connecting engineering and technology with other aspects of the students' curriculum was a primary goal of the PIEE project and the IQP students' lessons. By building bridges between different areas of study, the students leave the third grade with an improved ability to think about real world problems and how to solve them.

There was extensive group work involved with the engineering lessons. Students would have to work together to develop ideas and build models as a team. A Flagg Street teacher thought it was beneficial when the students had to work together to solve problems. "The students had to work cooperatively in small group activities. The higher level questioning helped students think in a more abstract way." As part of the PIEE project, pushing the students to think on a higher level helped open up students to new concepts earlier on in their education. One method of getting the students to think in the abstract was to question them. "Some of my shy students really blossomed because the [IQP] students made them feel very comfortable answering questions about their work," said a Midland Street teacher. Many of the students who blossomed were the students who had trouble with the English language along with students who were shy in general.

From the perspective of the third grade teachers, the PIEE project has been a success. It has reached out to all of their students, including the minorities and the females. All of their students benefited in the field of engineering and along with other important areas, such as math and science. When asked whether they would have the PIEE project back in their classroom next year, one Flagg Street teacher responded, "Yes, it's a very innovative and creative way to learn." The hands on lessons designed by the IQP students generated enthusiasm within the classroom. With lessons that grabbed the attention of the students, the PIEE project made engineering in the classroom fun to learn, and exposed the students to new and exciting concepts.

4.3 Classroom Trends

4.3.1 Classroom Trends: Flagg Street School

At Flagg Street Elementary School the class was made up of a wide variety of personalities. Some of the kids were very quiet while others were more energetic. A handful of the students had attention disorders and had a difficult time focusing. There was a chart system in place to monitor behavior. If a student was not on task or misbehaving he or she had to write his or her name on the board. For each offense after that, a check went next to the student's name. Each successive check meant that the student lost a portion of his or her recess time and after three checks a note was sent home. This method did help control behavior. For the most part though, the class was very well behaved. It was generally the same group of students who had to put their name on the board.

Overall, the students at Flagg St. School were very bright. They could write very well, they had a good grasp on addition and subtraction, and they picked up on engineering concepts quickly. Many of the students were very enthusiastic about learning. It was obvious that the students acquired knowledge outside of the classroom, probably by asking their parents questions. Their questioning skills were also very obvious in the classroom. They always had pertinent questions during lessons.

Along with asking questions, many of the students liked to input their knowledge. No matter what topic was being discussed, there was always a student who had a story or bit of information that they wanted to share. Many of them were fountains of random knowledge. For example, one student, while discussing units of measurement, gave the conversion of miles into yards. Instances such as these make it clear that their interest for learning extends beyond the classroom.

4.3.2 Classroom Trends: Midland St. School

At Midland St. School, each IQP student worked in a separate classroom. When implementing a lesson, the team member who designed it was present in whichever classroom was being taught. One class had approximately 19 students, while other class had only 16 students. In each classroom, the students were organized into groups of three or four; however they changed seats for different subjects. For certain subjects, such as math, some students would even change classrooms. Each class had a wide range of ability levels. There were students reading above their grade level while conversely, there were students who struggled to read or write. Some students even struggled with the English language.

One of the classrooms was full of very energetic students, which caused them to struggle with staying focused. Fortunately, they were also extremely eager to learn. They enjoyed participating in engineering lessons, and always wanted to know when the next one would be taught. They always asked questions, although the level of sophistication of these questions varied greatly. Some students did not know what to ask and became so focused on asking their question that they often repeated a question that was already asked.

The other class was relatively well behaved. When the students started to get rowdy, the teacher was quick to calm them down and regain control of the class. These students grasped engineering concepts very well. Even the students who could not speak fluent English were able to catch on quickly with personal attention. When they asked questions, they would many times surprise the group with the level of thought in their question. Other times they would ask about something that did not matter at all, such as video games. Overall, the students' attention sometimes wandered when the teacher or one of the project team members would lecture to them. With any hands on activity though, such as engineering, their attention was undivided. Like any group of third grade students, they could be a handful, but with the help of the teacher and patience, the students could be managed effectively.

4.4 Suggestions

In general, the successes of the PIEE partnership with Worcester Public School System heavily outweigh the failures. On the classroom side of the project, there have been very few problems. The communication between the students and teachers has been more than adequate to fulfill the goals of the project. Initially the project met some resistance in Flagg Street School. The project was not fully understood by the teachers. As the year progressed, the teachers at this school came to understand the purpose of the project and what it encompassed. For future years, especially in PIEE initiation groups, the goals and methods of the project should be outlined at the beginning of the year. The curriculum for the year should be reviewed so that appropriate places for engineering lessons can be found. It is more advantageous to outline the PIEE project as a whole with the teachers than to introduce parts of it one at a time.

On the IQP group side of the project, there were many areas that could be improved for future years. The group suffered a major setback when the advisor was changed and this contributed to some of the confusion. Outside of that, there were a few issues involving goals of the IQP group. An outline of goals for each term of the project was given out at the beginning of the project. This outline needed to be more detailed so that all of the IQP groups in the project would be able to work along the same guidelines. When the advisor for the IQP group was changed, a new advisor was tossed into the role without an idea of where the project should be at that point. If more guidelines were given from the PIEE project leaders as to what should be accomplished each term, the project would run much more smoothly. These expectations should be uniform across the individual groups to reduce confusion. Communication between the upper echelon of the project and the actual IQP groups doing the work should also be improved so that goals are understood and more easily met. Fortunately, the outcome of the project in relation to the third grade classrooms was not affected by this and the project was still a resounding success.

5. Appendices

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5.3 Lesson Plans

Lesson 1: Boating Tools

Lesson Title – Boating Tools

Grade Level -- 3

Lesson Time -- 1 hour +/- 15 minutes for flexibility

Instructional Mode -- Entire Class

Team Group Size – Individual

Summary – This lesson was designed to be a break from the normal engineering lessons. It was implemented during a testing week. It contains simple activities for the students that teach them about the history of the USS Constitution, Morse Code, and basic nautical vocabulary.

Learning Objectives --

03.SC.TE.01: Identify materials used to accomplish a design task based on a specific property, e.g., weight, strength, hardness, and flexibility.

03.SC.TE.03: Identify a problem that reflects the need for shlter, storage, or convenience.

Essential Questions --

What types of boats are there?

What are boats used for?

What are sails used for?

Introduction/Motivation – Today we are going to learn about boats. How many people have been on a boat? What was it like? Was it a big boat? What made the boat move? Well, there are two different types of boats. Powerboats have an engine that turns a propeller to push them through the water. Sail boats use a big piece of cloth to catch the wind and move through the water. Today we are going to learn about the USS Constitution.

Procedure --

1. Teacher will go through the introduction/motivation
2. Go over the basic nautical terms from the vocabulary section.
3. Hand out the Constitution work sheet and go through it as a class.

4. Hand out the Morse Code worksheet and let the students work on it individually.
5. The answer to the Morse Code worksheet is: X marks the spot on treasure island. Students who finish can try writing their name in Morse Code.
6. Hand out the word find to those students who finish early.
7. Have the students review the vocabulary after the lesson.

Materials –

1. Worksheets
2. Scrap Paper

Vocabulary --

Sail – A piece of cloth that catches the wind to propel a boat

Port – The left side of a boat

Starboard – The right side of a boat

Submarine – A ship that goes under water.

Galley – The kitchen on a ship

Head – The bathroom on a ship

Bow – The front of the ship

Stern – The back of the ship

Mast – The large pole that holds up the sail

Compass – A device that always points to magnetic north.

Assessment/Evaluation of Students – Worksheet evaluating students (pass/fail)

Lesson Extensions –

Attachments – Three Work Sheets

Troubleshooting Tips --

Safety Issues -- None

Redirect URL -- N/A

Key Words –Boats, Ships, Sea, Navy, USS Constitution

Name: ________________________________ The USS Constitution

Background:

The USS Constitution is the oldest warship in the United States Navy. It was built in 1797 as part of the America's plan to arm itself against England. It fought in the War of 1812 where it earned its nickname, "Old Ironsides." The nickname was given by the English because their cannon balls bounced off the side of the Constitution during battles. She was one of the most feared ships in the U.S. Navy. During the late 1800's, it was decided the USS Constitution should be kept as a museum for future generations.

Situation:

The year is 1801 and the USS Constitution is setting sail for the Mediterranean Sea under the command of Captain Silas Talbot. On board the ship, Captain Talbot has 37 sailors and 4 officers. He carried 1267 pounds of food for the voyage. They also brought 500 cannon balls for the ships 50 guns.

On the way to the Mediterranean Sea, they encounter the HMS Cyane. The HMS Cyane has 38 cannons aboard. The Cyane attacks the USS Constitution and Captain Talbot is forced to respond. He fires 25 of the ships guns twice before the HMS Cyane escapes. The Constitution arrives in the Mediterranean Sea after 15 days of sailing.

<u>Exercises:</u>

1.) How many crew members are there total on the USS Constitution?

2.) If each cannon has an equal number of cannon balls, how many cannon balls does each cannon have?

3.) How many more guns does the USS Constitution have compared to the HMS Cyane?

4.) If Captain Talbot fired 25 of the ships guns twice to scare off the HMS Cyane, how many cannon balls did he have left?

5.) On the thirteenth day of the voyage, the crew has eaten 388 pounds of food. How many pounds of food are left on the USS Constitution?

Name: ____________________ Blackbeard's Treasure

Situation:

180 years ago, Captain Blackbeard stole a U.S ship that was carryin 400 pounds of gold. You have been assigned to recover the lost gold. Captain Blackbeard buried it on an unknown island. He left only one clue. The clue is in Morse Code. You must decode the clue to find the treasure.

Morse Code Key:

Letter	**Morse**	**Letter**	**Morse**
A	.-	N	-.
B	-...	O	---
C	-.-.	P	.--.
D	-..	Q	--.-
E	.	R	.-.
F	..-.	S	...
G	--.	T	-
H	....	U	..-
I	..	V	...-
J	.---	W	.--
K	-.-	X	-..-
L	.-..	Y	-.--
M	--	Z	--..

Words are separated by "/"

Clue:

-..- / -- .- .-. -.- ... / - .... . / ... .--. --- - / --- -. / - .-. . .- ... ..- .-. . / .. ... .-.. .- -. -..

____

____

____

Nautical Word Search

I	S	Y	A	O	A	I	H	N	T	M	B	Q	E	V	J	W	C	P	C
H	N	N	U	X	S	A	E	F	R	N	O	Q	M	C	O	P	T	D	N
U	F	X	C	Y	Q	I	S	C	P	E	W	P	S	Y	R	V	Y	S	F
U	U	O	A	R	T	T	F	T	U	I	T	K	H	V	J	D	W	F	I
G	V	N	B	M	U	Y	E	L	L	A	G	S	F	M	V	K	G	K	J
Z	B	O	N	E	X	S	X	T	T	N	H	N	N	O	B	S	J	B	O
M	M	O	C	C	J	C	I	A	S	T	L	J	X	A	R	E	Y	V	W
F	Q	X	R	A	T	D	L	E	J	R	R	P	Y	B	T	L	Y	S	Z
E	T	Q	L	G	E	K	F	D	R	O	E	S	A	I	L	G	A	R	U
R	A	W	Z	D	U	M	R	U	Z	P	Y	S	O	G	W	J	S	M	H
Y	W	T	I	F	U	A	I	O	L	V	O	C	I	N	C	S	A	C	Q
N	M	H	P	G	O	O	G	G	A	B	R	A	B	P	V	S	K	U	X
P	T	C	E	B	K	C	A	N	M	L	T	T	I	N	X	Z	L	S	C
M	D	N	R	A	O	R	T	V	S	W	S	B	A	I	U	K	G	H	J
U	X	A	Y	M	R	D	E	F	G	J	E	P	N	S	B	K	T	C	W
D	T	G	P	Y	A	O	T	T	P	J	D	K	S	I	R	D	R	Y	L
S	C	A	F	K	G	S	R	V	R	H	G	H	C	X	X	B	U	D	P
D	S	H	P	L	B	O	T	U	F	E	F	E	I	C	V	E	U	O	Y
S	T	R	I	Q	T	M	P	B	G	E	J	Q	D	B	I	X	Z	K	U
O	S	U	B	M	A	R	I	N	E	K	Q	Z	I	C	O	P	W	U	B

BOW
COMPASS
CRUSIER
DESTROYER
FRIGATE
GALLEY
MAST
NAVY
PORT
SAIL
STARBOARD
STERN
SUBMARINE

Lesson Title – Building A Biome

Grade Level – 3rd

Lesson Time – 3 – 1 hour and 15 minute lessons

Instructional Mode – Small Groups

Team/Group Size – 4 students per group

Summary – Students will research a specific animal as specified by their teacher. Then using the engineering design process, students will be asked to construct a biome of the animal's habitat. The biome will show the environment the animal must have to survive, show any natural predators the animal may have, show one adaptation the animal uses to protect themselves, and one other interesting fact.

Learning Objectives – 2002 Worcester Public Benchmarks (WPS) for 3rd Grade:

03.ET.CA.07 – Collaborate with classmates to use teacher-selected Websites.

03.ET.SE.01 – Follow classroom rules for responsible use of computers.

03.ET.SE.03 – Explore practices for evaluating Websites.

03.ET.SE.04 – Develop understanding of how the computer is a tool for learning.

03.ET.RC.01 – Explore and develop understanding of how to gather information from a variety of electronic sources, including teacher-selected Websites, CD ROM encyclopedias, and automated card catalog.

03.SC.TE.01 – Identify materials used to accomplish a design teach based on a specific property.

03.SC.TE.02 – Identify and explain the appropriate materials and tools to construct a given prototype safely.

Essential Questions –

(1.) What is a biome?

(2.) What type of environment does your animal need for survival?

(3.) What are your animal's natural predators?

(4.) How do your animals use adaptation to protect them?

(5.) What are some other interesting facts that you discovered about your animal?

Introduction / Motivation – To motivate the students you should begin by introducing them to the animal that you researched. To move the along answer the "Let's See What We Know" part for your animal and share it with the students. Then explain to them how you found the information for your animal. Tell them what animal you have researched. Go through a quick explanation of how you found your information, through websites, book, magazines, etc. Then show the class your sample diorama, this will get the students excited to build their own. Explain how you constructed it (the basics). For reference on the construction of the biome see the Teachers Reference Sheet at the end of the lesson. Next explain how you showed the animal's natural habitat/biome/environment. Next show how you displayed some of the animal's natural predators. Next explain how you showed an adaptation the animal has to protect itself. Lastly show an interesting fact you displayed about your animal. For the information used in the sample biome, refer to the Sample Worksheet at the end of the lesson.

Procedure –

<u>Part I :</u>

1. Give student groups their assigned animal
2. Give them a list of resources that either the teachers have selected from the library or the list of websites in the URL section of this lesson plan.
3. Help students research their respective animals.
4. Pass out (one to every student) a Biome Worksheet and go over the set of instruction with them through Part II.
5. Students should use the information they gather to complete Part II "Let's See What We Know" of their Biome Worksheet.
6. Sample Biome should then be shown.
7. Explaining how you researched your sample animal and how you built your biome (Refer to Teacher Reference Sheet).
8. Then explain how you showed the predators, adaptations, environment, and interesting facts in your biome. (Refer to the Sample Worksheet).

9. Have them store their worksheets in a safe place and continue in free time to do research on their animal.

Part II:

10. Have students stay in seats. Their will be a brief review.
11. Ask students who can describe what a biome is? (See vocabulary section for definition).
12. Ask if they remember what a diorama is?
13. Explain what a diorama is. (See vocabulary section for definition).
14. Ask each group what animal they have been researching.
15. Ask students to take out their Biome worksheets
16. Go over directions out loud with students for the worksheet for Parts III & IV.
17. Give each group a shoebox and other materials to begin construction of their diorama using the instructions on the worksheet.
18. After the students have completed the biome, have them pass in their biome diorama.
19. Before ending the lesson read over Part V of the Biome Worksheet with the student so they have time to prepare for their presentations, then have them put away their worksheet in a safe place.

Part III:

20. Pass back the biomes and have the students take out their Biome Worksheets.
21. Have each group get up in front of the class and present their Biome.
22. Since the groups should be of about 4 students (this can be adjusted as necessary), one student should explain the environment and habitat of the animal, another should explain its predators, another should explain the animals adaptations, and lastly another should explain the interesting facts that they found out about their animal. Each member of the group should talk about the animal.

23. After each group presents, all the remaining groups must ask at least once question about the animal in the presentation.
24. After all groups have presented, go over the final part, Part VI of the Biome Worksheet with the students.
25. Have the students finish the Biome Worksheet and collect them at the end of class.

Materials List (per class, per group and / or per student) –

For each group of 4…

One Shoebox (Adult Sized) (The cover isn't necessary but can be used for additional cardboard)

Construction paper

Cardboard scraps

Glue

Tape

Scissors

Markers/Crayons

Assorted Craft Materials

For each student…

One Biome Worksheet

Pencils

Vocabulary with Definition –

<u>Biome</u> – A global region characterized by its climate, animals, and plant life.

<u>Climate</u> – A region of the earth having a certain weather condition (i.e. : desert (really hot), tundra (really cold), rainforest (really wet), etc)

<u>Diorama</u> – A 3-D miniature scene to copy a natural climate setting.

<u>Predator</u> – An animal that survives by hunting other animals.

<u>Adaptation</u> – Something that can change to help an animal better in a certain situation.

Assessment/Evaluation of Students – Class presentation of biome and Biome worksheet (pass/fail).

Lesson Extensions – none

Attachments – Biome Worksheet, Teacher Reference Sheet, Sample Worksheet (with photos).

Troubleshooting Tips – Unfortunately, for this lesson the students must work cooperatively in groups. Some teachers may want to assign groups, but that may run into complications with students not wanting to work together. To avoid this maybe let each student pick a partner and then have the teacher pair up the pairs to create groups of 4.

Safety Issues – Watch out for paper and scissor cuts!!!

Redirect URL –

http://www.enature.com/ (general animals)
http://www.nwf.org/ (national wildlife federation) (general animals)
http://www.dec.state.ny.us/website/dfwmr/wildlife/endspec/huwhfs.html (humpbacked whale)
http://www.chelydra.org/ (snapping turtle)
http://birds.cornell.edu/birdhouse/speciesaccounts/EABLBIRD.HTM (eastern bluebird)
http://www.enchantedlearning.com/subjects/birds/printouts/Easternbluebird.shtml (Eastern bluebird)
http://www.enchantedlearning.com/biomes/ (habitats and biomes)
http://www.nhptv.org/natureworks/whitetaileddeer.htm (white tailed deer)
http://www.nhptv.org/natureworks/nw4.htm (general animals)
http://museum.gov.ns.ca/mnh/nature/nsbirds/bns0269.htm (chickadee)
http://www.geocities.com/Athens/Atrium/5924/ladybuglinks.htm (ladybugs)
http://www.geocities.com/Athens/Atrium/5924/schoolyardscience.htm (ladybugs)
http://www.dec.state.ny.us/website/dfwmr/wildlife/endspec/tirafs.html (timber rattlesnake)
http://www.herpnet.net/Minnesota-Herpetology/snakes/TimberRattlesnake.html (timber rattlesnake)
http://www.baylink.org/wpc/woodchuk.html (woodchuck)
http://www.nearctica.com/biomes/edf/mammal/woodchk.htm (woodchuck)
http://www.conservation.state.mo.us/nathis/mammals/woodchuck/ (woodchuck)
http://www.npwrc.usgs.gov/narcam/idguide/american.htm (American toad)
http://www.dnr.state.wi.us/org/caer/ce/eek/critter/amphibian/toad.htm (American toad)
http://www.herpnet.net/Minnesota-Herpetology/frogs_toads/american_toad.html (American Toad)
http://yahooligans.yahoo.com/content/animals/ (general animals)
http://www.desertusa.com/june96/du_cycot.html (coyote)
http://www.bright.net/~swopejak/coyote.htm (coyote)
http://www.mbr-pwrc.usgs.gov/id/framlst/i7610id.html (American Robin)

http://birds.cornell.edu/BOW/AMEROB/ (American Robin)
http://www.npwrc.usgs.gov/narcam/idguide/wood1.htm (Wood Frog)
http://wlapwww.gov.bc.ca/wld/frogwatch/whoswho/factshts/woodfrog.htm (wood frog)
http://www.enchantedlearning.com/subjects/whales/species/Rightwhale.shtml (right whale)
http://www.tenan.vuurwerk.nl/reports/mickle/whale.htm (right whale)
http://www.desertusa.com/mag99/mar/papr/porcupine.html (porcupine)
http://www.nhptv.org/natureworks/porcupine.htm (porcupine)

Key Words – Biome, Climate, Animal, Predator, Adaptation

Name: ______________________

Date: ________________________

What's a Biome???

