Utilizing Non-Formal Teaching Strategies to Enhance Student Engagement within Environmental Themed Science Units

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Utilizing Non-Formal Teaching Strategies to Enhance Student Engagement within Environmental Themed Science Units

by

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Chapter One: Introduction

The integration of non-formal teaching approaches within environmental themed units as part of the science curriculum allows students the opportunity to make stronger personal connections with the material through the expression of material in real-world applications. By expanding the learning to multiple locations and incorporating knowledge and perspectives from multiple sources the students would be able to interact with the content in a more experiential way that would promote greater interest for students, while expanding motivation and relevance. The utilization of trips is typically disregarded in many schools due to several negative concerns, many of which are hypothetical. One concrete concern that teachers have resulting in their decision to instruct in non-traditional ways is because of the tension that typically exists between the teachers and administrators for doing so (Fowler & Meisels, 2010). In addition, many traditional formal methods of instructions do not allow students to be interactive with content in a way that allows for meaningful science to take place. However, the use of these activities in which the students are actively engaged through hands-on experiential learning linked to real world applications is more likely to produce more realistic experiences with the content that will be beneficial to student learning in multiple contexts.

While traditional methods of teaching are effective within the classroom in some cases, these formal methods of instruction to have their disadvantages. While the instruction by some educators does reflect the interest of the students and their futures, the traditional methods of lecture and prepared laboratory exercises do not allow individuals to reflect on the nature of science in genuinely applicable situations that are relevant (Stocklmayer, Rennie, & Gilbert, 2010). The use of more informal and non-formal learning opportunities allow the
students to carry out more inquiry-based experiential learning in which the students are less
guided, but more actively involved with the content they are investigating (Ainsworth & Eaton,
2010). These interactive, research-based learning methods allow the students and teachers
alike to embrace that science is a form of testing to build knowledge (Köse, 2010).

Research suggests that the out-of-school experiences that students have directly
influences and relates to a child’s interest in science (Uitto, Juuti, Lavonen, & Meisalo, 2006).
Specifically, those experiences which were related to the outdoors including working with
animals, and the use of science tool kits outdoors had the greatest affects on student interest in
curriculum. In addition, the use of trip-based learning experiences has shown to build not only
knowledge about the content itself, but also develop cognitive, affective, and psychomotor
skills throughout the process (Bozdogan, 2012). From the student’s perspective, the utilization
of these types of trips appears to have many benefits within the realm of skill development,
content knowledge, and overall interest and enjoyment of the experience.

From a teacher’s perspective, the preparation and carrying out of these non-traditional
learning experiences are valuable. Teachers often utilize a wealth of resources including
previous experiences, guidance from others, or various forms of training to assure that their
trips are effective (Rebar, 2012). While these sources of knowledge are sometimes limited,
especially among new teachers, there is often hesitance and insecurity from both personal and
outside sources for all teachers with respect to conducting site-based learning experiences
(Bozdogan, 2012). However, as educators it is important to understand and appreciate that it is
not only “what” we teach that is valuable, but also “how” we teach material to the children in
our classes (Köse, 2010). Moreover, effective planning of these trips coupled with both pre
and post-trip activities have been shown to be highly significant to student learning in the short
and long term (Davidson, Passmore, & Anderson, 2009).

While opportunities for theme based units incorporating site-based learning, specifically
in Western New York are very expansive, there is a lack of actual learning within these
environments. Despite the relative closeness to an abundance of free natural learning
resources in the area, few teachers take advantage of these relatively costless elements that
the natural setting can provide for instruction and learning opportunities. Therefore, the
design of this project is to create a set environmental theme based units that could be utilized
throughout the Western New York area. Within these units are multiple opportunities for the
students to engage in site-based learning that integrate formal and non-formal learning
opportunities together. These units will be organized to promote scientific inquiry within the
natural and school setting, and utilize experiential learning as the hub of knowledge acquisition.
Therefore, the availability of multiple interactive lessons along with pre and post-trip activities
will be available to enhance student understanding in a way that allows students to be more
interactive and involved with their learning.
Chapter Two: Review of Literature

Introduction

All throughout a human’s life, the process of learning evolves and changes. Even as an infant in the memories that can’t be remembered, the ability to learn and gather information from the surrounding environment is a trait that everybody on this planet possesses. However the progression of how an individual learns goes through interesting progressions over time. Typically informal learning experiences drive a child’s understanding of the world around them starting at birth (Ainsworth & Eaton, 2010). These unorganized life experiences provide the first background information about their lives through spontaneous and typically experiential experiences. This more natural approach to learning however is usually replaced my more formal and traditional methods of teaching by the time a child reaches schooling in traditional institutions.