Directions : Recently we have been learning about animals, and their habitats. Now I want you to show me where your animals live. Use the following worksheet to build a biome for your animal. First answer the questions below, before you begin constructing.

I. WHAT'S OUR PROBLEM????

Your job is to use an ordinary shoebox, and other materials to build a biome to help teach the class and your teacher what you have learned about your animal.

II. LET'S SEE WHAT WE KNOW!!!

(1.) What is the name of your animal?

____

(2.) What area of the world does your animal live in?

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(3.) What kind of climate does your animal like?

(4.) What kind of a home does your animal have? (In a tree? In a nest? In the water?)

(5.) Name a few of your animals predators?

(6.) Does your animal have any adaptations against these predators? If so names them.

(7.) If your animal does not have any adaptations how do they protect themselves from predators?

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(8.) List any facts you found different or interesting about your animal? Try to list things you think nobody not even your teacher knows about this animal.

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III. HOW MIGHT WE SOLVE OUR PROBLEM????

Now that you have done all your research its time to start building but first see a teacher or WPI student to make sure you've completed the first part of the worksheet. Once you have checked in, you will be given some supplies to continue with this worksheet and build your biome.

IV. LET'S MAKE IT & SEE IF IT WORKS!!!!

Before you start building I want you to look at the materials available to you and think then answer the following questions….(Please in your answer list any materials you used and WHY???)

(1.) How will we show the climate/habitat our animal lives in? List below some things you will include to show the habitat.

____

(2.) How will we show some of the animal's predators?

____

(3.) How will we show the animal's adaptations?

____

Now that you've thought about it I want you to go ahead and use your imagination while building your biome, Before you begin building I want each person in the group to share his or her ideas for building the biome. Then I want each one of you to pick one part of the biome to build and present. If you need any help or ideas, please ask.

V. SHARE YOUR IDEA WITH OTHERS!!!!

Now that you have finished building your biome, I want your group to present the biome to the rest of the class. I want each person to present one part of the biome. One person presents the climate, one person presents the predators, one person presents the adaptation, and one person presents the interesting fact or facts you found out about your animal.

Also be prepared after you finish presenting to answer a few questions about your animal asked by the teacher and your fellow classmates.

Please write your name below next to which part you presented. Please have your teammates write their names next to their parts.

(1.) CLIMATE : ____

(2.) PREDATORS : ____

(3.)ADAPTATION :____

(4.)INTERESTING FACTS :______________________________________

VI. CAN YOU MAKE IT EVEN BETTER????

Lastly list below questions you still have about your animal, things that maybe you couldn't find the answers to. And when you get this paper back I will do my best to answer your questions.

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TEACHERS REFERENCE SHEET

To build a Wild Turkey sample biome, first get a shoe box, the bigger it is the easier it is to put stuff in, and see it. Next, coat the back and side walls of the diorama with either a woodsy themed paper, or just green and brown construction paper to make it look like a forest. Now take a 2 ½ in Styrofoam sphere, or a crumpled ball of construction paper, or paper, and cover it with brown construction paper and tape it down using scotch tape. Next show the students will know it's a turkey I stuck feathers in the ball and a push pin for a beak.

Since turkeys lay eggs in nests on the ground and that is where they are the most vulnerable to predators, I used green pipe cleaners to make a nest and grass for the turkey to sit on and be concealed. Then also I built a tree to show that turkeys also when not hatching eggs, roost in trees, because unlike domestic turkeys wild turkeys can fly.

Lastly I showed two predators of the wild turkey one is the snake signified by the coiled up green pipe cleaner, and the other made of crumpled balls of black construction paper, with a white stripe is a skunk. Both these animals eat the turkey eggs.

Anything else is really just up to the imagination.

Sample Worksheet

II. LET'S SEE WHAT WE KNOW!!!

(1.) What is the name of your animal? Wild Turkey

(2.) What area of the world does your animal live in? Every state in the United States except Alaska.

(3.) What kind of food does your animal eat? Insects, spiders, snails, slugs, salamanders, small lizards, small frogs, millipedes, grasshoppers, very small snakes, worms, grasses, vines, flowers, acorns, buds, seeds, fruits, clovers, dogwood, blueberries, cherries, hickory nuts, beechnuts, and other vegetation.

(4.) What kind of a home does your animal have? (In a tree? In a nest? In the water? In the forest? In the desert?) Wild Turkeys do most of their traveling and eating in the daylight. At night they roost in trees, especially oaks and pines. When they lay eggs turkeys build a nest on the ground hidden by bushes or vines. In the woodlands (forest or a well vegetated area, having a lot of plant-life).

(5.) Name a few of your animals predators?
Eggs - raccoons, skunks, opossums, crows, snakes, raccoon and bobcats, Foxes and coyotes,
Adults – man

(6.) Does your animal have any adaptations against these predators? If so names them.
The turkeys brown colors help it blend into its woodsy home. Also the wild turkeys are very fast runners and fliers(for short distances).

(7.) If your animal does not have any adaptations how do they protect themselves from predators?

Wild Turkeys do have adaptations.

(8.) List any facts you found different or interesting about your animal? Try to list things you think nobody not even your teacher knows about this animal.

Wild Turkeys do not fly south for the winter or hibernate their diet changes with the seasons depending on what food source is available. Also Benjamin Franklin wanted the turkey to be declared as the national bird instead of the bald eagle.

III. HOW MIGHT WE SOLVE OUR PROBLEM????

Now that you have done all your research its time to start building but first see a teacher or WPI student to make sure you've completed the first part of the worksheet. Once you have checked in, you will be given some supplies to continue with this worksheet and build your biome.

IV. LET'S MAKE IT & SEE IF IT WORKS!!!!

Before you start building I want you to look at the materials available to you and think then answer the following questions….

(1.) How will we show the climate/habitat our animal lives in? List below some things you will include to show the habitat.

I've included tree in the background, and a tree made of construction paper. These show that turkeys live in mostly woodsy areas. Also I've used green pipe cleaners to show that the turkeys when roosting live on nest on the ground made of twigs and brush and are surrounded by bushes and vines.

(2.) How will we show some of the animal's predators?

I've shown two predators of turkey eggs. The snake which is represented by the coiled pipe cleaner, and the skunk made of black and white construction paper.

(3.) How will we show the animal's adaptations?

The turkey body is covered with brown construction paper, and although the feathers are very bright in the biome, in

actuality the feathers are mostly brown. This is so they blend in with their woodsy surroundings.

Now that you've thought about it I want you to go ahead and use your imagination while building your biome, if you need any help or ideas, please ask.

V. SHARE YOUR IDEA WITH OTHERS!!!!

Now that you have finished building your biome, I want your group to present the biome to the rest of the class. I want each person to present one part of the biome. One person presents the climate, one person presents the predators, one person presents the adaptation, and one person presents the interesting fact or facts you found out about your animal.

Also be prepared after you finish presenting to answer a few questions about your animal asked by the teacher and your fellow classmates.

Please write your name below next to which part you presented. Please have your teammates write their names next to their parts.

(1.) CLIMATE : ____

(2.) PREDATORS : ____

(3.)ADAPTATION :____

(4.)INTERESTING FACTS :_____________________________________

VI. CAN YOU MAKE IT EVEN BETTER????

Lastly list below questions you still have about your animal, things that maybe you couldn't find the answers to. And when you get this paper back I will do my best to answer your questions.

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Lesson 3: Butterfly Lesson

Lesson Title – Butterfly Lesson

Grade Level -- 3

Lesson Time – 1 hour for the first lesson. 20 minutes a day, 3 times a week afterwards.

Instructional Mode -- Entire Class

Team Group Size – Individual

Summary – This lesson is designed as a whole unit on the metamorphosis of butterflies. Students will collect caterpillars, feed them, observe them go through the stages of metamorphosis and watch the final product that is a butterfly.

Learning Objectives –

03.SC.TE.01: Identify materials used to accomplish a design task based on a specific property, e.g., weight, strength, hardness, and flexibility.

03.SC.TE.03: Identify a problem that reflects the need for shlter, storage, or convenience.

Essential Questions --

What is metamorphosis?

Introduction/Motivation – Before students go out to collect caterpillars, they should be introduced to the concept of metamorphosis. Metamorphosis is the process that a caterpillar goes through when it changes into a butterfly. The first stage is the larva, which is the caterpillar. This comes from eggs laid by the butterflies. The second stage is the pupa. This is when the larva attaches itself to a branch or other object and begins to grow a husk to cover itself. For butterflies, this is called the chrysalis. Once the transformation is complete in the chrysalis, the adult butterfly splits open the pupa, and emerges.

Procedure --

8. Teacher will go through the introduction/motivation
9. Have the students catch caterpillars or order a set for the classroom.
10. Give each student a jar.
11. Place a branch that leans diagonally in each jar.
12. Put plenty of fresh leaves in the jar.
13. Put the caterpillar in the jar.

14. Cover the jar with screen and tape it down on the sides.
15. Observe the jars daily or every other day. Have the students write down what they see in a journal. Add fresh leaves when doing this. Tell the students to try not to disturb the caterpillar.
16. Release the adult butterfly when it has completed metamorphosis.

Materials –

3. Jars
4. Caterpillars (either from outside or ordered from a nature supply store)
5. Sticks
6. Constant supply of green leaves for the caterpillar to eat.
7. Screen material to cover the jars.
8. Tape
9. Notebooks to record changes in.

Vocabulary --

Caterpillar – The larva stage of the butterfly. It hatches from a butterfly egg.

Larva – The stage of a butterfly before it metamorphosis's and after it has hatched.

Chrysalis – The pupa stage of a butterfly

Pupa – The stage where a butterfly forms a husk around itself while hanging from a branch. This is when the butterfly begins its metamorphosis.

Metamorphosis – The process by which a butterfly goes from a freshly hatched larva to a full grown butterfly.

Assessment/Evaluation of Students – Completion of daily journal.

Lesson Extensions – none.

Attachments – none

Troubleshooting Tips – Some of the butterflies may not make it. Be prepared to counsel kids who's butterfly dies.

Safety Issues -- None

Redirect URL -- N/A

Key Words –butterflies, metamorphosis

Lesson 4: Engineers Work Together

Lesson Title – Engineers Work Together

Grade Level – 3rd Grade

Lesson Time – 1-1.5 hr

Instructional Mode – Class discussion, individual work, partner feedback

Team/Group Size – 2 students/group

Summary – The students will learn the history behind the invention of the modern day vacuum cleaner and then do an engineering activity. The activity will be a worksheet that brings them through the engineering design process with the goal of designing their own device for storage to keep their bedrooms clean.

Learning Objectives – Worcester Public School Benchmarks for 3rd Grade:

Technology and Engineering: Students will

03.SC.TE.02 – identify and explain the appropriate materials and tools (e.g. hammer, screwdriver, pliers, tape measure, screws, nails, and other mechanical fasteners) to construct a given prototype safely.

03.SC.TE.03 – identify a problem that reflects the need for shelter, storage, or convenience

Additional Learning Objectives-

Students will learn how it often takes more than one person to engineer something new.

Students will use the K-3 engineering design process.

Essential Questions –

- How do engineers come up with an idea to solve a problem? (engineering design process)
- What materials do you need to build your invention?
- Who invented the vacuum cleaner?

Introduction / Motivation – Ask the students if their parents ever tell them that they have a messy room. Ask them what they have to do before their parents can vacuum their room. Tell them that they are going to learn a little bit about the inventors of the vacuum cleaner and then come up with an invention of their own that will help them keep their room clean.

Procedure –

1. Ask students if their parents ever complain that their bedroom is messy.
2. Ask the students what they need to do before their parents can vacuum their room. Look for answers such as "I need to put my toys away" or "I have to pick up my clothes."
3. Give brief intro to the lesson by letting them know that they are going to learn about the inventors of the vacuum cleaner and then have a chance to design an invention of their own.
4. Ask the students, "How did people clean their floors before vacuum cleaners were invented?" Answers will probably be mops and brooms.
5. Ask the students, "Would you ever clean your floors by blowing on them and then walking around the room trying to catch the dirt that was blown up into boxes?"
6. Ask them why not.
7. Explain to them that Hubert Cecil Booth didn't think that it was a very good idea either. He saw this method of cleaning in the 1890's and proposed that they try to suck up the dirt instead of blow up the dirt. To prove his point he placed a handkerchief over his mouth and sucked on what looked like a clean chair. Try to give them a visual understanding of this without actually sucking on a chair through a handkerchief. He then showed the people blowing the dirt just how much dirt he had been able to get out of the chair. *Remind students that this is not a good idea for them to try.*
8. Show a picture of Booth's first vacuum cleaner. Tell the students that in 1901, Booth used his idea of sucking dirt out of things to make the first vacuum cleaner. This vacuum cleaner was very large and could not be brought inside. Instead, this horse drawn device was brought to people's houses and long hoses were brought inside to vacuum.
9. Ask them, "Do you think a lot of people owned a vacuum cleaner like this?" Make sure they understand that it was expensive to make and hard to store. Instead people hired Booth to come to their house with one and clean.

10. Ask them if they can come up with reasons why we don't have these types of vacuum cleaners anymore. Try to lead them to the idea that someone made the vacuum cleaner better by making it smaller and less expensive to make. If they don't seem to be headed in the right direction ask, "If Booth invented the vacuum cleaner that had to be carried by a horse then who made the vacuum cleaners that we use today?" They will not know the answer but this question will lead into the next step.
11. Tell them about James Murray Spangler. Spangler was a janitor who always had a cough from the dust he was cleaning. In 1907 he made his own vacuum cleaner out of a box with a fan in it that sucked the dirt into a pillowcase. The box was pushed around by a broom handle that he attached to it. It rolled on a brush made of goat hair. He patented the idea and tried to start his own vacuum company called Electric Suction Sweeper Co. in 1907. He didn't have a lot of money though. If the students do not know what a patent is, you can leave that fact out and just tell them that he started his own vacuum company.
12. Ask the students if they know why you need to have money to get a business started. Look for answers such as: you need enough money to make whatever it is that you want to sell, you need money to advertise…..
13. Tell them that the husband of Spangler's cousin bought the company from him. His name was William H. Hoover. Hoover let Spangler work for the company.
14. Review with the students that it took three people to get to the modern day vacuum cleaner. Emphasize how each inventor saw room for improvement in the previous person's invention. Make sure they understand that this is often the case with new inventions.
15. Quickly review the engineering design process with the poster before moving on to the worksheet. Ask students to read each step from the process out loud to the class.
16. Handout the first packet to each student. Ask them to look at the first page. Let them know that the packet helps them go through the engineering design process.
17. Have them look at the problem. Ask one student to read the problem out loud.

18. Ask for volunteers to read the questions out loud. Give them approximately 2 minutes per question on the first page. Try to get them to see that they are trying to come up with a better way to do things. For example you could say, "Remember that Booth didn't think that blowing the dirt off the floor was a very good idea. I bet that you feel the same way when your parents tell you to pick up your toys, fold your clothes, or do anything else to make your room cleaner. There has to be a better way to keep your room clean right?"
19. Give them 10-15 minutes to draw and label their invention. Remind them to clearly label their drawing. Adjust the time if they seem to need more or if they make a drawing quickly then start to lose attention. If they seem to have a difficult time coming up with ideas ask them to look at their answers for the first page of the handout. Maybe their toys belong in the closet but the shelves in the closet are high and it is hard to reach. Can they come up with an invention that will put things up and take things down from the shelf? Perhaps their toys belong in a toy chest but they can never find what they are looking for in there. Can they come up with an invention that will let them organize the toy chest, such as compartments that rotate at the push of a button, so that something from the bottom of the chest is brought to the top? Maybe the student doesn't like to put their toys away because they can never remember where they put anything. Can they come up with a robot that will clean everything and remember where it put it all? Remind them that this does not need to be something that they actually have to be able to make so they can use their imaginations.
20. Have them complete the last page. Again allowing about 2 minutes per question.
21. Ask the students to turn back to the second page of their packet
22. Collect all packets and mix them up a bit.
23. Hand the packets out at random along with the second handout.
24. Explain to the class that sometimes what works well for one person does not meet the needs of another person. Tell them to look at the invention that was given to them (they are only allowed to look at the 1st and 2nd pages) and then complete the 2nd Handout.

25. Point out that the second handout had them modify someone else's design to fit their needs just like Spangler did with Booth's idea and Hoover did with Spangler's idea.
26. Collect all handouts. Look over each and make comments. Hand back to students at a later date.

Materials List (per student) – worksheets, pencils, crayons

Vocabulary with Definition – n/a

Assessment/Evaluation of Students – The worksheet will be looked at to see how well the students applied the engineering design process to the assigned problem. Feedback should be given to each student on his or her worksheet. A grade of check, check plus, or check minus should be given based off of effort and completeness.

Lesson Extensions – n/a

Attachments – 2 handouts, engineering design process

Troubleshooting Tips – n/a

Safety Issues – n/a

Redirect URL – n/a

Key Words – vacuum cleaner, Hubert Cecil Booth, James Murray Spangler, William H. Hoover

Lesson References-

This Book Really Sucks. By the editors of Planet Dexter.

http://inventors.about.com/library/inventors/blvacuum.htm

Name:__________________________Date:__________

Handout 1: I Can be an Inventor Too!

What is Our Problem?- Almost everyone has a messy bedroom. Come up with your own invention to help keep your room organized.

Let's See What We Know:

1.) What kind of things are on the floor of your room that make it messy?

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2.) Where do the things from the floor actually belong?

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3.) Why are these things on the floor instead of where they belong?

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4.) <u>How might we solve our problem?</u> What can you invent to help keep your room clean?

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<u>Let's Make It</u>

Draw a picture of your invention on this page and *<u>label</u>* it. Give your invention a name.

Name of Invention ____________________________

Name:__________________________________

<u>Share your ideas with others.</u>

5.) Explain how your invention would help you keep your room clean.

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6.) What materials would you need to make your invention? How would you build it?

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7.) Can you think of any way to make your invention better?

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See, you can be an inventor just like Hubert Cecil Booth!

Handout 2: How would this work better for me?

1.) Look at the invention that was given to you. Is there anything that you could change that would make it work better in your room?

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2.) Why would this invention work better for you?

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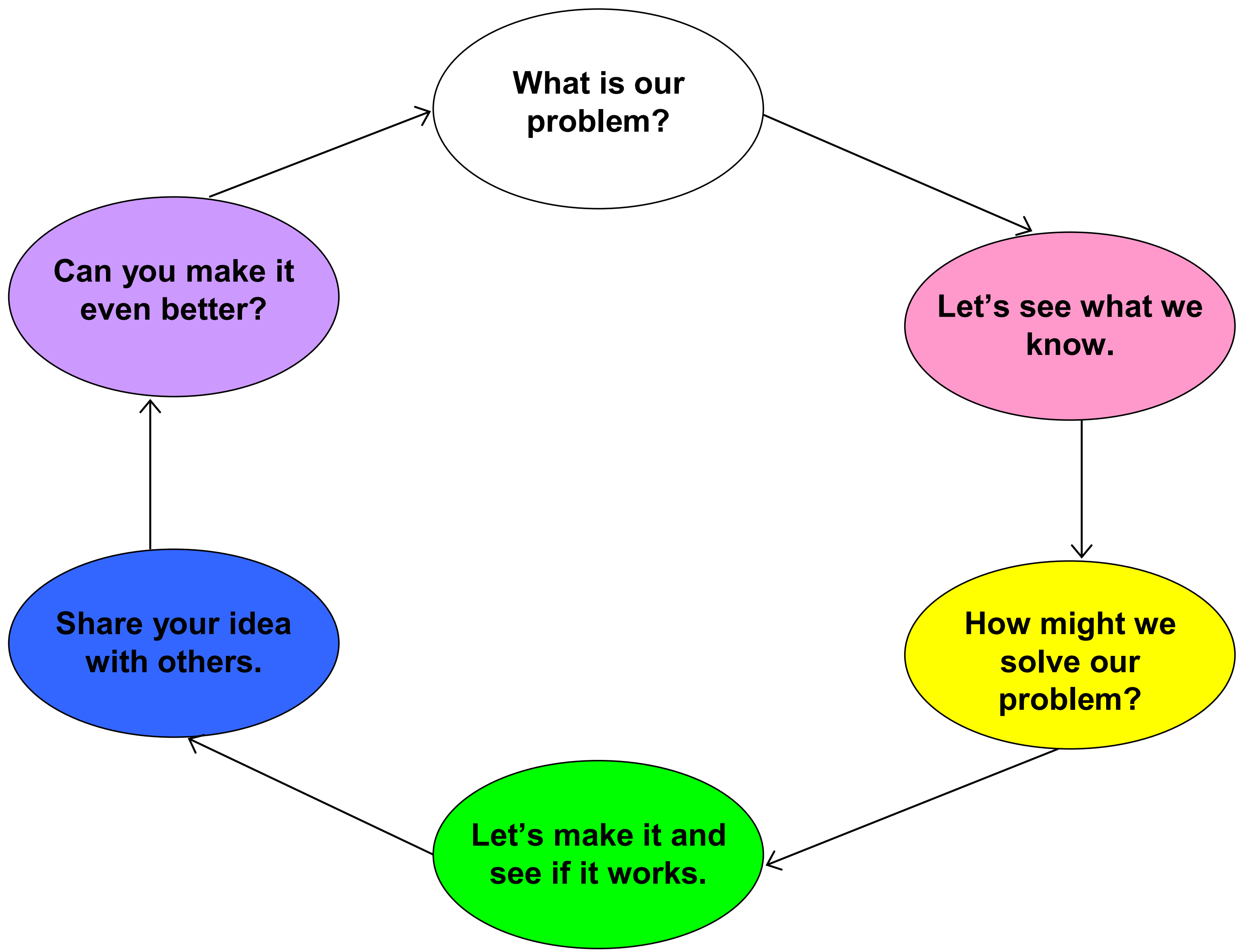
Redrawn the invention with your changes and *label* your picture. *Write* down the old name of the invention as well as the new name that you would give it.