While formal methods of teaching are effective and do have their place within academic curriculum, the absence of additional forms of learning within curriculum can be detrimental. In essence, a question that may be asked is “how can school science education both prepare some students to go on to careers in science and technology and prepare all students to be responsible, scientifically literate citizens?” (Stocklmayer, Rennie, & Gilbert, 2010, p. 2). There could be many answers to this question with all of them having validity. However, the addition of more informal learning opportunities could address many of the outlined concerns with the question at hand. By allowing students to interact with the content in a more natural way in which they are immersed with the ideas and knowledge within a non-academic setting, the
connections between careers and general awareness of how the material relates to their lives can be better established. While the implementation and support of these types of learning events are often seen as difficult or negative, the benefits and effectiveness of their use for students and teachers alike should be considered.

Formal Education Today

The science educational system today is fairly unstable, mainly because of the constant reforms and changes that schools and the system alike are trying to implement. Research has shown that one of the greatest negative effects towards interest in science education comes from the culture of school science itself (Stocklmayer et. al., 2010). The general view of school education today is that pupil’s learn from teachers within the walls of an academic building (Uitto et. al., 2006). Unfortunately there are too many individuals who believe this and therefore carry on the tradition of a simplified education that is specified to a single location. This overarching concern implies several different issues and the negative effects of each. For example, professionals often do not make connections between various fields of study which leads to, in both general and specific realms, lost opportunities for students (Ainsworth et. al., 2010). The lack of relevance to the personal lives of students is often detrimental to the interest that students express for the material. Another issue with the culture of the science that is taught today deals with the nature of the curriculum itself. As Stocklmayer (et. al., 2010) described, how science content is taught today is often dishonest as it portrays science as something that is not practiced. The heavy focus on terminology, formulas, and various other specific components often is not related to the lives of the students and how they interact with
the concepts in their daily lives. Another related issue with current science education in schools is the establishing of scientific literacy among students. While this term has been defined in many different ways by various authors, some of the overlying principles with regards to the definition of the term include what the public should know about science. Moreover, the appreciation of the nature, aims, and limitations of science as a whole among specific ideas and concepts is often implied among definitions (Ainsworth et. al., 2010). This implies that a scientifically literate person will not only be able to know about the content and its societal implications, but can also use their knowledge in everyday decision-making (Stocklmayer et. al., 2010). Regardless of the specific definition, the question of whether students are “using” or “doing” science is the fundamental question. As Gyllenpalm (et. al., 2010) refers to, the call for scientific literacy also requires an emphasis that students develop and understanding of science beyond just the concepts and skills. As a result, the current trends of education and how information is presented and taught to children today is scrutinized.

Looking back to the practice of formal education in general, these learning activities tend to be intentional, organized, and structured by some authority; whether it is a teacher or institution (Ainsworth et. al., 2010). Therefore learning through a formal sense is initiated as soon as a child sets foot into any learning establishment. As Ainsworth (2010) described, while it is typically a school setting where formal learning opportunities first arise, participation at other locations such as play schools or other learning environments could also induce formal learning. Regardless of the location, the activities that are carried out by the children during these experiences are often associated with learning guidelines as determined by a curriculum or specific program (Ainsworth et. al., 2010). This form of learning is the most apparent in
one’s life as they are exposed to formal teaching methods as students are exposed to it throughout their academic careers. As Ainsworth (2010) identifies, the process of learning led by experts or trained professionals where students learning is recorded and often graded is held in high regard and considered very valuable and credible by the academic community. Therefore, the use of strictly formal learning styles can be detrimental to students as it restricts the type of experiences that students can have. As a result and as proposed by Ainsworth (et. al.,2010), a collaboration between many different learning styles should be included in students instruction so that an emphasis and value of lifelong learning can be established.