What is our problem?
Let's see what we know.
How might we solve our problem?
Let's make it and see if it works.
Share your idea with others.
Can you make it even better?

Lesson 5: Inventor of the Month, Alexander Graham Bell

Lesson Title – Inventor of the Month, Alexander Graham Bell

Grade Level – 3rd

Lesson Time – One hour

Instructional Mode – Small Groups

Team/Group Size – 4 students per group

Summary – Student will learn what a patent is and how they are used. They will also learn about Alexander Graham Bell and his invention of the telephone, and how he used patents to invent it. Students will then use this knowledge to make improvements upon the following commonly used items: lunchbox, backpack, TV, bicycle, rollerblades, toothbrush, and school bus.

Learning Objectives – 2002 Worcester Public Benchmarks (WPS) for 3rd Grade:

Technology – The student will…

03.SC.TE.01 – "identify materials used to accomplish a design task based on a specific property."

03.SC.TE.02 – "identify and explain the appropriate materials and tools to construct a given prototype safely."

03.SC.TE.03 – "identify a problem that reflects the need for shelter, storage, and convenience."

03.HI.NE.07 – After reading a biography of a person from Massachusetts in one of the following categories, summarize the persons life and achievements:

Science and technology (e.g., Alexander Graham Bell, Nathaniel Bowditch, Robert Goddard, John Hayes Hammond, Edwin Land, Samuel Morse)

Essential Questions – What is a patent?

Who is Alexander Graham Bell?

What did Alexander Graham Bell invent?

How did Alexander Graham Bell use a patent?

Introduction / Motivation – Ask students if they know what a patent is. Using an actual patent teach them what a patent is, and how it is used. Ask students what else patents can be used for. Ask them if they think there's a patent for the telephone.

Procedure –

26. Have students stay in seats.
27. Ask students if they know what a patent is.
28. Explain what a patent is. (See vocabulary section for definition).
29. Show students patent attachment so they understand that a patent is rights to a product and not a physical thing by showing them an actual patent document (See Actual Patent attachment).
30. While showing them the patent explain that a patent contains an author, a date, a patent number, the name of the invention, the description of the invention, and a well labeled picture.
31. Explain to them that Velcro has a patent. Explain using Velcro sneakers as an example of another patent using an previous patent as an idea. Explain that a man had a patent for Velcro, so he was the only person who could make and call his product Velcro. However the man who has the patent to Velcro sneakers has a different patent, giving credit to the original inventor of Velcro.
32. Ask students to name something else they use that has a patent.
33. If no one mentions the telephone, ask if students if they think the telephone has one.
34. Ask if the students know who invented the telephone.
35. Explain Alexander Graham Bell invented the telephone. Alexander Graham Bell was born in 1847 in Edinburgh, Scotland. He moved to the United States where he settled in Boston. Bell had been interested in the education of deaf people. So he pursued to invent the "electrical speech machine". Bell made improvements to the telegraph machine. His first telephone patent was granted on March 7, 1876. Bell was granted 18 patents in his name, and 12 he shared with collaborators. Alexander Graham Bell died in Baddek, Nova Scotia, on August 2, 1922, he was 75 years old when he died.
36. Ask if the students have ever heard of a telegraph machine.
37. Explain what a telegraph machine is (see vocabulary for definition). And that it was invented by Samuel Morse.

38. Explain how the telegraph machine works and give a brief background on Morse Code (see vocabulary for definition). Also emphasize that the telegraph machine had its own patent, so when Bell wanted to invent a communication device he could not use that idea.
39. Have one student come to the board and write their name on it.
40. Then pass out a Morse Code worksheet (see Morse Code Guide attachment).
41. Have students tell you letter by letter how you would write the students name on the board in Morse Code.
42. Explain how Alexander Graham Bell envisioned the telegraph machine, but since someone else already had a patent to it, he *improved* it to make the telephone (see vocabulary for definition). Explain how he decided that instead of sending messages by code it was better to send them by electricity (this will be further explained in a follow-up lesson). THIS STEP HERE IS THE MAIN POINT OF THE LESSON SO BE SURE TO EMPHASIZE IT.
43. Have the students split in groups of about 4-5 students each. (If they are already in groups have them stay in their groups).
44. Pass out the patent worksheet with directions and questions on it to all students (see Patent Worksheet attachment).
45. Go over directions out loud with students for the worksheet.
46. Pass out a small-medium sized poster paper (1 per group).
47. Pass out each group a picture of a common object (See Object Sheet attachment).
48. Have students follow the worksheet to create a new invention from the old one by following directions, and when finished answering the questions on the worksheet. This step will work best if a teacher reads the directions one by one out loud or has one of the students read the directions, then wait for everyone before moving on to the next step. This will keep the class more on task.
49. Regroup as a whole class and present material (Have only the students who properly followed directions present, so the students who did not quite understand can learn from them).

50. Wrap-up discussion of how material all relates.

Materials List (per class, per group and / or per student) –

For each group of four:

- One Poster Paper (size varies, depending on availability from teacher)
- One Object Picture
- Pack of Crayons

For each student:

- One Patent Worksheet
- Pencils

Vocabulary with Definition –

Telephone – a device for sending and getting sounds over long distances by electricity.

Telegraph Machine – a device for sending and getting messages over long distance by code.

Patent – A paper allowing one inventor to have ownership to his inventions. Allows that inventor to be the only one to make, use, or sell the invention. Ends after a period of time.

Morse Code – a telegraph code in which letters and numbers are represented by strings of dots and dashes (short and long signals)

Assessment/Evaluation of Students – Class presentation of invention and questions on Patent worksheet (pass/fail).

Lesson Extensions – If students finish before time is up have them work on the Morse Code worksheet attached. (see Morse Code Worksheet attachment).

Attachments – Patent Worksheet
Morse Code Guide
Morse Code Worksheet
Actual Patent
Object Sheet

Troubleshooting Tips – none

Safety Issues – Make sure students know that you are only drawing patents that they should not go home and actually try to improve any appliances or other assorted objects.

Redirect URL – http://www.uspto.gov/main/patents.htm

http://sln.fi.edu/franklin/inventor/bell.html

Key Words – Alexander Graham Bell, Telephone, Patent, Invention

Name : ______________________

Date:________________________

<u>You Be The Inventor!!!!</u>

Directions : Today we learned about inventions and patents. You are now being given a picture of an object. This object already has a patent. Let's following the Engineering Design Process and invent something!!!

I. What's Our Problem???

(1.) Your job is to take this object and redesign it to make a new invention.

II. Let's See What We Know!!!

(1.) What is your object?

____

(2.) What does it do?

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III. How Might Se Solve Our Problem??

(1.) How could you make this object more helpful?

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IV. Let's Make It & See If It Works!!!

(1.) On you poster with your group, draw your new invention. Remember you will be sharing this with the class at the end, so try to be as *NEAT* as possible. Also please *LABEL* your drawings parts, and you may color it in if we have time.

(2.) What would you call your invention?

____

(3.) How does your invention work?

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(4.) What is a patent?

(5.) How is what you just did like what Alexander Graham Bell did with the telegraph machine and the telephone?

V. Share Your Idea With Others!!!

(1.) Now that you are through making your new invention let's share them with the class.

VI. Can You Make It Even Better!!!

(1.) Lastly let's discuss how we could make our ideas even better!!!

CONGRATULATIONS YOU ARE NOW AN INVENTOR!!!!!

NOW LET'S FILL IN YOUR PATENT!!!

United States Patent :
Date :

Invention:

Abstract (What did you make and what does it do?)

Inventor:
School:
Grade:
Filed:

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention (What is your invention?)

2. Background Description (What does your invention do?)

BRIEF DESCRIPTION OF THE DRAWINGS (Draw and Label your invention!)

MORSE CODE GUIDE

A	.-
B	-...
C	-.-.
D	-..
E	.
F	..-.
G	--.
H	....
I	..
J	.---
K	-.-
L	.-..
M	--
N	-.
O	---
P	.--.
Q	--.-
R	.-.
S	...
T	-
U	..-
V	...-
W	.--
X	-..-
Y	-.--
Z	--..

Name : ______________________

Date:________________________

<u>Morse Code: What does that say?</u>

Part I : Using the Morse Code Guide write down next to the word how it would look in Morse Code.

CAT ____

HOUSE ____

TEACHER ____

GAME ____

MOVIE ____

CAR ____

TIME ____

(your name)

____

ACTUAL PATENT

To view an actual patent go to:

http://patft.uspto.gov/netacgi/nph-Parser?Sect1=PTO2&Sect2=HITOFF&p=1&u=/netahtml/search-bool.html&r=1&f=G&l=50&co1=AND&d=ptxt&s1=6,802,348&OS=6,802,348&RS=6,802,348

This will allow you to view the patent of a book bag. The patent is much to large to include in the lesson plan.

Object Sheet

Lunchbox

Roller Blades

Backpack

Toothbrush

TV

School Bus

Lesson 6: Inventor of the Month for Black History Month, George Washington Carver

Lesson Title – Inventor of the Month for Black History Month, George Washington Carver

Grade Level – 3rd

Lesson Time – 2-3 hours. 2 lessons

Instructional Mode – Lecture about history of GWC, followed by group work making Peanut butter and then using it to make bird feeders

Benchmarks –

03.SC.TE.01 Identify materials used to accomplish a design task based on a specific property.

03.SC.TE.02 Identify and explain the appropriate materials and tools to construct a given prototype safely.

Team/Group Size – Between 3-5 students per group

Summary – This lesson can be broken into 2 lessons, the first being a background of peanuts and how they are used today and how they are grown. This background will be followed by a brief introduction on the accomplishments of George Washington Carver followed by a worksheet challenging the students to come up with a creative invention using a part of the peanut. The second part of the lesson is to make peanut butter to use making bird feeders. The students will all make their own bird feeder using their freshly made peanut butter, pinecone and bird seed.

Essential Questions – Who is George Washington Carver?

What are some of his inventions?

Where do peanuts come from?

How do you make peanut butter?

Introduction / Motivation – Who likes peanut butter? Ever wonder where peanuts come from? Well today we are going to learn where peanuts come from, and that in fact they come from plants and grow in the ground. We are also going to talk about who did the most to make peanut a popular food in America. This man is credited with being one of the first people to popularize peanut butter. And today we are going to have a chance to make some peanut putter and help out some animals that may not be able to get enough food during the winter. The man that made peanut butter famous was George Washington Carver.

Procedure –

1. Begin the lesson with the introduction/motivation session, as above, perhaps excluding the part of making the peanut butter if only the first part of the lesson is being done.

2. Background on Peanuts. This as well as the background on George Washington Carver can be explained in a couple different ways. Asking questions about peanuts and having the students guess should work well with the teacher writing the answers on the board for the worksheet later.

Peanuts were first grown in either Brazil or Peru and were first brought to the United States by African slaves. They were known as goobers.

Peanuts are planted in the ground about 2” deep, 3-4” apart in rows of warm, sandy soil rich in calcium about 3’ apart. When the peanuts are ready to harvest, farmers use a digger (long blades 4-6” underground following the blades is a shaker which lifts and shakes the plant and puts it back down into a “window” peanuts up, leaves down) to cut the tap root of the peanut plant and prepares them for the next step. The next step comes two days later, so the peanuts that can dry out, a combine is driven over the windrows and separates the peanuts from the vine and blows them into a hopper (container) at the top of the machine and lays the vines back down in the windrows.

Over 600 million peanuts are eaten in the United States a year. March is national Peanut month and with two former presidents, Thomas Jefferson and Jimmy Carter being peanut farmers, its apparent how important peanuts have become to the United States.

Every aspect of the peanut is used in different applications. The skin covering the peanut itself has been used to make paper. The shells have been used in wallboard. Of course peanuts have been used the most and they have been used for such applications as soap, ink, rubber, explosives and the obvious peanut butter. Peanut oil is also a very important product developed from peanuts for its tasteless effect that works great for cooks.

The important thing to remember with peanuts is that since its induction into America the technology has grown considerably making it easier to produce in larger quantities which allow for more uses of peanuts. At the beginning of its farming in America peanuts had to be harvested by hand, primarily by using slaves.

Peanuts can not be grown everywhere. For a good crop of peanuts there must be at least 180 days of frost free weather. This is why peanuts are grown in the south of the United States and probably why it was first grown in South America.

2. History of George Washington Carver. This part would probably be better taught by reading this to the students and answering any questions after.

Born 1860 in Missouri on the Moses Carver Plantation. His parents were slaves the plantation he was born at. As a baby he had a disease called whooping cough and could not do regular slave work so he cooked, sewed and tended to his beloved garden.

He taught himself to read and at the age of 12 he went off to school. He loved to study and would often skip recess and read. Soon he knew more than his teacher. He studied botany at Iowa State, where he became the best student in his field. After graduation he was asked to stay and teach and he accepted.

GWC started studying many things including diseases of farmer's crops and a lot of experiments with different plants. He used peanuts in over 300 products, such as soap, ink and of course peanut butter. He made candy from potatoes and building material from cotton stalks.

He later turned down $100,000 to work with Thomas Edison because he'd rather stay and teach. He did not end up rich, but that was not important to him. He believed the successful person was the one who learned to serve others.

3. Pass out the peanut invention worksheet and go over with the class each question giving the student's time to work on each part before moving on.

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4. The next part can be done separately. Making bird feeders to help the lonely birds of Worcester find some food in the winter. You're going to have a chance to build your very own bird feeder using different objects that you can get around your house.

5. Show an example of the peanut butter pinecone bird feeder. The example is just a pinecone (preferably with one that is open) with peanut butter spread over it with bird seed stuck on the peanut butter. Then have a string glued to the top of the pinecone so that it can be hung.

6. Help the class to make peanut butter. For reference, 2 cups shelled peanuts and 1 tablespoon peanut oil to make 1 cup of peanut butter. Blend to a liquid consistency. Depending on how many students there are, depends on how many peanuts are necessary.

7. Hand out a pinecone and birdseed to each student. The pinecones should have string glued to them already to hang.

8. Have the students come up in groups to cover their pinecones in peanut butter. When they go back to their desks have them spread the bird seed on the peanut butter covered pinecones.

Material List – Several bags of peanuts (shelled or unshelled, have kids shell them if They are not already).

Peanut oil.

Blender.

Pinecones, enough for everyone to have one.

Assessment/Evaluation of Students – none

Lesson Extensions – One extension

Attachments – Peanut invention worksheet

Teacher Reference – To make the peanut butter blend 2 cups shelled peanuts and a 1 tablespoon peanut oil for every 4 students. Blend the ingredients in a blender until the desired consistency is reached. Should be smooth without chunks.

Troubleshooting tips – Try rolling the pinecones in the peanut butter but if it is not Liquidity enough then have the students apply it with a butter knife.

Safety Issues – Only an adult may use the blender.

Redirect URL –

Key Words – Peanut, Peanut butter, George Washington Carver, Food engineering

You Are the Inventor

Directions: Today's method for harvesting peanuts takes 2-3 days with 2 steps to gather the peanuts. Your problem is to develop a machine that can harvest the peanuts in one step in one day. Use what you know about peanuts to decide what this machine must be able to do.

What is Our Problem?:

Let's See What We Know:

How Might We Solve Our Problem:

Design Your Machine: Be sure to label all parts including what they are made of.

Show Your Machine to Other People At Your Table to Receive New Ideas.

Can You Make It Even Better?:

Lesson 7: Inventor of the Month, Robert Goddard

Lesson Title -- Inventor of the Month, Robert Goddard

Grade Level -- 3

Lesson Time -- 1 hour +/- 15 minutes for flexibility

Instructional Mode -- Entire Class

Team Group Size – Individual

Summary -- Students are going to learn about the first man to develop a modern rocket, Robert Goddard. Goddard's hometown heritage will be pointed out also. Students will be introduced to basic concepts of a rocket and design a balloon rocket that flies along a string. This will be related to the Apollo moon missions for a later lesson on Moon Bases. Also, students will be asked to list all the uses for a rocket they can think of.

Learning Objectives --

03.SC.TE.01: Identify materials used to accomplish a design task based on a specific property, e.g., weight, strength, hardness, and flexibility.

03.SC.TE.03: Identify a problem that reflects the need for shlter, storage, or convenience.

03.HI.NE.07: After reading a biography of a person from Massachusetts in one of the following categories, summarize the person's life and achievements. (H, C)

Essential Questions --

Who is Robert Goddard?

What is a Rocket?

What is a Rocket used for?

What materials should we use to build a rocket?

Did the rockets perform as expected? Why or why not?

Introduction/Motivation –

Ask the students what they know about astronauts. How do they get into space? They will probably answer either the space shuttle or a rocket. Explain what a rocket is. The rocket burns fuel to push things up into space. Does anyone know who invented the rocket? Robert Goddard did, and he is this month's inventor of the month. He was born in Worcester, and moved to Boston for the first part of his life. He went to college at WPI, and after graduating, taught at WPI and Clark

University. He also invented the bazooka, which is a type of rocket launcher. Now who wants to design their own rocket?

Procedure --

17. Teacher will go through the introduction/motivation
18. Teacher will demonstrate a Balloon rocket. This is done by putting a straw on a string, and securely attaching the two ends of the string to walls. Then construct a previously constructed balloon rocket to the straw. Inflate a balloon (possibly two depending on the size of your rocket), seal off the end with a clip and attach that securely to the rocket. Then release the clip and the balloon will shoot across the room.
19. Student will then go through a worksheet to design their team's rocket.
20. Students will construct their rockets in groups
21. Four or five strings of about 10-15 ft will be set up for racing
22. Groups will compete to see whose rocket flies best.
23. The teacher will wrap up with a discussion of what has been covered.

Materials --

Straw (2 per group)

Paper towel tubes (4 per group)

String (100 ft)

Balloons (20-30 large balloons)

Tape

Clothespins (20-30)

Vocabulary --

Rocket – A cylindrical projectile propelled by a rocket engine.

Projectile -- A fired, thrown, or otherwise propelled object, such as a bullet, having no capacity for self-propulsion.

Thrust – The force from the engine that pushes the rocket

Fuel – The material that explodes in the engine to provide thrust for the rocket.

Bazooka – A World War II rocket launcher used against tanks.

Nose Cone – The front of a rocket, shaped as a cone or sphere to punch through the air.

Rocket Body – The main tube that comprises the rocket.

Assessment/Evaluation of Students – Worksheet evaluating students (pass/fail)

If a student group can work together to provide a good solution for their given problem, they will be considered to have understood the problem extensively.

If a group cannot complete their task, then they will be asked what their problem was. If they can define their main problem, and possible solutions they had, they will have understood part of the engineering design process.

Lesson Extensions –

Write about a movie or TV show they saw recently where rockets were used. What were the rockets used for? Did they perform as expected?

Attachments –

Teachers Attachment

Worksheet for students

Pictures of Rockets

Troubleshooting Tips --

If the students start to get out of control when their rockets are complete, move onto the next part of the lesson. The classroom teacher will also be effective in subduing the students.

The issue of the Columbia and Challenger Shuttle disasters may come up. Teachers should be prepared for such a question and quickly get the group back on topic.

Safety Issues --

Scissors will be used. Students use these commonly, so it shouldn't be much of a problem

When the rockets are complete, the students will want to throw them around. Control will have to be maintained to prevent injuries.

Redirect URL -- N/A

Key Words -- Robert, Goddard, Rockets, Sun, Moon, Earth, Space

Names: ___________________

<u>Rocket Design Worksheet</u>

You will work in a group to design and build a balloon rocket, but complete your own worksheet.

1. What is a rocket?

   ____

   ____

   ____

   ____

   ____

2. What are rockets used for?

   ____

   ____

   ____

   ____

   ____

   ____

3. What **materials** are rockets made from?

   ____

   ____

   ____

   ____

   ____

   ____

4. **Draw** and **label** your group's idea for a rocket. Your group's rocket should be about 12 inches long.

5. Write down a **list of the materials** needed for your group's rocket

____

____

____

____

6. Now we will construct balloon rockets:
    1. Cut the paper towel tubes as long as you want them
    2. Glue or tape the tubes together to form your rocket
    3. To make a nose cone, cut out a circle of paper. Then cut into the center of the circle. Fold the paper so that it creates a cone.
    4. Attach the cone to the nose of the rocket.
    5. Inflate the balloon(s), and pinch off the end of it with a clothespin.
    6. Tape the rocket to the straw.
    7. Tape the balloon(s) to the rocket.

7. We will now test all the group rockets to see which performs best.

8. What happened when you took off the clothespin?

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____

9. How could your group improve their rocket?

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Teacher Worksheet:

This lesson is designed to teach student's about Robert Goddard and his most famous invention, the rocket. It was designed for public school in Worcester, MA. The hometown heritage part of the introduction can be left out for anyone implementing this lesson outside of Worcester.

The point of this lesson is to take kids through the design process and get them thinking about not only how to design their rocket, but what materials are required to build it. This will help students understand the big picture when it comes to developing something. They will have to take into account materials and design and work as a team to develop and build their design.

As a teacher, you should construct a model of a rocket, preferably more complex than that the students will be building. To construct the rocket, you can cut and tape together shorter paper towel roles at the base of your rocket to look like engines. Glue can also be used, and may be preferred. A nose cone can be made by cutting out a circle of paper, and then cutting into the center of it. Then fold the paper into a conical shape and secure it to the rocket with either tape or glue. Test your rocket to make sure the balloons you are using will be able to propel it along the string. Demonstrate this to the students before they begin their worksheet. Testing your rocket design and your balloons is important to the success of this lesson.

Lesson 8: Inventor of the Month, Eli Whitney

Lesson Title – Inventor of the Month : Eli Whitney

Grade Level – 3rd

Lesson Time – 45 minutes to 1 hour

Instructional Mode – Entire Class

Team/Group Size – Individual

Summary – Students will learn about Eli Whitney a local inventor, and about his invention of the cotton gin. Then students will use the attached worksheet to come up with a device that can improve the speed at which one of their chores gets done. To aid in ideas, a sample worksheet is attached.

Learning Objectives – 2002 Worcester Public Benchmarks (WPS) for 3rd Grade:

03.SC.TE.01- Identify materials used to accomplish a design task based on a specific property, e.g., weight, strength, hardness, and flexibility.

03.SC.TE.03- Identify a problem that reflects the need for shelter, storage, or convenience.

Essential Questions –

(1.)Who was Eli Whitney?

(2.)What was the cotton gin?

(3.) How did the cotton gin help out farmers?

(4.) What can you invent that can help you you're your chores?

Introduction / Motivation – To motivate the students you should begin by introducing them to the life of Eli Whitney. Students should be able to relate since he is a local inventor.

Procedure –

1. Gather students as a group.
2. Teach them about the life of Eli Whitney using the attached sheet (The Life of Eli Whitney & the cotton gin attachment).

3. Using the same sheet as a guide, teach the students about the Cotton Gin, making sure they understand how it sped up production of cotton. (Make sure you emphasize the Industrial Revolution)
4. Have students return to their seats (if they have moved).
5. Pass out the "Let's Speed Things Up" worksheet.
6. Go over the directions to the worksheet aloud with the class.
7. Then let the students work on the worksheet for the remainder of the time.
8. Allot 5-10 minutes at the end to regroup, collect the finished worksheets, and to share any really outstanding inventions with the rest of the class.

Materials List (per class, per group and / or per student) –

For each student…

One "Let's Speed Things Up" Worksheet

Pencils

Crayons/Colored Pencils

Vocabulary with Definition –

Eli Whitney – Inventor of the cotton gin

Cotton Gin – a machine that separated the cottonseed from the cotton fiber.

Assessment/Evaluation of Students – "Let's Speed Things Up" worksheet (pass/fail).

Lesson Extensions – none

Attachments – "The Life of Eli Whitney & the Cotton Gin" Worksheet, "Let's Speed Things Up" Worksheet,

Troubleshooting Tips – none

Safety Issues – none

Redirect URL – http://www.bookrags.com/biography/eli-whitney/
http://inventors.about.com/library/inventors/blcotton_gin.htm

Key Words – Eli Whitney, Cotton Gin

THE LIFE OF ELI WHITNEY & THE COTTON GIN

- Eli Whitney born in Westborough, Massachusetts on December 8, 1765.
- He took an early interest in mechanical work.
- Although he worked on his father's farm, he preferred his father's shop.
- At the age of 15, he was engaged part-time in making nails for sale.
- He taught school to earn money to continue his education.
- He graduated from Yale College (in Connecticut) in 1792.
- He wanted to study law.
- To make money for law school he tutored children on a plantation in Savannah, Georgia.
- By April 1793, Whitney had designed and constructed the cotton gin.
- The Cotton Gin was a machine that separated the cottonseed from the cotton fiber.
- Eli Whitney's machine could produce up to 50 pounds of cleaned cotton daily.
- When African American slave cleaned the cotton they would only get about one pound per day.
- Even though this make the process move faster, Whitney didn't make any money from his invention.
- This was because when he would try to sell his invention to farmers they would look at it, and then go make their own cheaper than it was to buy Whitney's.
- Eli Whitney died on Jan. 8, 1825.

Name:____________________________ **Date:**__________________________

Let's Speed Things Up

I. WHAT'S OUR PROBLEM?

I want you to think of a chore that takes up a lot of your free time. You will be using the engineering design process to create an invention to decrease the time of your chore. Remember be creative!

II. LET'S SEE WHAT WE KNOW…

Describe one chore that you think takes up too much of your free time:____

____

____

____

____

____

____

____

III. HOW MIGHT WE SOLVE OUR PROBLEM??

In the box on the next page I want you to draw an invention of what you would build to help you do your chore in less time. Label what you would use for parts to build your invention. If time allows, you are encouraged to color the picture at the end.

IV. LET'S MAKE IT & SEE IF IT WORKS…

Since we do not have the ability to actually build our invention, in this section I want you to write down why you chose the different parts you used to build your invention. Include at least three parts,

V. CAN YOU MAKE IT EVEN BETTER??

Below please write what you would have liked to add or change to your invention if more time was allowed.

Lesson 9: Inventor of the Month, Steve Wozniak

Lesson Title – Inventor of the Month, Steve Wozniak

Grade Level – 3rd

Lesson Time – One hour

Instructional Mode – Whole Class

Team/Group Size – Small groups

Summary – The students will explore the inside of a computer and different hardware while learning about the inventor of the modern personal computer, Steve Wozniak

Learning Objectives – Students will…

03.SC.IS.01 – Ask questions and make predictions that can be tested.

Essential Questions – Who invented the personal computer? What is the difference between hardware and software? What are some hardware components and what do they do? What is the difference between input and output?

Introduction / Motivation – Introduce Steve Wozniak as the inventor of the personal computer. Explain how he started a company from his garage and grew it into one of the largest, most successful companies in the world, Apple Computers.

Procedure –

1. Ask the students when the first computer was invented.
2. Give a history of the creation of the computer. This can be best explained using a timeline. Write the timeline on the board before hand marking the key dates. *1946 the first working computer was created*. Many people contributed to the idea behind the computer but Maxwell Herman Alexander Newman is credited with the first working machine. *1977 the Apple II was invented* which is the first modern computer that could use software. Explain that today we will be talking about Steve Wozniak, the inventor of the Apple II, and some different parts of the computer. Explain that Steve Wozniak did not invent the computer but changed an earlier design of someone else's so that it was better. Today we use computer's built based on Steve's Apple II. For an idea of where computers are now the *internet was invented in 1990 (WWW).*

- 1946 the first working computer was created
- 1950 Steve Wozniak was born
- 1977 the Apple II was invented
- 1990 the internet was invented (WWW)
- 1994 the Pentium was invented

3. Introduce Steve Wozniak as the inventor of the personal computer and provide a picture for the students to associate with. Include Steve Wozniak's background in the timeline mentioned above.

   Steve Wozniak background – *Born 1950*. AKA the wizard of woz, as a child occupied himself with mathematics and computers. First started working for Hewlett Packard where he joined John Draper working on the "Blue Box" which was effectively a pocket-size telephone attachment that would allow for free long distance calls, this was actually illegal. Steve's first call with this attachment according to John was to the pope to ask for a confession. He later joined up with Steve Jobs to invent the Apple I and co-found the Apple Computer company. The invention that really stands out as a break through for Wozniak was the Apple II which was the first computer that had a game that worked through software, correctly named Breakout. To begin their company the founders, Wozniak and Jobs sold their most valuable possessions, a scientific calculator and a Volkswagen microbus respectively.

Apple soon grew into one of the most successful companies in the country. Soon after starting the Macintosh project Wozniak's private plane crashed, causing him to not be able to use his short term memory. Wozniak later left Apple to pursue charitable actions and did a lot of work in the public sector. He has donated over 7 million to charities and is now out of the public eye. He is responsible for making the computer an everyday tool. Http://ei.cs.vt.edu/~history/WOZNIAK.HTM

4. Go over the difference between hardware and software, explaining both. Software is not a physical part of the computer but is used to make the computer more useful. Some examples of software are computer games, music cd's, internet explorer etc… Hardware is a physical part of the computer that works with electricity.

   Ask students to name different computer hardware and to list them on the board. After every new hardware device listed give a brief description of it. This does not need to be written down but just gone over with so that everyone knows about them and not just the kids that brought them up.

   Printer: prints out papers from the computer

   Monitor: like a TV, displays what is going on

   Mouse: lets a person move the cursor around the screen and select things

   Keyboard: lets a person enter information into the computer

   Scanner: opposite of a printer, this takes a piece of paper and transforms what on it into the computer as a picture

   Modem: connects the computer to the internet/web

   Speakers: sends out the sounds of what ever computer program your running (games)

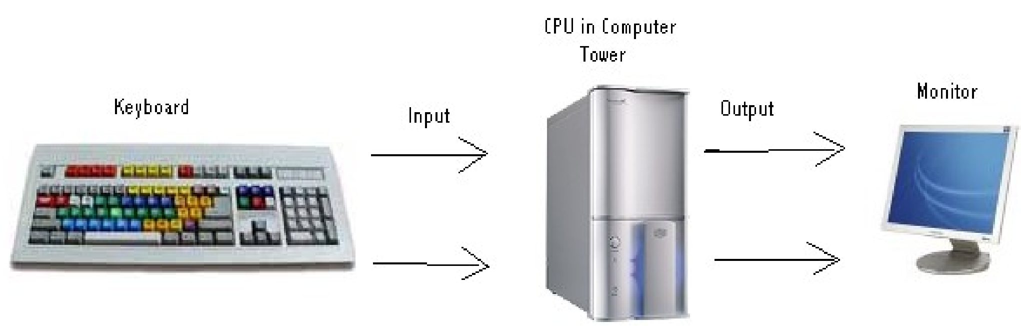
   Tower: holds all the electrical parts that make a computer work

   Digital Camera: takes photos that can be stored on the computer

5. Pass out the first two worksheets and go over them as a class
6. Go over the correct answers to the worksheet.

1. Monitor
2. Tower case
3. Keyboard
4. Digital Camera
5. Track ball
6. Mouse
7. Scanner
8. Speakers
9. Printer

7. Introduce the two types of hardware, input and output. Ask the students if they know what input and outputs are. Guide them to the answer below and write it on the board for the students to see. Input enters information into the computer and output gives information to the user.



8. Hand out the Input/Output worksheet for the students to fill out. Go over the correct answers after.
    1. Output
    2. Input
    3. Input
    4. Input/Output
    5. Input

6. Output
7. Input
8. Output
9. Output

9. Students now have a chance to use what they have learned to design their own computer. Handout to the students the Design Your Own worksheet.

. First go over the safety steps involved in taking apart the computer. Then demonstrate how, after allow students to come up in small groups to observe the insides. While students are coming up in small groups they should be working on the last worksheet designing their own workstation.

A-C Should be explained as the teacher is doing it. Also **stress** that only adults should open a computer while following the safety tips we've gone over. Do not go home and try this!

A. Shut down computer through the start menu safely.

B. After the computer is shut down, unplug it.

C. Put on safety equipment such as a anti-static jacket or a wristband that grounds to the computer

D. Carefully remove the screws holding the case on, these will be around the edges on the back for most computers.

E. Gently lift the case up and clear of the electronics and set aside.

F. Let kids come up in small groups and if they want to touch the inside of the computer then have them wear some sort of protection as stated above.

G. After all kids have been up, close the computer back up following the same safety procedures.

10. Ask the students what they learned as a class to sum up the lesson. Answer any other question they may have about the actual computer.

Material List – For the whole class

Hardware worksheet, Input/Output worksheet, computer and anti-static protective gear.

Vocabulary with Definitions –

Hardware – A physical part of the computer that works with electricity. Monitor, Keyboard, mouse, etc…

Software – Not a direct part of the computer but is used to make the computer more useful. CD's, games…

Input – A type of hardware that a user can enter information into a computer with (A keyboard enters information)

Output – A type of hardware that displays information for the user. (monitor displays information)

CPU -- Central Processing Unit. Brain of the computer.

Internet – A world wide network that computers can connect to and look up almost anything. WWW is the world wide web

Assessment/Evaluation of Students – Worksheet for assessment only, as well as the group discussions.

Lesson Extensions – possible extension on an engineering problem for a second lesson

Attachments – Computer hardware worksheet, Computer Input/Output Worksheet, Design Your Own worksheet

Teacher Reference – Important dates to know are, 1946 the first working computer was created. Many people contributed to the idea behind the computer but M.H.A Newman is credited with the first working machine. 1977 the Apple II was invented which is the first modern computer that could use software. Important parts inside a computer are, the hard drive where information is stored, the cd-rom where software in the form of cd's can be read by the computer, the video card where the images seen on the monitor are created, the sound card where the sound is created that is heard through the speakers, the motherboard where all the other parts inside attach too, the modem is where a connection to the internet can be made through a cable to either a phone line or other on-line services, and the CPU which is the brain of the computer where all the data is processed.

Different ways to connect to the internet are through a regular PBX phone line, DSL which is a generic name for digital lines that are provided by telephone companies to their local subscribers and that carry data at high speeds is in essence a dedicated phone line just for your computer, cable modems which transfer data digitally through Ethernet cable most commonly known as category 5 or just cat 5 cable transfers data at very speeds and does not require a phone line. Also wireless connections are available and these are done using wireless internet cards inside the computer that can make a connection to a wireless router nearby that allows access.

Troubleshooting tips – none

Safety Issues – Make sure to stress not to take apart computers. This should only be done by adults and by always following the rules of wearing anti-static protection, such means of protection are through using grounding wristbands or an anti-static jacket.

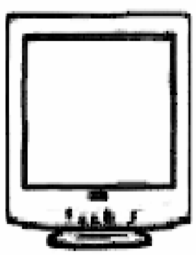
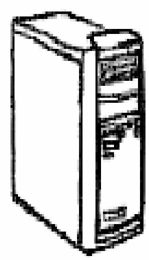
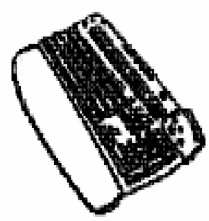
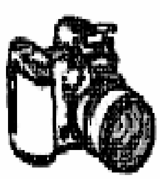
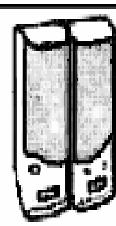
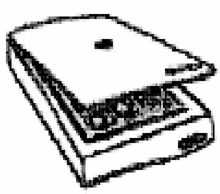
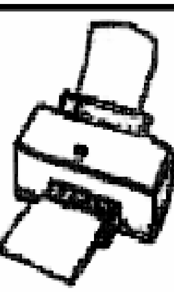
Redirect URL – http://ei.cs.vt.edu/~history/WOZNIAK.HTM

Key Words – Computers, hardware, software, static electricity, Steve Wozniak

Computers: Inside & Out - Outer Hardware
Labeling Worksheet

Choose the word that best describes the picture and write the word in the blank.

scanner	tower case	monitor
mouse	digital camera	printer
keyboard	speakers	

 1. ________	 2. ________	 3. ________
 4. ________	 5. ________	 6. ________
 7. ________	 8. ________	

Computers: Inside & Out - Outer Hardware
Input/Output Worksheet

Output devices receive information from the CPU and translate it into sounds or images we can understand.

Input devices allow us to send information to the CPU to tell the computer what to do.

Write INPUT or OUTPUT in the blank next to the components listed.

1. Monitor ____________________
2. Keyboard ____________________
3. Scanner ____________________
4. Digital Camera ______________
5. Touchpad ___________________
6. Laser Printer _________________
7. Mouse ____________________
8. Speakers ____________________
9. Inkjet Printer _________________

Design Your Own

Instructions: Design your own computer workstation, include several types of inputs and outputs. Make sure to label all parts of your workstation by their name and as an input or output.

Lesson 10: Life Cycle of a Plant

Lesson Title – Life Cycle of a Plant

Grade Level – 3rd

Lesson Time – ongoing

Instructional Mode – hands on

Team/Group Size – groups of 4

Summary – This lesson will build upon the water cycle lesson and is meant to be implemented after your regular life cycles lesson. This lesson is not intended to teach life cycles. The students will try to grow a seed in a bottle and make observations about the life cycle.

Learning Objectives – – Worcester Public School Benchmarks for 3rd Grade:

Skills of Inquiry: *Students will…*

O3.SC.IS.01-ask questions and make predictions that can be tested.

03.SC.IS.03-keep accurate records while conduction simple investigations or experiments.

Essential Questions –

- Why doesn't the seed need to be watered?
- What observations can be made during the growth of the seed?
- What is the life cycle of a seed?
- What do seeds need to germinate?

Introduction / Motivation –

Tell the students that they are going to conduct an experiment using what they know from a past activity and what they have learned about the life cycle of a plant.

Procedure –

1. Review the water cycle lesson with the students. See if they can recall how it worked. They should remember that the blow dryer provided heat which caused the evaporation. As the water vapor rose it hit the ice which caused condensation. The condensation collected and it began to "rain."
2. Have the students split up into groups of four.

3. Have a selection of seeds available for the students to pick from (ex: dandelion, apple, orange, oak tree, beans, corn, pinecones, etc. You could also have baby spider plants available as these will root themselves).
4. Have each group discuss which seed they would like to use.
5. Give each group a soda bottle (no label) with a top, a piece of paper, a plastic cup of potting soil, and a plastic cup of water.
6. Ask one student from each group to pick up the piece of paper and show them how to roll it into a cone. Have the student hold the tip of the cone in the top of the soda bottle.
7. Ask another person from each group to pour half of the cup of potting soil into the bottle.
8. Ask a third person from each group to drop the seed into their bottle.
9. They can now pour in the remainder of the soil.
10. Remove the paper funnel from the bottle.
11. Have the fourth student carefully pour the water into the bottle. They may not need to pour the whole cup in. Explain that the soil needs to be wet but it should not be so wet that there is water on top of the soil.
12. Have each group put the cap on their bottles.
13. Have each group write a prediction of what will happen in their journal.
14. Place the bottles on a windowsill.
15. Have the students check the bottles once or twice a week and make observations in a journal. They should note what stage of the cycle their seed is in and any differences from the last time they checked their bottle. Note that not all seeds will go through the complete life cycle. Some seeds may not even grow. If this happens have the students try and explain why the seed did not grow. Most seeds will probably germinate but not grow much after that. For example there is not enough room in a bottle to grow a pine tree.
16. After a few weeks have each group give a short oral presentation of their results.