**Informal vs. Formal Learning**

As Ainsworth (2010) describes, it used to be that formal learning was viewed as the only type of learning that could occur within academic institutions and would be deemed as credible. However emerging practices outside of the formal realm are empowering learners and offering them new ways to be included in the learning process (Scanlon, 2012). Additional modes of learning would simply be additional compared to the true learning in a more “proper” education. However, as the times change and as education has moved into the 21st century, additional styles of learning including informal and non-formal are being acknowledged for their values. Looking first at informal learning, this type of learning is never organized and built around spontaneity and experiential opportunities (Ainsworth et. al., 2010). The focus of informal learning tends to be around more basic principles; however the value of these skills and ideas that are developed are essential to the development of more specific information and skills throughout a student’s life. Ainsworth (2010) identifies concepts such as
identification, classification, observation, hypothesizing, counting, measuring, and communicating as some of the fundamental abilities that students develop, especially at earlier ages, through the informal learning. Another attribute about informal education as identified by Ainsworth and his associates is that the learning context is limitless (2010). Any location, place, or time under can offer valuable knowledge experiences for individuals under informal learning experiences. As compared to the structured learning and instruction by another individual in formal learning, the informal learning that typically occurs up until age 5 or so presents a limitless environment from which children can naturally plunge into their surroundings and start to build a foundation for the rest of their lives (Ainsworth et. al., 2010). This internally driven instruction provides better opportunities for learning that is longer lasting and through a holistic lens (Stocklmayer et. al., 2010).

Non-formal learning acts as a bridge between the formal and informal realms of learning. As Ainsworth (2010) describes, non-formal learning usually involves some form of organization, but it can be extremely loose. In contrast to formal learning situations, there is no credit system established through non-formal learning. Therefore the learning can be more genuine and realistic as the focus is on building knowledge without outside pressures or concerns. Compared to informal learning opportunities, non-formal learning typically does have a defined location and time (Ainsworth et. al., 2010). In addition, non-formal learning like informal learning is often viewed as less credible. Places such as zoos, museums, and other learning locations where this experience is often one-time event would be classified as non-formal (Davidson et al., 2009). Similarly to formal learning however, non-formal learning often has someone with more experience and training providing scaffolding for the instruction and
can be adapted to the individual needs of students. Ainsworth (2010) also acknowledges that non-formal learning is different than both informal and formal learning in that these experiences are often fee-for-service based. This means that admission into the location for the experience often has a cost to the student or family providing the experience for their child. While some formal learning does require money, such as admission into a private school or college, there are opportunities for free and public learning. Regardless of the location, non-formal opportunities allow the students to become more enriched as they enter a new learning environment (Ainsworth et. al., 2010).

While each form of learning is unique, Ainsworth and his colleagues note the importance of valuing all forms of learning (2010). The clear use of formal learning strategies in schools and other institutions provides evidence that these types of learning opportunities and instruction are effective in one or more ways. Specifically, the ability for students to understand specific concepts and pieces of information is a benefit of formal learning. As the emphasis of this type of instruction is centered on these more precise pieces of information, the student’s ability to remember the specific bits is enhanced. However, and as previously acknowledged, areas such as scientific literacy fall victim to more formal learning strategies. As Ainsworth and his colleagues recognized (2010), the use of “minds-on” activities as implemented in informal and non-formal learning are necessary for improving scientific literacy. As Stocklmayer (et al., 2010) noted in their report, a recent study showed that students who visited the museum created their own narratives about the specimens that they saw. This identifies that informal learning opportunities do promote the development of individual literacy skills among the participants. Additional research conducted by Davidson
Instructional Benefits of Informal Learning