Materials List (per class, per group and / or per student) –

1 small journal per group, one soda bottle per group, paper, potting soil, cups, water, various seeds.

Vocabulary with Definition –Taken from Discovery Works published by Silver Burdett Ginn Science, 1996.

Seedling-The new plant that develops from and embryo and has roots, a stem, and leaves.

Germinate-To sprout and begin to develop into a seedling. Most kinds of seeds need moisture, air, and warmth to germinate.

Pollination-The process by which pollen reaches a pistil. After pollination, a flower can produce seeds.

Assessment/Evaluation of Students – Journal of observations

Lesson Extensions – n/a

Attachments –n/a

Troubleshooting Tips – n/a

Safety Issues – n/a

Redirect URL –n/a

Key Words – life cycle, seeds, pollination, seedling, water cycle, germination, observation

Lesson 11: Lunar Bases

Lesson Title—Lunar Bases

Lesson Time-- 1 hour +/- 15 minutes for flexibility

Instructional Mode—Individual Effort

Summary-- The purpose of this lesson is to show students what tools were used on the moon. Pictures of astronauts from the Apollo missions will be used to inspire the students. Students will design and construct out of cardboard a lunar habitat with a rover to collect rocks.

Learning Objectives--

03.SC.TE.01: Identify materials used to accomplish a design task based on a specific property, e.g., weight, strength, hardness, and flexibility.

03.SC.TE.03: Identify a problem that reflects the need for shlter, storage, or convenience.

Essential Questions--

What is the moon and where is it?

Who was the first man on the moon?

What is gravity like on the moon?

What is the atmosphere like on the moon? Can you breathe up there?

How can you get to the moon?

Introduction/Motivation--

Who here can tell me about the moon? Where is it? Who was the first man on the moon? Neil Armstrong was the first man to land on the moon July 20th 1969. Does anyone know what he said when he landed? "One small step for man, one giant leap for mankind." How did he get to the moon? What did he wear while on the moon? Why did he have to wear a spacesuit? Astronauts need protection from the lack of oxygen and cold temperatures. How would Neil Armstrong have gotten around on the moon? You are going to design and build a lunar habitat today that will allow people to live on the moon. The requirements will be outlined in the worksheet.

Procedure--

1. Go through the introduction and motivation section.

2. Pass out the Lunar Habitat design worksheet and lead the class through it.
3. Develop a list of things needed for living on the moon.
4. Have the students draw and build their own lunar base. When completed, let the students share and explain their ideas.
5. Introduce the next part of the lesson by referring to it as one of the missions after Neil Armstrong landed on the moon.
6. Explain to them what happened on the mission. One of the oxygen tanks was damaged before it was put in the rocket. When the astronauts went to use it, it exploded, destroyed the other oxygen tanks around it, and also blew off the side panel of the rocket. The astronauts then had to carefully bring their rocket home while slowly running out of oxygen.
7. Without their oxygen tanks, a poisonous gas began to appear in the rocket. The astronauts had to find a way to filter the oxygen they had so they could continue breathing.
8. NASA engineers came up with a way to get rid of the poisonous gas in the rocket. We are going to show a clip from the movie Apollo 13, where NASA engineers worked to solve the problem with very limited materials. With socks and duct tape, the engineers came up with a carbon dioxide filter. Emphasize how it is impressive that the NASA engineers did so much with very limited materials.

Materials--

Apollo 13 movie clip – The scene where NASA engineers are discussing the carbon dioxide problem.

Cardboard

Scissors

Vocabulary:

Earth – The planet we all live on

Moon – The moon orbits the earth. You can see it almost every night in the sky.

Gravity – Gravity is what keeps on the surface of the earth. Without it, we would float away into space

Atmosphere – The atmosphere is the air we breathe everyday. The moon doesn't have an atmosphere, so you have to have your own air supply

Apollo Program – The NASA mission designed to take astronauts to the moon

Apollo 11 – The mission that landed Neil Armstrong and Buzz Aldrin on the moon.

Apollo 13 – The mission to the moon that had to be aborted when there was an explosion in the rocket on the way to the moon.

Assessment/Evaluation of Students--

The students will have a worksheet to complete to evaluate their understanding of the lesson (Pass/Fail).

Lesson Extensions – Hotel Costs (explained in teacher's worksheet)

Attachments--

Worksheet for students

Pictures of Astronauts and the Moon

Teacher's attachment

Troubleshooting Tips – The students may have trouble understanding all of the different Apollo missions and rocket concepts. Clearing up the students ideas may take some time.

Safety Issues – None

Redirect URL – None

Key Words – Space, Moon, Earth, Tools, Astronauts, Rockets, Apollo, Base

NAME: ______________________

Design Your Own Lunar Base

What is our problem?

You have been hired by Star Tours, a company that wants to build a hotel on the moon for about 10 tourists. They also want to provide tours around the moon. Your job is to draw and construct a moon base that tourist can stay at.

What do we know about the moon?

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What will our moon base need?

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Parts of the Moon Base

Landing Pad – This is where the rockets full of tourists will land and take off
Escape Rocket – This is an emergency rocket in case the hotel has to be evacuated
Garden – This is where the hotel's food and water will come from
Power Plant – This is the where the hotel's power will come from
Hotel Rooms – This is where the tourists will stay
Lunar Rover and Garage – This is a car that will take the tourists around the moon. It will be stored in the garage. Draw the rover parked outside the garage.
Activity Building – This is where the tourist will be able to exercise, play games, swim, and relax while not on tours.

<u>You can also add anything that you feel will make your base better</u>

Remember that there is no air on the moon! All of your buildings will have to be able to keep the air they have inside them. Also, they should be connected by tubes so that tourists can walk to each building. This way the tourists won't need space suits.

Draw and Label your idea for a Lunar Base. Remember what was mentioned about what you need for your base.

Now construct your moon base out of cardboard!

Teacher's Worksheet:

During the moon base design worksheet, one of the main points the student should understand is that there is no air on the moon. Their buildings need to be enclosed.

There may be issues showing Apollo 13 in the classroom because it is rated PG. If so, it is suggested that you use the lesson extensions idea. The basis of the hotel costs extension is that the students will be able to practice some of their math skills while applying it to a real world problem.

Possible Questions:

If it costs $200,000 to send 10 people to the moon, how much will it cost per person?

It cost $800,000 to build the moon base. At $20,000 per tourist, how many tourists will it take to pay off the moon base?

Lesson 12: Nuts, Bolts, and Screws

Lesson Title – Nuts, Bolts, and Screws

Grade Level – 3rd

Lesson Time – 45 minutes

Instructional Mode – Hands on discussion followed by a group exercise.

Benchmarks –

03.SC.TE.02 Identify and explain the appropriate materials and tools to construct a given prototype safely.

Team/Group Size – Groups should be 3-5 students

Summary – A hands on demonstration on how a screw works. Followed by a group exercise where groups of students have a chance identify which, a screw or bolt is used in making an invention.

Essential Questions – What is a screw? What is a bolt? What is a nut?

Introduction / Motivation – Engineers in almost all fields need to use screws, nuts and bolts at some point in their profession. Understanding the value of each and when they are useful will make any job easier and better designed. An example of when a bolt would be used and a screw would not is a bike. The wheels are connected to the frame using a nut and bolt.

Procedure –

1. Start with the introduction as seen above. Show examples of a screw, nut and bolt so students can associate what you are discussing with the actual object. Give each group a sample of screws, nuts and bolts for them to examine during the lesson.

2. Explain the properties of the screw first. Cut a piece of paper in a spiral toward the middle before class. Hold the middle of the spiral and let the rest fall, if cut properly the paper should make a screw like spiral. Use this as a large example of what a screw is in essence, just an incline plane wrapped around itself. Some uses of a screw should be given to let the students understand the value of it. As opposed to bolts, screws do not need to go all the way through to hold two objects together. The other main difference is that the screw is capable of making its mating end by making a threaded hole in the object, while a bolt needs the nut which is its mating end. Some examples of this are into a wall where the other side is inaccessible or if one of the objects is much thicker than the other a screw would be used since it does not need to go all the way through.

3. Ask the students to brainstorm why a screw might be an incline plane wrapped around itself. The answer they should be guided to is that the incline plane is a simple machine that makes work easier. This simple machine makes it easier to make the mating end in the object being screwed together.

4. Explain the properties of the bolt. The bolt has no point and is used in conjunction with a nut. The bolt must go all the way through the objects it is being used on to be able to attach to the nut. The bolt usually has a small threaded area for the nut but the rest is smooth, relying on compression of the nut and not the threads to keep the two objects together. It is incapable of making its mating end as explained earlier.

5. Pass out the worksheet for the Screw, nuts and bolts. Go through the directions with the students answering their questions before they begin, lead them through the examples on the worksheet and help the students to decide which would be used in the example, a screw or bolt.

6. After the examples have been finished. The students can then brainstorm different devices or structures or instances when a screw or bolt or both are used.

Material List – Many different size screws, bolts with matching nuts. Also precut, predrilled pieces of wood in packs

Vocabulary with Definitions –

Screw, inclined plane wrapped around itself capable of making its mating end.

Bolt, threaded, non-pointed inclined plan that can not make its mating end, requiring a nut to work properly.

Assessment/Evaluation of Students – The objects that students make must not deform themselves under normal pushing and pulling. The precut pieces of wood will be made such that without using screws and bolts at the appropriate places the objects will not hold their shape, it will also show that

Lesson Extensions – none

Attachments – Screws, Nuts and Bolts worksheet

Teacher Reference – none

Troubleshooting tips –

Safety Issues – Explain to students that these are not tools and to not poke each other with the screws. Obviously screws should not be dropped on the group because of the risk of injury. Throwing of any parts is to be strictly discouraged.

Redirect URL –

Key Words – Screws, nuts, bolts, incline plane

Screws, Nuts and Bolts

It’s important for engineers to understand which parts are needed in the project their working on. Knowing which part is to be used in a project makes the job easier.

What is our Problem?

____

____

____

____

What do we know?

____

____

____

____

Which would be used in the building of these objects? A screw, a bolt or both?

Bicycle	____________________	Desk	_________________________
Door hinge	____________________	Basketball hoop	_______________________
Car	____________________	Computer	_________________________

Brainstorm a list of other inventions that need a screw or bolt listing which one or both. This can be done in groups.

1. ____

2. ____

3. ____

4. ____

5. ____

Discuss your list as a class and go over any problems you may have had.

Lesson 13: Maple Sugaring

Lesson Title – Maple Sugaring

Grade Level – 3rd

Lesson Time – 1 and ½ hours

Instructional Mode – Whole class

Team/Group Size – Small groups for engineering exercises

Summary – The students will be introduced to the maple sugaring process, including how to identify a maple tree, when to tap a tree, how to tap a tree, how many taps to put in a single tree and how much sap is necessary to actually make syrup. This will be followed by a description of the boiling process and how to turn sap into syrup. After learning about maple syrup, students will have an opportunity to make their own maple milkshakes. Lesson also includes explanation of how to tap a tree as a class activity if your school has access to maple trees.

Learning Objectives -- 2002 Worcester Public Schools Benchmarks (WPS) for 3rd Grade

> 03.SC.LS.06 – Study maple trees and to maple sugaring. Identify the structures in the maple tree and their functions.
>
> 03.SC.TE.03 – Identify a problem that reflects the need for shelter, storage, or convenience.

Essential Questions – What is a maple tree? What is sap? Where does maple syrup come from? How do you make maple syrup?

Introduction/Motivation – Ask the students if they like the taste of maple syrup. (Can even bring in maple syrup for them to taste to really grab their attention) Have a brief discussion on how important maple syrup is to the New England area. Maple syrup generated over 35 million dollars of revenue in 2003. This was generated by the sale of over 1.2 million gallons of maple syrup.

Procedure –

1. Begin the lesson by asking the students if they know how to identify a maple tree. Either bring in a maple leaf or if one is not available show a picture of one for students to observe.

2. Some interesting facts about maple trees and their syrup are that the Canadian national flag has the maple leaf on it. Also maple syrup is only produced in eastern Canada and northeastern United States, although it could be produced in other parts of the world. Nobody knows the reason for this oddity.

3. When does the sap run in a tree? The sap will run all the time in warm weather but only between the beginning of March to mid-April do they tap the trees. Any later than this, the sap when boiled down to syrup will be very bitter and will taste burnt. The days that are good for the sap to run is when the nights are cold, 27*F followed by a warm day of 36*F.

4. Refer to attached document on how to tap a tree and boil the sap down to syrup. To teach this to the students, bring in an actual maple log (a cross section from the trunk of a maple tree. This can be prepared by having a big log correctly drilled according to the directions given below and have the spouts tapped in gently). Have students come up in groups to examine how the spouts were put into the log, the important thing for the students to understand is how the spouts were put in. The angle should be stressed as well as the distance between each tap. Next explain as simply as possible the boiling process by following the steps in the attached file. The important thing for the students to understand about the boiling process is that a lot of sap is needed to boil down to syrup.

5. There are 4 different flavors of maple syrup. Extra light syrup, from the beginning of the season. Light syrup, has a stronger taste and collected a little later. Medium syrup is even stronger and collected even later. Amber syrup is dark syrup and is collected just before the leaves start to bud on the trees.

6. Begin the second stage of the lesson and tell the students some new foods that can use maple syrup to make them even better. Here are some examples: Maple Banana Eggnog, **Maple Milkshakes**, Maple Lemonade, Maple Soda, Maple Snow, etc.

7. Pass out a handout with different recipes to use maple syrup with that they can take home to share with their parents. Also pass out Word Search worksheet for the students to work on while students are doing the next step.

8. Call groups up to make maple milkshakes. Let them use the recipe from the handout and have them measure the ingredients. Help if necessary to explain the metric system if they are not familiar with it.

The recipe is 250mL Milk, 30mL of syrup and 2 scoops of vanilla ice cream blended together. This will make 2 servings.

9. Enjoy Maple Milkshake!

Materials List –

1. Syrup samples for entire class
2. Milk and ice cream for milkshakes
3. Measuring cup
4. Blender
5. Real maple sugaring spout
6. Handout with different maple syrup recipes

Vocabulary with Definitions –

Maple sap – is boiled to make syrup.

Spout – A piece of plastic, metal or wood that fits in the tree and is hollow to allow syrup to flow.

Assessment/Evaluation of Students – none

Lesson Extensions – 1 with several small follow ups. The major one will be to actually go out and have the kids help to tap some trees to get sap for making maple syrup.

Attachments – "How to Tap Maple Trees and Make Maple Syrup"

Maple syrup recipes

Word Search

Teacher Reference – Some simple trivia about maple trees and the sap.

1. When does sap run? After a frosty night and on a warm day. The running of sap means when sap will be moving inside of a tree and if tapped correctly will flow out.
2. Does tapping hurt the tree? No, some tapped trees have been used for 100 years.

3. How long can you tap a tree for? All year but only in the spring before the leaves start budding will it be sweet.
4. Where is the sap? The sap is found everywhere in the tree but is tapped from the trunk because it is the easiest to get too and the most can be found there.
5. Do not tap more than 4 holes in a tree regardless of the size because over tapping can hurt the tree
6. An average maple tree can yield over 60 liters of sap a year.
7. Trees with the most leafs make the best sap bearing trees.
8. Definitions to help with word search
    - Hydrometer – measures the amount of sugar in sap or syrup
    - Evaporator – used in boiling sap into maple syrup
    - Sugar Bush – a collection of maple trees
9. It takes 40 gallons of sap to make 1 gallon of maple syrup

Troubleshooting Tips – none
Safety Issues – Explain proper safety when using a blender, only to use it with an adult
Redirect URL – http://www.umext.maine.edu/onlinepubs/PDFpubs/7036.pdf
Key Words – Maple Tree, syrup, sap

Maple Syrup Recipes

Maple Milkshakes
250 mL milk
30 mL maple syrup
2 scoops vanilla ice cream
- Put everything in a blender, blend for one minute or foamy. Makes 2 milkshakes.

Maple Banana Eggnog
1 ripe banana
1 egg
30 mL maple syrup
250 mL cold milk
- Put everything in a blender, blend for 2 minutes. Makes 2 servings.

Maple Lemonade
2 lemons
60 mL maple syrup
500 mL cold water
- Squeeze juice from lemons into a pitcher with other ingredients and mix.

Maple Soda
1 can club soda
60 mL maple syrup
- Mix syrup and soda in a cup with a spoon.

Maple Snow
250 mL milk
1 egg
125 mL sugar
15 mL vanilla extract
- In a large bowl mix all ingredients. Add clean fresh snow to absorb all the liquid. Scoop out and enjoy. Makes 6 small servings.

Maple Gingerbread
2 cups of flour
1 egg, beaten
1 cup sour cream
1 cup pure maple syrup
1 teaspoon ginger
½ teaspoon salt
1 teaspoon baking soda
- Combine and sift dry ingredients into a bowl. Mix maple syrup with the beaten egg and add the sour cream. Combine the mixtures and bake in moderate oven (325F-350F) for 40 minutes. Makes 8 servings.

Try making these delicious treats at home with the help of your parents.

How to Tap Maple Trees and Make Maple Syrup

Step 1. Drill the hole using a drill bit with a diameter of 7/16 inch, at a convenient height and two inches deep if you are using standard size spouts. Look for unblemished bark. Drill the taphole with a slight upward angle so the sap flows out readily. Use a sharp drill bit to minimize rough wood in the taphole, which can reduce sap yield and cause sap quality problems.
Step 2. Tap the spout in so that it is tight and cannot be pulled out by hand. But don't drive it in so hard that you split the tree. Tap on warm days when the temperature is above freezing to minimize the risk of splitting the tree.
Step 3. Hang your bucket or container on the hook of the spout if it is a purchased one; or, if you have made your own, fashion a length of wire to serve as a hanger. Be sure to cover the bucket to keep out rain and snow.
The following steps are only for boiling the sap into syrup. This will not actually be done but it can still be explained to the students
Step 4. To boil sap, use an evaporator or an outdoor fireplace. Do not do this inside
Step 5. Once the sap has started to run and you have collected enough to fill your pan for boiling, you are ready for the fire. Do not fill your pan to the top, as it will boil over. As the sap boils down, keep adding more sap. Keep the sap at least 1-1/2 inches deep in the pan.
Step 6. Do not leave an accumulation of sap in the collection buckets, especially in warm weather. Sap is like milk: it will sour if left in the sun. Keep the sap in cold storage. Boil it as soon as you can.
Step 7. Sap becomes finished maple syrup when it reaches 66-67% sugar content and 7.1 degrees F above the temperature of boiling water. You can learn the boiling point of water, which varies depending on your elevation and the barometric pressure, by measuring the temperature of the raw sap when it begins a rolling boil. A syrup or candy thermometer is very useful. If you have a large operation, you might consider using a syrup hydrometer and testing cup to tell you when the syrup is done. Using a hydrometer is an accurate method of determining sugar concentration.
Step 8. Filter the syrup while it is still hot, through clean filter material such as wool or Orlon™. If you don't have filter material, you may put the syrup in a container and let it cool for 12 hours or more. The sediment will settle to the bottom and the clear syrup can be carefully poured off. This should be reheated to 180 degrees F (almost boiling) before it is poured into containers for final storage.
Step 9. Syrup should be canned hot (180 degrees F). Pour the hot syrup into sterilized canning jars and seal. Fill them full so that very little air will be in the jar. Lay them sideways while cooling for a better seal.
Step 10. Store your syrup in a cool, dry place, with the jars turned on their sides to coat the air space at the top of the jar. After a container has been opened for use, it must be refrigerated.

- http://www.umext.maine.edu/onlinepubs/PDFpubs/7036.pdf

For more in depth instructions for exact process

WORD SEARCH

S	A	P	B	E	C	H	B	S	E
U	Y	C	A	V	Y	B	A	U	V
G	F	R	G	Z	I	O	R	G	A
A	S	E	U	L	K	S	R	A	P
R	Q	U	S	P	L	P	I	R	O
B	V	A	P	S	A	L	N	I	R
U	M	H	S	S	C	O	G	N	A
S	W	A	U	L	C	X	T	G	T
H	V	S	P	O	U	T	O	I	O
K	A	R	R	L	I	O	N	G	R
E	V	A	H	Y	E	R	O	M	A
H	Y	D	R	O	M	E	T	E	R

Circle these words in the word search above!

Sugar Bush	Maple	Spout
Sap	Sugaring	Hydrometer
Barrington	Syrup	Evaporator

http://www.maplesugarshack.net/kids.htm

Lesson 14: Phases of the Moon

Lesson Title – Phases of the Moon

Grade Level – 3rd

Lesson Time – One hour and a half

Instructional Mode – Whole Class

Team/Group Size – 4-5 students

Summary – Student will learn the phases of the moon and the order they occur. Then they will use two pre-constructed moon boxes to observe the phases of the moon, and fill out a moon phase worksheet. Additional worksheets will be provided for extra time.

Learning Objectives – 2002 Worcester Public Benchmarks (WPS) for 3rd Grade:

Essential Questions – What is a new moon?

What is a crescent moon?

What is a half/quarter moon?

What is a gibbous moon?

What is a full moon?

What is waning?

What is waxing?

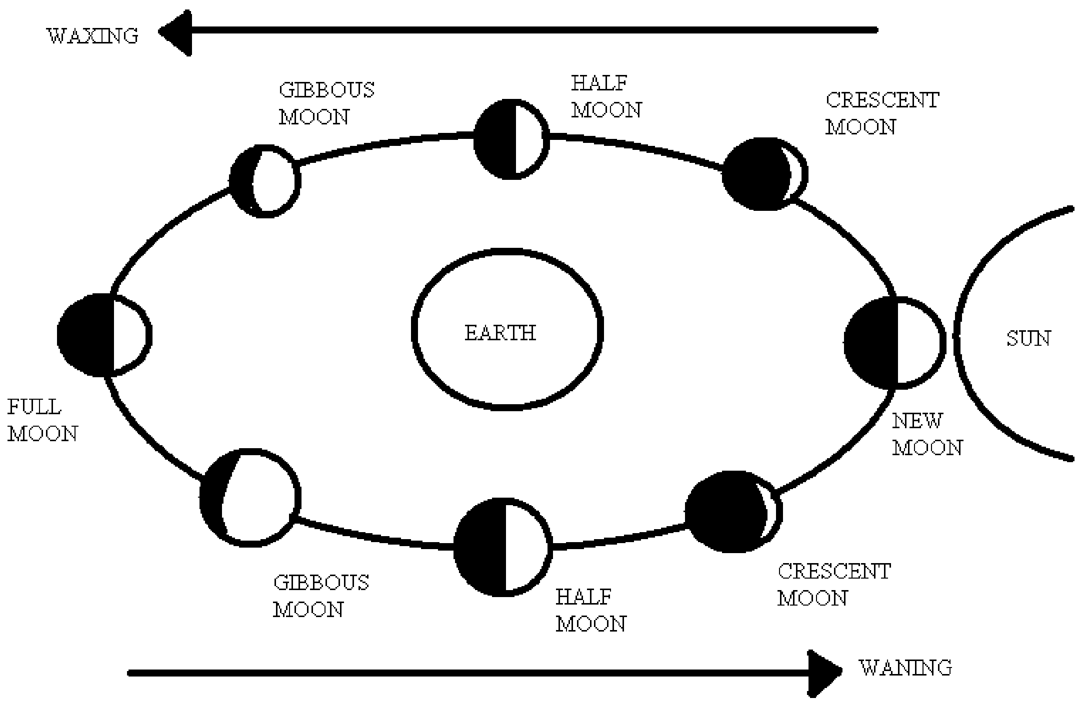
What is a blue moon?

How long does the moon cycle take?

Introduction / Motivation – Ask students who has ever seen the moon? Ask them what the moon looked like when they saw it? Have a few of the draw it on the board. Ask them why they think the moon looks different some of the time. List on the board their reasons.

Procedure –

1. Have students gather at the front of the class.
2. Ask students who has seen the moon?
3. Ask students what it looked like when they saw it? (Take several responses)
4. Start with New Moon (see vocabulary for definition) and draw the phases on the board going over what they are named, when they occur and what you can see. Also explain the concepts of waxing and waning.(See teacher reference section for more information) Se diagram below for more explanation.



5. Explain the moon box, and why we are using it. That the classroom is not dark enough to observe the different phases so we use the box to create a dark environment.
6. Ask students to come up in groups to observe the phases of the moon using the moon box.
7. Each student will stick their head in the moon box (they will represent the earth) while the moon will revolve around them so they can observe how it changes.
8. Have students observe one at a time, a single phase of the moon, and circle it on the board. Repeat this rotating the students until each phase has been completed.
9. Students will then once they have viewed the box complete the Moon Activity Sheet (See Moon Activity Sheet attachment).
10. Then discuss/summarize as a whole class what the students learned.

Materials List (per class, per group and / or per student) –

For each pair of students:

- Moon Box Activity Packet (See Moon Activity Sheet attachments)

For whole class:

- 2 Moon Boxes(See Moon Box Instructions (for teachers) attachment)
- 2 Flashlights

Vocabulary with Definition –

Blue Moon - When two full moons occur in a single month, the second full moon is called a "Blue Moon."

Crescent Moon - part way between a half moon and a new moon, or between a new moon and a half moon.

Full Moon - appears as an entire circle in the sky

Gibbous Moon - between a full moon and a half moon, or between a half moon and a full moon.

Half Moon - A half moon looks like half a circle. It is sometimes called a quarter moon (this Moon has completed one quarter of an orbit around the Earth from either the full or new position and one quarter of the moon's surface is visible from Earth).

New Moon - The new moon is the phase of the moon when the moon is not visible from Earth, because the side of the moon that is facing us is not being lit by the sun.

Waxing – Phases decrease in the size of the area lit by the sun

Waning – Phases increase in the size of the area lit by the sun

Assessment/Evaluation of Students – Moon Box Activity Worksheet, and Phases of the Moon Packet

Lesson Extensions – Moon Phases Word Search, Moon Phases Crossword, Moon Maze

Attachments – Moon Box Instructions (for teachers)

Moon Box Activity Worksheet

Phases of Moon Worksheet

Moon Phases Word Search

Moon Phases Crossword

Moon Maze

Phase Explanation for Teachers/Instructors

Troubleshooting Tips – Since not all of the students will be able to view the moon box at the same time the word search, crossword, and maze worksheets have been attached to give the students waiting some moon activities to do**.**

Safety Issues – Have students be extremely careful while sticking their head in the moon box.

Redirect URL – http://www.classbrain.com/artaskcb/publish/article_51.shtmlnone

http://www.ioncmaste.ca/homepage/resources/web_resources/CSA_Astro9/files/multimedia/unit3/phases_moon/phases_moon.html

Key Words – Phases, New Moon, Half/Quarter Moon, Gibbous Moon, Crescent Moon, Full Moon, Blue Moon.

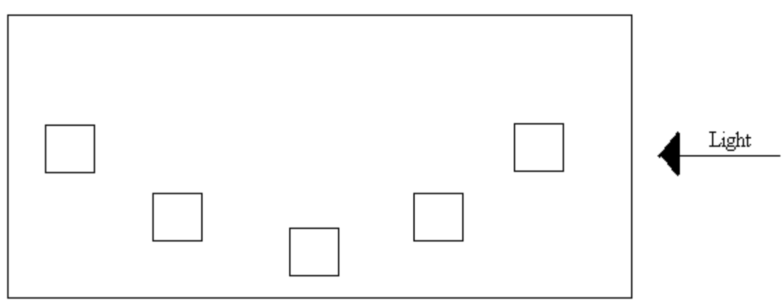
MOON BOX INSTRUCTIONS(for teachers)

MATERIALS (per box):

- 1 Large Box (approximately 25.5” x 12” or larger)
- Black spray paint
- Pipe Cleaner (Black)
- Pencil
- Duct Tape
- Scissors
- Racquet Ball
- Flashlight

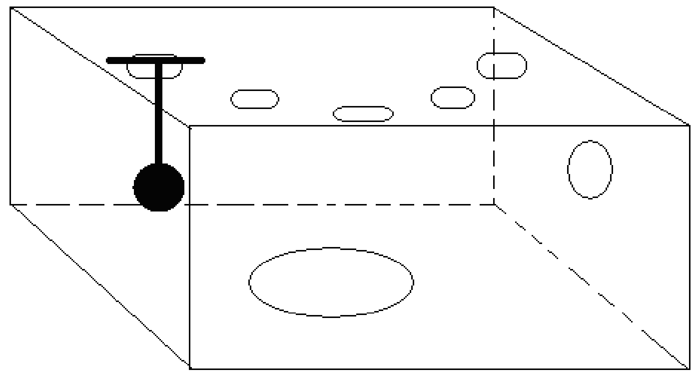
DIRECTIONS:

1.) Tape box closed.
2.) Spray Paint inside of box black.
3.) Allow to dry.
4.) Cut a whole in the bottom (large enough for a head to fit through). Make sure to make it large enough that a head will not get stuck but small enough that not a lot of light will escape.
5.) Pick one side to cut a small hole in for the flashlight (this will represent the sun).
6.) Tape a pipe cleaner to the ball(this will be suspended from the top of the box and represent the moon.
7.) Cut 5 flaps into the top of the box to allow the moon to move around the child’s head. See diagram below for placement of flaps.



TOP VIEW OF BOX

8.) Next wrap the end of the pipe cleaner around the pencil to allow you to suspend it easier. The final design should look like the diagram below.



Name :______________________________

Date:________________________________

Moon Box Activity Sheet

1. What does the Blue ball represent?

2. What do you represent?

3. What does the flashlight represent?

4. Draw a Waxing Crescent Moon.

5. Draw a Waxing Half Moon.

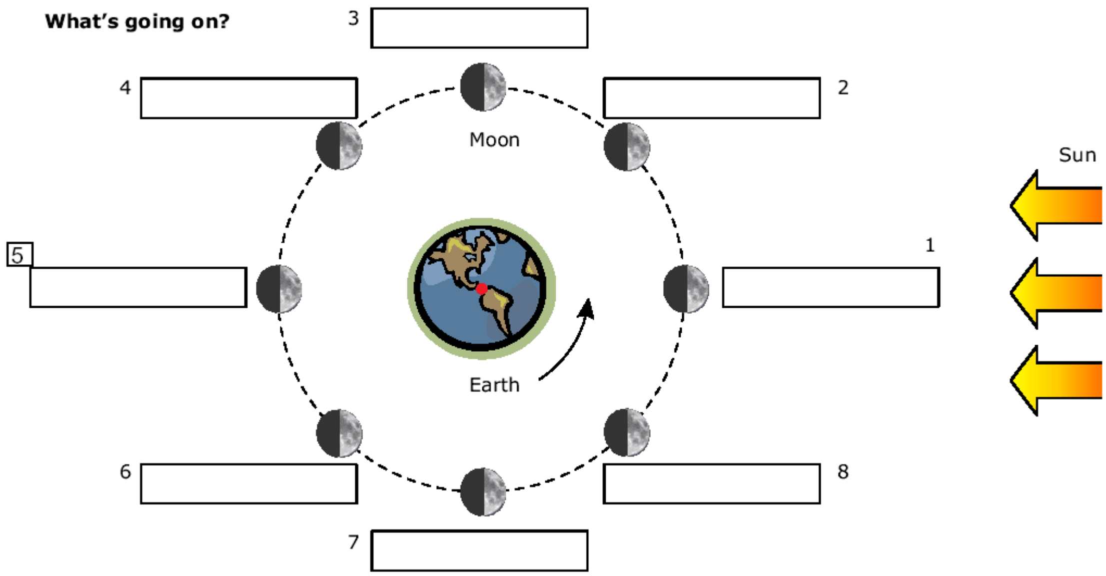
6. Draw a Waxing Gibbous Moon.

7. Draw the relationship of the Sun, Earth, and Moon when there is a New Moon. LABEL your drawing!!!!

INSTRUCTIONS : First look at the bottom pictures and write the name of each phase on the lines below the picture. Then match the pictures on the bottom with the order they go in on the top, by writing the number in the box.

The Phases of the Moon

What's going on?



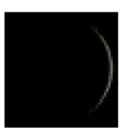
Explanations:

8

7

6

1



5

2

3

4

Name :______________________________

Date:_________________________________

Moon Phases Word Search

M K X D Y V I A C J G H E G W
F D S V F G C O F N A T C I A
Q A V U J U V B I L W I A B N
Q U A R T E R X F U S B P B I
U N G G U Y A A A I A R S O N
T F N A V W H T R A E O C U G
N N U E J H F W L V P E P S R
M J E L W N U S K J K X D I B
J N W C L U R P C B C X P J Z
M O O N S C V I J N E W D C A
A E S B N E Z N C B J S Y O J
N H R U F K R S N V R T F S L
U O K C M K C C S A F V J Y Z
G H T B S W H R I C T E L D P
Z K I X N M G C N A C O O Y I

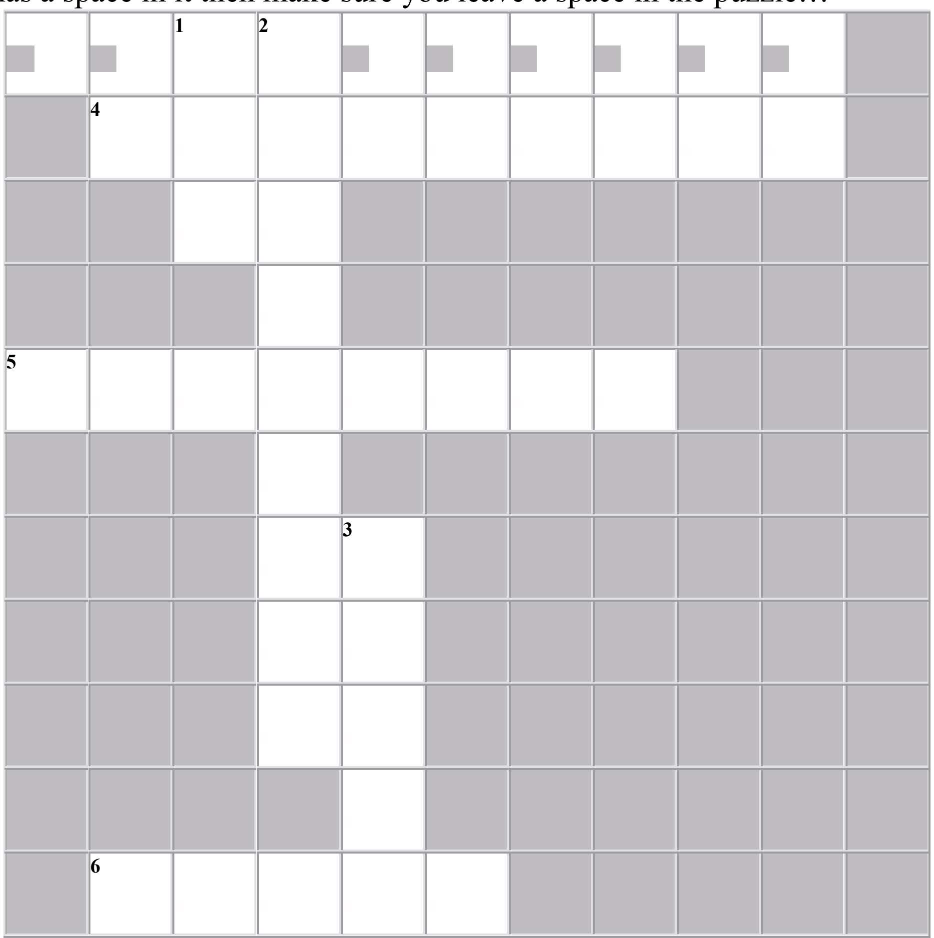
CRESCENT	EARTH
FULL	GIBBOUS
HALF	MOON
NEW	ORBIT
QUARTER	SPACE
SUN	WANING
WAXING	

Name :______________________________

Date:_________________________________

Moon Phases Crossword

DIRECTIONS: Using the clues on the next page fill in the crossword below. If the answer has a space in it then make sure you leave a space in the puzzle!!!



CLUES:

Down

1. This shines on the moon allowing us to see different phases?
2. This happens when two full moons happen in the same month? (2 words - include space in puzzle)
3. This is the path moon goes in around the earth?

Across

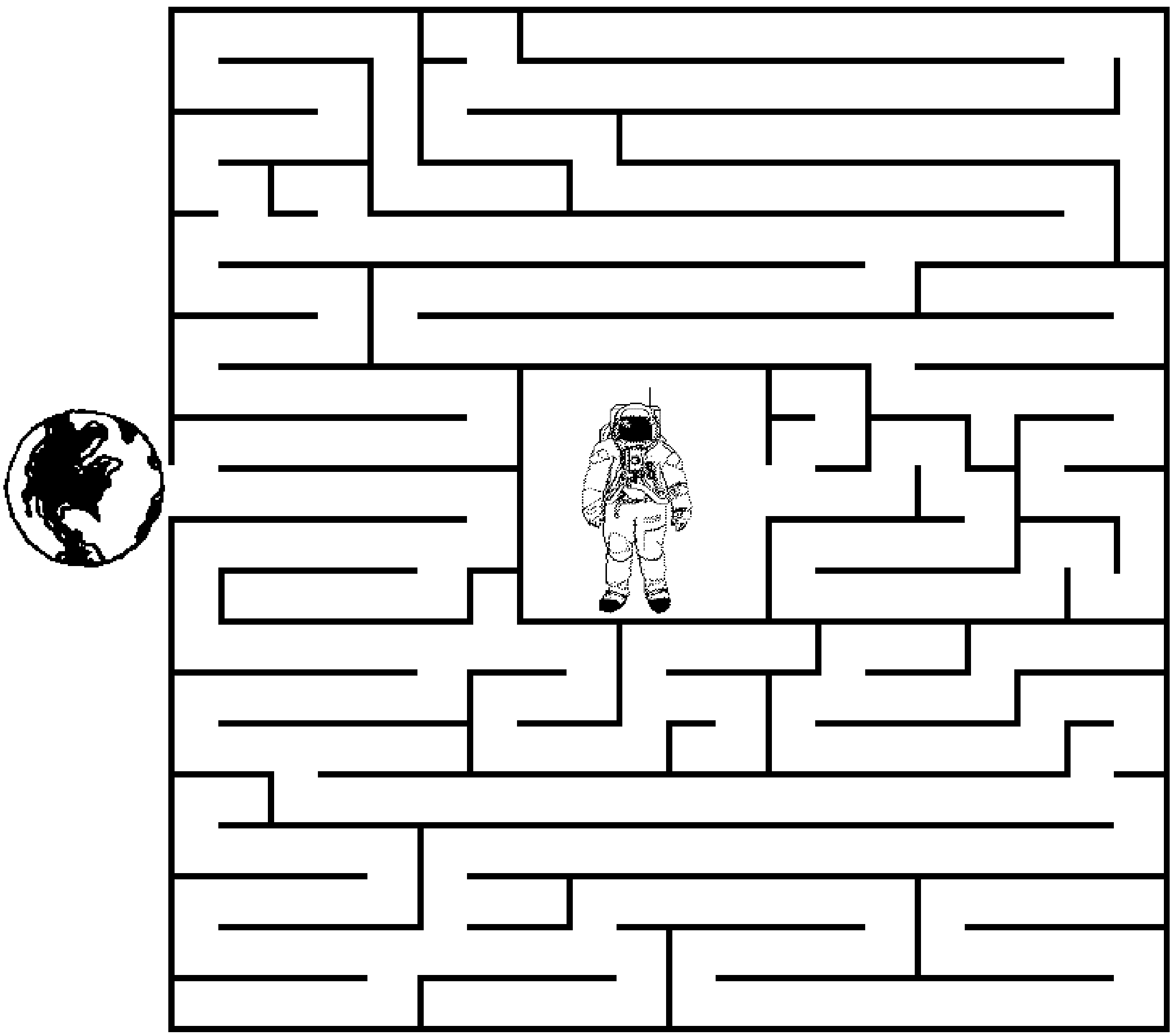
4. This is when the moon looks like a whole circle in the sky? (2 words - include space in puzzle)
5. This is when the moon is not visible from earth because the side facing the earth is not being lit by the sun? (2 words - include space in puzzle)
6. This is the planet the moon orbits around?

Name :____________________________

Date:_______________________________

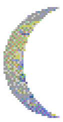
Moon Maze

DIRECTIONS: Help the astronaut get back to earth from the moon!!!!



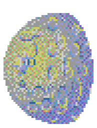
Phase Explanation for Teachers/Instructors

Blue Moon - When two full moons occur in a single month, the second full moon is called a "Blue Moon." Another definition of the blue moon is the third full moon that occurs in a season of the year which has four full moons (usually each season has only three full moons.)

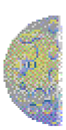


CRESCENT MOON
Crescent Moon - part way between a half moon and a new moon, or between a new moon and a half moon.

FULL MOON
A full moon appears as an entire circle in the sky. The full moon is given different names, depending on when it appears. For example, the "Harvest moon" is the full moon that appears nearest to the Autumnal Equinox, occurring in late September or early October. Some other full moon names (by month) include:



GIBBOUS MOON
A gibbous moon is between a full moon and a half moon, or between a half moon and a full moon.



HALF MOON
A half moon looks like half a circle. It is sometimes called a quarter moon (this Moon has completed one quarter of an orbit around the Earth from either the full or new position and one quarter of the moon's surface is visible from Earth).

NEW MOON
The new moon is the phase of the moon when the moon is not visible from Earth, because the side of the moon that is facing us is not being lit by the sun.

**And the entire cycle will take 29 days to complete

Lesson 15: Sound, See the Vibration

Lesson Title – Sound, See the Vibration

Grade Level – 3rd

Lesson Time – One hour

Instructional Mode – Small Groups

Team/Group Size – 4 students per group

Summary – Student's will learn what sound is, what causes sound, and where sound occurs. Students will understand what happens to sound vibrations when the pitch of their voice changes. This lesson is designed to be taught in conjunction with the Inventor of the Month: Alexander Graham Bell.

Learning Objectives – 2002 Worcester Public Benchmarks (WPS) for 3rd Grade:

Physical Science:

03.SC.PS.08 – Design and construct a simple sound-producing device that demonstrates how to change the properties of volume and pitch.

Technology:

03.SC.TE.01 – Identify materials used to accomplish a design task based on a specific property, e.g., weight, strength, hardness, and flexibility.

Essential Questions – What is sound?

What is a vibration?

Where does sound occur?

What is an oscillation?

What is pitch?

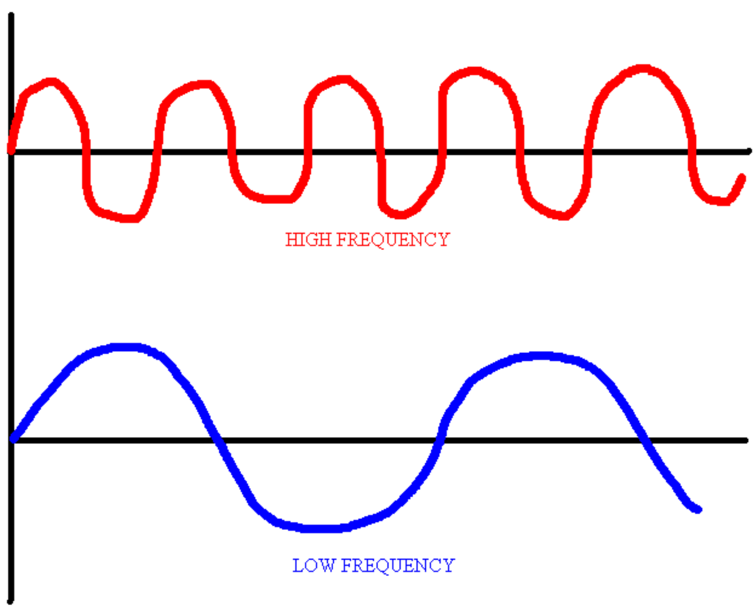
What happens to sound waves when the pitch of your voice changes?

Introduction / Motivation – Ask students what they think sound is. Ask what the students think causes sound. Have them hum at low and high pitches in their voices to see if they can distinguish a difference.

Procedure(See Vocabulary section for any unknown vocabulary**) –**

11. Have students gather at the front of the class.

12. Ask students if the know what causes sound.
13. Explain that sound is a vibration. (Example speech comes from your vocal cords vibrating) The vibrations of your vocal chords cause the air in your throat to vibrate back and forth as well, this causes the air in your mouth to vibrate, which causes the air in front of your face to vibrate and so on. Sound, then, is just vibrating air. The quicker the vibrations the higher the note you make (try humming high and low notes while holding your throat again to see what I mean...can you feel any difference?). What if there was no air? Well, then you would not hear any sound since there is nothing to transfer the vibrations from their source to your ear.
14. Sound travels in waves. Compare these to waves on a beach. Teach them how waves at a beach have a peak and a base. The same goes for sound waves, and this is called an oscillation. A wave like the one below going up and down is considered an oscillating wave. The more peaks there are the higher the frequency and visa versa for low frequencies.



15. Explain to students that the faster the vibration, which is a higher frequency (more peaks in a wave), this will then cause the pitch(see vocabulary section for definition) heard to be higher. Where as with slower vibrations, there are less peaks and the pitch will be lower. Go through some examples of this

using different voices. Try humming in a very low voice see how much your lips move. Then try humming in a higher voice and see how much faster your lips move.

16. Have students return to seats.
17. Ask students if any of them have ever heard of an oscilloscope?
18. Explain that they are going to be making a simple oscilloscope which is a device that will allow you to see sound vibration. Explain the connection between oscilloscope and oscillate, that an oscilloscope is a device that allows you to see oscillations, or waves.
19. With a partner have them construct their own oscilloscope using the directions in the attached sheet.
20. After construction is complete have the students complete the Sound Activity Worksheet.
21. When everyone is finished collect as a whole class again, and discuss what students observed.
22. Ask students if they remember learning about Alexander Graham Bell?
23. Ask what he invented.
24. Ask students how they think sound works in a telephone.
25. Explain using the teachers reference attachment how sound works in a telephone.

Materials List (per class, per group and / or per student) –

For each pair of students…

- 1 can
- 1 balloon
- Duct tape / masking tape
- Mirror
- Flashlight
- White cardboard/or just white piece of paper.

For each student…

- Oscilloscope Instructions
- Sound Activity Sheet

Vocabulary with Definition –

Sound – Vibrations sent through the air that we can hear.

Oscilloscope - An instrument that allows us to see sound waves.

Oscillation – The steady back and forth movement of sound waves.

Sound Wave - How sound is transferred through the air.

Pitch - the property of a sound that changes with each frequency.

Vibration - To move back and forth

Frequency – The number of waves in a given time period.

Assessment/Evaluation of Students – Construction of oscilloscope and completion of Sound Activity Sheet.

Lesson Extensions – None

Attachments – Oscilloscope Instructions
Sound Activity Sheet
Teachers Reference Sheet

Troubleshooting Tips – none

Safety Issues – Be sure there are no sharp edges on the cans!!

Redirect URL –http://www.sme.org/memb/neweek/actosc.htmnone
http://electronics.howstuffworks.com/telephone-image.htm

Key Words – Sound, vibration, oscillation, wave, pitch

OSCILLOSCOPE INSTRUCTIONS

Materials :

- **Balloon**
- **Masking Tape/Duct Tape**
- **Scotch Tape**
- **Small Mirror**
- **Flashlight**
- **Small steel can (pre-cut at both ends)**
- **Plain white card and/or white paper**

Directions :

1.) **Be sure an adult as already cut both ends of the can off.**

2.) **Cut off the large end of the balloon.**

3.) **Pull the balloon over one end of the can.**

4.) **Tape the edge of the balloon down around the can to secure it with Duct or Masking tape.**

5.) **Attach a small mirror using scotch tape to the balloon. Do not put it directly in the middle, put it a little to the side!!!**

6.) **Hold up the cardboard/white paper**

7.) **Shine the flashlight on the mirror sot he light reflects onto the paper.**

8.) **Now your all set to go….**

Name :____________________________

Date:______________________________

Sound Activity Sheet

WHAT DO WE KNOW?

(1.) What is sound?____

(2.) How does sound travel?________________________________

(3.) What is pitch?____

WHAT ARE WE TRYING TO FIND OUT?

Using your oscilloscope I want you and a partner to discovery what happens when your pitch changes.

WHAT DO WE DO?

(1.) First talk in a regular voice into the oscilloscope. What happened to the light? (circle what happened)

IT MOVED IT DIDN'T MOVE

(2) Now talk in a deep slow voice. What happened? (circle what happened)

IT MOVED FASTER IT MOVED SLOWER

(3.)Now talk in a fast squeaky voice like a mouse. What happened (circle what happened)

IT MOVED FASTER IT MOVED SLOWER

WHY DID THIS HAPPEN?

(1.) Why did the light move faster when you talked in a fast squeaky voice?

____

____

____

(2.) Why did the light move slower when you talked in a low slower voice?

____

____

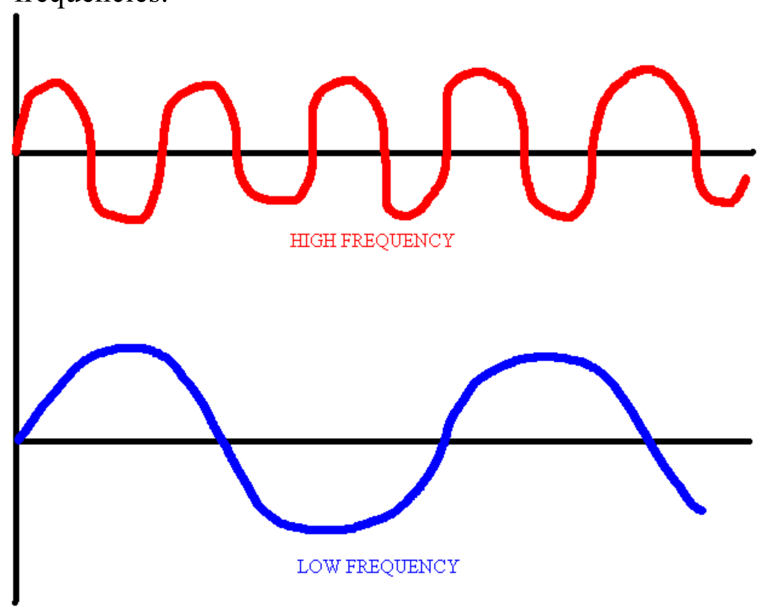
____

NOW JUST SIT QUIETLY UNTIL THE CLASS HAS FINISHED THEN WE WILL TALK ABOUT YOUR ANSWERS!!!!

TEACHERS REFERENCE SECTION

Sound is vibration in the air, and these vibrations travel in waves. The vibrations of your vocal chords cause the air in your throat to vibrate back and forth as well, this causes the air in your mouth to vibrate, which causes the air in front of your face to vibrate and so on. Sound, then, is just vibrating air. The quicker the vibrations the higher the note you make (try humming high and low notes while holding your throat again to see what I mean...can you feel any difference?). What if there was no air? Well, then you would not hear any sound since there is nothing to transfer the vibrations from their source to your ear.

Sound travels in waves. Compare these to waves on a beach. Teach them how waves at a beach have a peak and a base. The same goes for sound waves, and this is called an oscillation. A wave like the one below going up and down is considered an oscillating wave. The more peaks there are the higher the frequency and visa versa for low frequencies.



The faster the vibration, which is a higher frequency (more peaks in a waveform), this will then cause the pitch heard to be higher. Where as with slower vibrations, there are less peaks and the pitch will be lower. Go through some examples of this using different voices. Try humming in a very low voice see how much your lips move. Then try humming in a higher voice and see how much faster your lips move.

An oscilloscope is a device that will allow you to see sound vibration.

HOW THE TELEPHONE WORKS WITH SOUND

You talk into the telephone receiver which has a microphone. This microphone picks up the vibrations of air that come from your mouth. The microphone then turns the sound into a “signal”. If they ask any questions about signals, just tell them that is college material that is way to advanced for them. The “signal” is then sent through a wire (phone cord , power lines) to another receiver this time a speaker, where it is turned back into vibrations that the other person can hear as your voice. They may ask about wireless or cordless phones. Once again tell them this is a hard concept to understand but a simple version of it is that the “signal” that the phone makes is special and much larger than a normal “signal” it is sent out through the phones antenna and is received by a satellite. The satellite then bounces the “signal” back to the other phone where it is turned back into a sound that can be heard by our ears. To understand more about this visit the following website and watch the animation…..

http://electronics.howstuffworks.com/telephone-image.htm

Lesson 16: Temperature Probes and Graphing

Lesson Title – Temperature Probes and Graphing

Grade Level – 3rd

Lesson Time – 1 hour

Instructional Mode – discussion and activity

Team/Group Size – class discussion, small group activity, individual handouts.

Summary – A short lesson will introduce the students to graphing. The temperature probes will then be used to explore the presentation of data by graphing.

Learning Objectives – Worcester Public School Benchmarks for 3rd Grade:

Skills of Inquiry: *Students will…*

03.SC.IS.01- Ask questions and make predictions that can be tested.

03.SC.IS.02- Select and use appropriate tools and technology in order to extend observations.

03.SC.IS.03- Keep accurate records while conducting simple investigations or experiments.

03.SC.IS.04- Conduct multiple trials to test a prediction. Compare the results of an investigation or experiment with the prediction.

03.SC.IS.05- Recognize simple patterns in data and use data to create a reasonable explanation for the results of and investigation or experiment.

03.SC.IS.06- Record data and communicate findings to others using graphs, charts, maps, models, and oral and written reports.

Technology/Engineering: *Students will…*

03.SC.TE.04- Describe different ways in which a problem can be represented, e.g., sketches, diagram, graphic organizers, and lists.

03.SC.TE.05- Develop a knowledge and understanding of the metric measurement system.

Essential Questions –

What are the parts of a graph?

Why do we use graphs?

How do we make graphs?

What are the advantages of using a temperature probe instead of a thermometer?

What does the word Celsius mean?

Introduction / Motivation – Show the students the temperature probe and ask them what it is. Show them a thermometer and ask them what it is. Then hold up the temperature probe again and ask them if they can guess what it is now. If you have already done graphing you can let them know that you will explore graphing more with the temperature probe.

Procedure –

Part 1-Graphs and data tables

Hold up the temperature probe and ask the class if they know what it is.

Hold up a thermometer and ask them what it is. You can do this with multiple types of thermometers if you have them available.

Hold up the temperature probe again and ask them if they can now guess what it is.

Explain to the class that the temperature probe is a type of thermometer that plugs into a computer. The temperature probe sends information to the computer about the temperature and the computer has a program that records this information as a data table and a graph.

Ask the class if they know what you mean by a data table. Explain that data is information and a data table is a way of organizing the information.

Ask them if they know what you mean when you say graph.

Draw two columns on the board. Write "Time" above the left hand column and "Temperature" above the right hand column. In the time column write 1-4. In the temperature column write some temperatures for example 3, 8, 10, and 11.

Explain that the numbers in the time column match up with the numbers in the temperature column. For example at time 1 the temperature is 3.

Ask them what the number 1 means in the time column.

Explain that you need units so that the number 1 means something. 1 could mean 1 second, 1 minute, 1 day, 1 year, and so on. In this case assign time to be minutes. Write minutes next to time at the top of the column. Make sure they understand that every number in that column is now in minutes and that the units are the label that clarifies this.

Ask the class what the units should be for the temperature column. They will probably say degrees.

Explain that there are two different measurements of degrees and that today you will be discussing Fahrenheit and Celsius. Label the temperature column Celsius and then let them know that you will talk more about the difference between Fahrenheit and Celsius shortly.

Now draw a set of axis on the board (the two lines that make up a graph).

Ask the class if they know what you just drew.

Explain that you drew an axis to make a graph. Explain that axis means the lines. One axis goes up and down (you can use the term vertical if they already understand this term) while the other goes across (horizontal).

Write time under the axis that goes across and temperature to the left of the axis that goes up and down. Make sure to include the units with the axis labels.

Now draw 4 evenly spaced dashes on the time axis and 11 evenly spaced dashes on the temperature axis. Label the dashes with the numbers.

Explain to the class that you are going to make a graph of the information in the table.

Begin by looking at the first column. The first number in the time column is 1. Place the chalk on the dash labeled 1 on the time axis of the graph. From here begin making dashes straight up. The first number in the next column is 3. Put the chalk on the dash labeled 3 on the temperature axis of the graph and make a dashed line across. Put a dot where the two dashed lines meet.

Explain to the class that this dot is called a data point. It tells someone looking at the graph what the temperature was at that time.

Erase the dashed lines and then continue to do the same thing for the remaining three data points. If you would like you can call students up to the board and have them draw in the remaining data points. Make sure that the class understands how to put points on a graph.

Now draw a line (in this case it will be somewhat curved) between the 4 points.

Explain that the line shows how the temperature changed with time.

Part 2 – Temperature probe

Next plug the probe into the computer and start the Go!Temp program.

Click the collect button and let the class see that the temperature does not change when the thermometer is just sitting there, therefore the graph is just a straight line.

Ask the class to predict what would happen if you held the end of the thermometer in your hand.

Now hold the thermometer in your hand and let them see how the graph starts to change. Let go of the probe and watch the temperature return to room temperature.

Invite 4 or 5 students up at a time to hold the probe. Write down their names in the order in which they hold the probe. Allow time for the temperature to drop in between each student. Save the graph. Begin a new graph for each group of students.

While the groups are coming up to try the probe, have the students work on the first two worksheets making graphs from data tables.

Once each group has gone, print out the graphs and write the name of each student next to the peak made when they held the thermometer.

Have the class compare the temperatures of their hands.

Open one of the graphs on the computer again and click the button to change the temperature units to Fahrenheit.

Ask the students what they saw change. They should notice that the numbers on the temperature axis changed but that the shape of the graph stayed the same.

Make sure they understand that changing the units of the temperature did not change how much the temperature actually changed.

Explain that Fahrenheit and Celsius are different units for measuring temperature. Celsius is based off of when water freezes and boils. When water first starts to freeze the temperature in Celsius is 0 degrees. In Fahrenheit it is 32 degrees. When water begins to boil it is 100 degrees Celsius and 212 degrees Fahrenheit.

Ask the class if the temperature is 80 degrees Fahrenheit will the number for Celsius be higher or lower. See if they can figure this out from the explanation you gave of Celsius.

Make sure the students understand that even though the number for Celsius is smaller than that for Fahrenheit the temperature is the same. If they have a hard time understanding this use time as an example. 1 minute and 60 seconds are the same amount of time even though the numbers are different.

Have the students work on the last worksheet using the graph to compare Celsius and Fahrenheit.

Discuss how instruments like the temperature probe are helpful.

Materials List (per class, per group and / or per student) – One temperature probe and computer. Different kinds of thermometers (at least one) Worksheets for each student. A projector if available.

Vocabulary with Definition –

Data- information

Axes- lines on which a graph is made

Horizontal- a line going across

Vertical- a line going up and down

Temperature Probe- a type of thermometer that sends information to a computer about the temperature at certain times

Data point- a point that shows how to pieces of information are related.

Fahrenheit- unit of measurement for temperature where the freezing point of water is 32 degrees and the boiling point is 212 degrees

Celsius- unit of measurement for temperature where the freezing point of water is 0 degrees and the boiling point is 100 degrees

Assessment/Evaluation of Students – **Worksheets should be corrected and given a mark of check plus, check, or check minus based on how well they understood the topic and how much effort they put into the worksheet.**

Lesson Extensions – N/A

Attachments – Worksheets, teacher guide to temperature probe

Troubleshooting Tips – get used to the Go!Temp program before using it with the class.

Safety Issues – temperature probe is pointy.

Redirect URL –

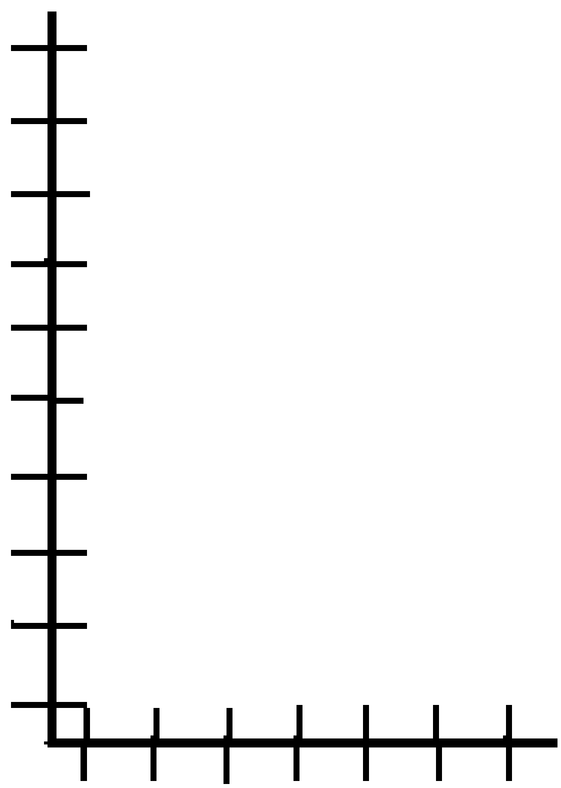
Key Words – graph, data table, Celsius, Fahrenheit, data point, and axis.

Name: ________________________________ Date: _______________

Directions: Use the data table given below and make a graph. Put time on the horizontal axis and amount of snow on the vertical axis. Make sure you include units. When you are done putting your data points on the graph, connect them with a line.

Make a Graph

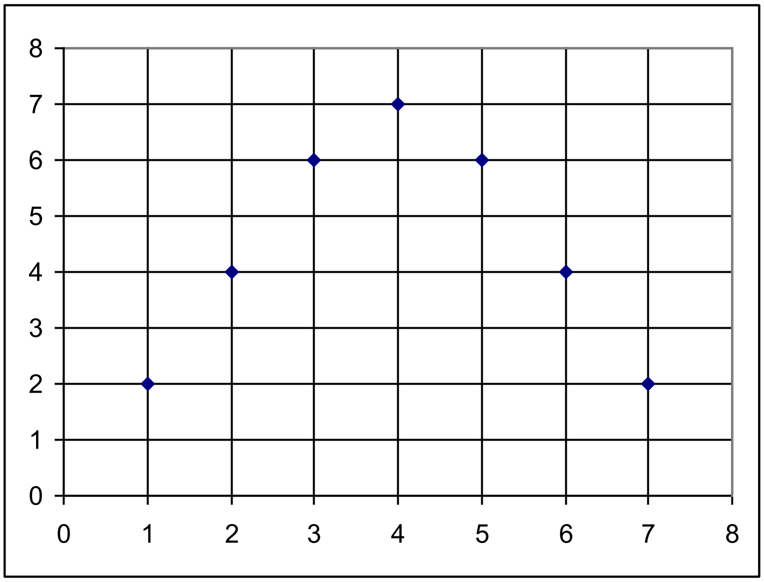
Time (hours)	Amount of Snow (inches)
1	2
2	4
3	6
4	7
5	8
6	8



Name: ______________________________ Date: ___________

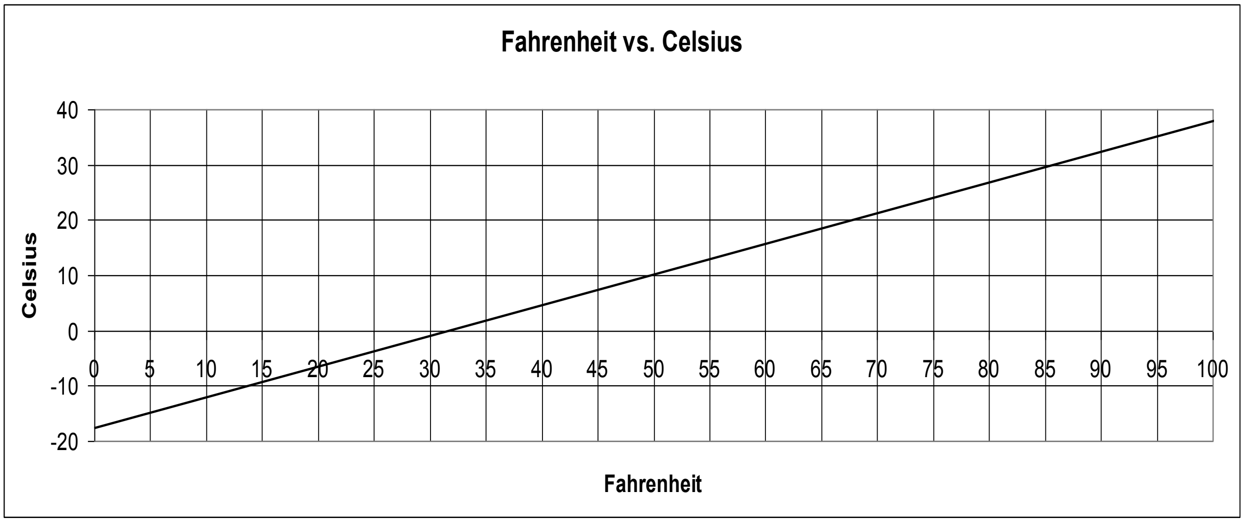
<u>Directions</u>: Use the information in the graph to create a data table. Make up your own labels for the data and don't forget to include your units. Write your labels and units on both the graph and the data table.

Make a Data Table



Name: ______________________ Date: ___________

<u>Directions</u>: This graph shows Celsius vs. Fahrenheit. Use the graph to answer the questions below.



1. What is the temperature in Celsius if it is 50 degrees Fahrenheit? ____________

2. What is the temperature in Fahrenheit if it is -10 degrees Celsius? ___________

3. What is the temperature in Celsius if it is 85 degrees Fahrenheit? ____________

4. What it the temperature in Fahrenheit if it is 0 degrees Celsius? (hint: you may have to make an estimation to find this answer) _____________

Teacher Guide to Temperature Probes

1. Temperature probes are available for loan from Mass Academy with Jackie Bonneau as the contact person. Her email is bonneau@wpi.edu.
2. To begin, load the CD that comes with the probe and install the software.
3. Plug the temperature probe into the USB port on your computer.
4. Double click the Logger Lite 1.0 icon to open the program.
5. To take a temperature reading click the green "collect" button at the top right of the icon tool bar.
6. To stop a reading click the red "stop" button. The stop button replaces the collect button during a reading.
7. To save a reading click the "save" icon (third from the left at the top) or click "file" and then "save." Give the file a name and click save.
8. To open a previous file click the "open" button (second from the left at the top) or click "file" and then "open." Select the file name you want and click open.
9. To change the units click the "switch" icon next to the "collect" icon.
10. To make the graph take up the whole page click the "scale" button in the middle of the icon tool bar.
11. To print click the "print" button in the icon tool bar.

note the program will only allow you to take a reading for 180 seconds at a time.

Lesson 17: The Water Cycle

Lesson Title – The Water Cycle

Grade Level – 3

Lesson Time – 1-2 hours (varies by the amount of material covered)

Instructional Mode – discussion and activity

Team/Group Size – class discussion and groups of 4-5 for the activity

Summary – This lesson is meant to sum up, bring together, and clarify much of the material covered in the water lessons while integrating engineering. The class will review the topics of energy, states of matter, heat transfer, and the water cycle through a class question and answer session. The review can be altered to fit the teacher's needs. If a topic was not covered in a previous lesson, do not include it in this activity and move on to the next part. The class will then work together to design water cycle in a bottle and test it.

Learning Objectives – Worcester Public School Benchmarks for 3rd Grade:

Skills of Inquiry: *Students will…*

03.SC.IS.01 - Ask questions and make predictions that can be tested.

03.SC.IS.06 - Record data and communicate findings to others using graphs, charts, maps, models, and oral and written reports.

Physical Science: *Students will…*

03.SC.PS.01 - Differentiate between properties of objects (e.g., shape, weight) and properties of materials (e.g., color, texture, hardness).

03.SC.PS.03 – Compare and contrast solids, liquids, and gases based on the basic properties of each of these states of matter.

03.SC.PS.05 – Describe how water can be changed from one state to another by adding or taking away heat.

03.SC.PS.06 – Do simple investigations with evaporation, condensation, freezing and melting. Confirm that water expands upon freezing.

03.SC.PS.07 – Identify basic forms of energy(light, sounds, heat, electrical, and magnetic). Recognize that energy is the ability to cause motion or create change.

Technology/Engineering: *Students will…*

03.SC.TE.01 – Identify materials used to accomplish a design task based on a specific property, e.g., weight, strength, hardness, and flexibility.

03.SC.TE.02 – Identify and explain the appropriate materials and tools (e.g, hammer, screwdriver, pliers, tape measure, screws, nails, and other mechanical fasteners) to conduct a given prototype safely.

Additional Learning Objectives –

- Students will use the engineering design process.
- Students will use what they know about the water cycle, states of matter and energy to build a water cycle in a bottle with no instructions.

Essential Questions –

- What is energy?
- How is energy transferred?
- What are the states of matter?
- How does energy affect that state of water?
- What are the steps of the water cycle?
- Which state(s) is the water in for each step of the water cycle?
- What are the steps of the engineering design process?

Introduction / Motivation – A class discussion consisting mostly of recall questions (see procedure) will remind the students of what they have already learned about water and bring together the separate water lessons.

Procedure –

Part 1- States of Matter, Energy, and Heat Transfer

1. Ask the students for the three states of matter. If they don't understand what matter is give them the book definition and then give examples of matter (water, gold, wood, air). Give them the opportunity to ask if certain things are matter. This will help them to understand that everything around them is matter. Make sure they understand that there are things that they cannot see or feel that are still matter, such as air. Write the three state of matter on the board. (refer to the attached diagram of suggested black board visuals)
2. Ask the class if they know why water can exist in three states. They may not understand how energy directly affects the state of water but they most likely

know that temperature affects the state. If they have a difficult time coming up with an answer ask them to think about where they keep ice and why they keep it there. They should be able to explain that ice is cold and therefore needs to be kept in a freezer.

3. Explain to them that the ice is not cold because it is a solid but that that the water is a solid because it is cold. Explain that different types of matter change states at different temperatures.
4. Explain to them that different temperatures are caused by the amount of energy. Energy is a difficult concept to grasp. Give them the definition from the book and then give them the following analogy to relate energy to the states of matter. You can draw pictures on the board as you talk that show each state (see attachment).

    Energy is the ability to move something or cause a change in matter. It is difficult to see how energy causes a change in matter though so we are going to think of each person in the class as a piece of matter. When you have a lot of energy you like to move around a lot. Remember that the definition of energy is the ability to move something, in this case, you are moving yourself. If everyone in the class has a lot of energy and you are all running around, you are acting like a gas. You are not very close together because you need your space to run, it is difficult to keep you in one area, and you are moving around so fast that you are likely to run into something. This is just like a gas. When matter is in the state of a gas it has a lot of energy that causes it to move around very rapidly and the matter spreads out to take up as much space as it can. For the most part the pieces of matter are not touching each other when they are a gas. They do, however, occasionally bump into each other as well as their surroundings.

    Now let's consider when you have some energy but not enough to run around. You would probably be closer to the other people in the room so that you can talk or play together. You would still move around a little bit but you wouldn't need to leave a lot of room between you and the person next to you because you aren't moving fast enough to accidentally bump into them. This is like matter that is in the state of a liquid. In a liquid, pieces of matter are close together. In fact, they are actually touching each other. Even though the matter is close together, it can still move though. This is why a liquid can flow and why it takes on the shape of the container that holds it.

Now let's say that you have been running around all day and all of you are exhausted so you decide that it is naptime. If you all had to lie down on the floor you would be very close together and you wouldn't be moving because you would be asleep. This is like a solid. In a solid the pieces of matter have less energy so they are closer together and not moving.

5. Ask them if they know how heat moves. This is a difficult question so you can lead them by asking them to think about things that are hot (the stove, the seatbelt in the car during the summer, the water that comes out of the hot tap in the sink, etc.).
6. Let them know that there are three ways in which heat moves. Write conduction, radiation and convection on the board. (see attachment)
7. As this lesson is designed to strengthen their understanding they should already have a basic knowledge of these words. If they do not it may be best to leave heat transfer out of the conversation. It is all right, however, to review the book's definitions.
8. To strengthen their understanding of these terms give examples. The hot seatbelt works well as an example. Ask them why the seatbelt gets hot. They should know that it gets hot from the sun. Explain that the sun making the seatbelt hot is an example of radiation (draw a picture of this on the board under radiation, see attachment). The energy from the sun moves in a way that we cannot see. Then ask them what happens if they touch the hot seatbelt. They will tell you that it burns their hands. Explain that when the heat moves from one object to another by touching it is called conduction (draw a picture of this on the board under conduction, see attachment). To explain convection you can use a bathtub as an example. Ask them if they have ever taken a bath and had the water get cold on them. Then ask if they have ever added a little bit of hot water to the bath to

make it warmer. Explain that the new hot water moves around in the cold water making it warmer by convection (see attachment for drawing to place under convection). (Feel free to use other examples as you see fit.)

9. Next discuss conductors and insulators. If they have already learned about these in class they should be able to explain that conductors allow heat to move while insulators do not. See if the class can come up with a list of things that act as conductors and insulators (conductors: the seat belt in the car, a metal pan, etc. / insulators: blankets, Styrofoam cups, the walls of their house, etc.).

Part 2- Water Cycle

10. At this point you have discussed states of matter, energy, and heat transfer. It is time to transition into the water cycle. Ask them to list the steps of the water cycle (evaporation, condensation, precipitation) and review their definitions. Write each on the board as they come up with them.
11. Ask them where each state of water can be found. Give them time to think. This is asking them to make a connection between two different things. As they come up with the answers write gas (water vapor) on the board under where you wrote evaporation, liquid (clouds) under condensation, and liquid (rain) and solid (snow, hail, and sleet) under precipitation.
12. Now draw a connection between the steps of the water cycle and energy. Ask the class why water evaporates. They should understand that the sun makes the water warm and it changes state from a liquid to a gas.
13. Ask them why the water then condenses in the sky as clouds. This is a very difficult question which most of them will probably not have the answer to. Explain to them that the air in the sky is colder than the air on the ground and without as much heat/energy the water condenses. They may want to know why the air is colder higher up. They probably think that the air in the sky should be warmer because it is closer to the sun. They may also think that the air in the sky should be warmer because hot air rises. The explanation to this is difficult. At higher elevations there is less pressure and therefore less matter in a given area of space. With less matter/gases in higher elevations there is less to hold on to the heat. Do not give this explanation to the students. Instead, try to point out to them

that there is pavement, buildings, dirt, trees, etc to capture heat from the sun and keep it by the ground. Point out that these items don't exist as high in the sky as clouds do.

14. Ask the students what happens after condensation, or what is it called when the condensed water vapor starts to fall. While the words rain, sleet, hail, and snow are all correct look for them to give you the answer precipitation.

Part 3- Activity

15. As you pass out the handout, tell students to keep the previous class discussion in mind. Introduce them to the activity by letting them know that they are going to build a water cycle in a bottle. They are not going to have instructions telling them how to make it though. Instead the handout will guide them through the engineering design process and they will use what they know to attempt to make a working design. Be sure to emphasize that it is ok if their design does not work. When engineers make something new, it takes a few tries to get everything right.
16. Write "Engineering design process on the board." As you get to each step in the packet, write that step on the board.
17. Tell the students what the problem is. "How do we build a water cycle in a bottle?" Ask them to write the problem on the worksheet in the space provided.
18. Read the first question to the class and make sure they understand that there is a word that fits into the blank that makes sense in the sentence. (In this case they can say either heat or energy.) Give them a minute to answer, without consulting with their neighbors, and then move on when it looks like most of them have finished.
19. Let the class know what materials will be available to them.
20. Ask a student to read the next heading and the instructions under it.
21. Give the student about 2 minutes per question. This time can be adjusted as necessary.
22. Work as a class to build their water cycle. Make sure they understand that there is no right or wrong way to build their water cycle and that they do not need to use all of the materials given to them.
23. Test the design.

24. Discuss as a class why the design did or did not work.
25. Congratulate the class on doing a good job as engineers!

Materials List (per class, per group and / or per student) –

per student – one handout

Per class – hair dryer, cooler to keep ice in, a water jug with the top cut off (a Poland springs crystal clear bottle is best. Be sure to cover the cut edge with masking tape if it seams sharp), the cap from the water jug, clay, tape (masking or scotch), warm water, cold water, ice, tinfoil, plastic wrap, paper towels, string.

Vocabulary with Definition – The following definitions are taken from the science text Discovery Works published by Silver Burdett Ginn in 1996. The lesson can be adjusted to use less vocabulary if this list is too extensive. The goal of the lessons is to take these definitions, which may not be clear to the students, and build understanding through observation and discussion.

Energy: The ability to move something or cause a change in matter.

Matter: Anything that has mass and takes up space.

Liquid: A state of matter that has no definite shape but takes up a definite amount of space.

Solid: A state of matter that has definite shape and takes up a definite amount of space.

Gas: A state of matter that has no definite shape and does not take up a definite amount of space.

Water Vapor: Water that is a gas.

Evaporate: To change form from a liquid to a gas.

Condense: To change form from a gas to a liquid.

Precipitation: The liquid or solid forms of water that fall to earth.

Water Cycle: The path that water follow from earth to air and back again.

Conduction: The transfer of heat through direct contact between particles of matter.

Conductor: A type of material that transfers heat or electricity.

Insulator: A poor conductor of heat or electricity.

Convection: The circulation of heat through a liquid or a gas.

Radiation: The movement of heat energy in the form of waves.

Assessment/Evaluation of Students – An informal evaluation of the students will be their classroom discussion. Did everyone participate? Did the students seem to understand and were they able to use the vocabulary? The students will also receive a homework assignment as evaluation. A list of the vocabulary without definitions (modified to cover only the terms you wish them to understand) will be provided for them to take home. The assignment is for them to write a science journal entry about this lesson. They will write about what they did and what they learned. Ask them to try and use as many of the vocabulary words as they can. Evaluate them on the effort they put into the assignment and their understanding of the vocabulary. This assignment will also serve an evaluation of how effective the lesson was.

Lesson Extensions – the suggested homework assignment can also be done as classroom work.

Attachments – worksheet, homework assignment, directions for teachers on how to build a working water cycle in a bottle, diagram of suggested material to write on the board.

Troubleshooting Tips – This lesson can be adjusted to include as many or as few of the suggested vocabulary words as you wish as long as it still includes a review of condensation, precipitation, and evaporation. A good understanding of the water cycle is necessary in order to do the activity. As this is a conclusion lesson it is suggested to not use vocabulary that is new to them. Stick to the words they have learned in previous sections. Also, if the students seem to be having a difficult time with the vocabulary, adjust the expectations to the ability of your class.

Safety Issues – The water should be warm but not hot enough to cause burns. Only the teacher should use the hair dryer. The edges of the plastic bottle should be smooth (they can be covered with masking tape if necessary).

Key Words – Please refer to vocabulary.

Water Cycle in a Bottle

Name:___________________Date:________

What is our problem?

____

____

Let's see what we know!

1. _______________makes water evaporate. Once it is gone, water will condense and eventually become precipitation.

How might we solve our problem?

Look at the materials you can use to make your water cycle and then answer these questions.

2. How will you get the water to evaporate?

____

____

____

3. How will you keep the evaporated water from leaving the bottle?

____

____

____

4. How will you get the water to condense?

____

____

____

Let's make it and see if it works!

Work with the class to build a water cycle in a bottle. Remember to listen to everyone's ideas!

Share your ideas with others!

Class discussion.

- Why did you choose the materials that you used?
- What did you expect to have happen?

Can you make it even better?

- What would you change if you could make it again?

Water Cycle Homework

Name:__________________________

Directions: Write a how- to paragraph on making a water cycle in a bottle. Explain what you did. What did you find interesting? The list below shows some of the words we used today. Try and use them in your writing.

Vocabulary

Energy
Matter
Liquid
Solid
Gas
Water vapor
Evaporate
Condense
Precipitation
Water Cycle
Conduction
Conductor
Insulator
Convection
Radiation

Directions for teacher model

1. Begin with a 1 gallon water jug with the top cut off. The Poland Springs bottles work the best because there is a raised portion in the middle of the bottom.

2. Using clay, attach the cap of the bottle to the raised spot.
3. Add a very thin layer (~1/4 in.) of warm water to the bottom of the bottle. Be sure not to get any water in the cap.

4. Using tinfoil, create a cover for the water bottle. It should sag into somewhat of a point over the cap on the bottom.

5. Place ice cubes or an ice pack on top of the tinfoil.
6. Heat the bottom of the bottle with the hair dryer.

7. Make the following points to the class as you demonstrate your model. Leave out any points that require knowledge not previously covered.

- The hair dryer provides heat energy in the form of radiation. In our model, the hair dryer acts as the sun.
- The water on the bottom of the bottle heats up and warms all the water by convection.
- As the water gets warm, it begins to evaporate.
- We cannot see the evaporated water because it is a gas.
- When the water vapor touches the tinfoil it condenses because it is cold. This is like the clouds.
- The heat from the water moves to the tinfoil by conduction. Tinfoil was used instead of plastic wrap because it is a good conductor.
- The water collects at the point where the cover sags and then drips into the cap below. This is just like precipitation.

Blackboard Drawings