One of the primary benefits of implementing informal instruction within the curriculum is being able to have students better connect with the material. This can be analyzed through many different interpretations. One such view may look at the overall ease of conducting the learning experience. As previously discussed, formal and non-formal learning can sometimes require a monetary fee. As a result, the ability for students to benefit from the learning experience may be altered due to the financial obligations. As Ainsworth acknowledges (2010), even the resources available in a child’s house and community can act as determining factors of
what type of learning the student is likely to experience. Regardless of money or other physical resources, informal learning does not require students to invest into the learning from a financial point of view. By utilizing natural resources and locations for the area of investigation the students can remained focused on the learning itself. The use of natural informal settings can be thought of as a “third space for learning” (Stocklmayer et. al., 2010). What this means is that the typical realm of learning is broken down into learning that occurs at home, and then the education within the school. The addition of this new area in which students can investigate and explore new ideas and practice skills allows for the instruction between the other two areas to be linked and more effectively. Depending on the type of informal setting, being able to link school and home learning can be done right from a computer at either location (Kara et. al., 2008). Therefore, the learning that occurs for the students is not only more valuable, but the learning process itself for everyone involved is more fluent.

Another significant benefit of the use of informal learning in instruction comes through the relevance of material to the students. As Stocklmayer (et. al., 2010) stated, the learning that occurs outside of the school is often that which is seen as most relevant and useful. Being able to make connections with students in regards to how the material relates to them and their lives is essential. A study conducted by Uitto, Juuti, Lavonen, and Meisalo in 2006 investigated how the out-of-school experiences of Finnish secondary science students was related to their interests in science. In this two-fold study, the team of researchers investigated whether gender and the types of experiences that students had outside of the classroom had any influence in their interest in biology concepts. The results of the study revealed that the experiences of the students outside of the classroom did have a large effect on their interests in
the classroom. Additional research in multiple contexts including the relation of an individual’s religious beliefs has also shown the significance of outside factors on educational interest (Köse, 2010). From the perspective of gender, males tended to enjoy the biological and environmental components whereas the females enjoyed more overarching science themes and anatomy connections (Uitto et. al., 2006). Alongside these results, it was identified that the experiences and activities that the students carried out had a significant effect on their interests in biology. These findings support the use of informal teaching methods as they allow the instructor to coordinate the student’s interests and experiences in a more collaborative manner. Formal instruction tends not to acknowledge the differences among students, as well as their personal experiences and interests. As the instruction in the formal setting is defined and relatively concrete, the ability for teachers to acknowledge the unique attributes of the students as a population becomes more difficult. By implementing informal methods of learning however, the teacher can allow the students to be more directly involved in their education. Uitto (et. al., 2006) states that by connecting pupils’ out-of-school natural experiences with their classroom education, the interest and motivation of the students would increase. The authors of this study also acknowledge that should a personal interest in a particular topic not exist at first for a student, by utilizing informal learning opportunities in which the student is more involved and experiential with their learning, they may develop a greater situational interest (Uitto et. al., 2006).

The diversity, both in terms of location and the experiences that the class can take part in, is another advantage of informal learning within schools. From the location perspective, informal learning is not restricted to a certain environment like formal learning. Where the
classroom tends to be the hub of all learning within the formal setting, informal and non-formal experiences can occur in more unique and realistic places. As Uitto (et. al., 2006) proposed the amount of diversity in out-of-school settings, whether through informal or slightly structured non-formal means of learning, if far greater than those apparent in the conventional classroom. Too often the relation to content is restricted to what can be seen or shown within the realm of the classroom only. The difficulty of this can be increased among topics such as evolution which are based primarily around theory and have controversial evidence as support (Kose, 2010). By opening up experiences outside of the classroom and allowing students to interact within the world they live, the material and information that they work with will become more genuine and relatable. With respect to the diverse experiences that can occur from informal instruction, Uitto and her colleagues (2006) reveal findings from a previous study that showed that interest and exploration of applied biology in particular has become a popular issue among students. These pupils want the opportunity to see how the knowledge they get from their class experiences can translate to nature or occupations in their present and future lives. While these connections can be made in the classroom, there appears to be a lack of the associations as the demand for this information still exists. By taking students to gardens, food industry facilities, or health centers the students are able to relate not only the content to potential professions, but also the skills necessary to the occupations and content alike (Uitto et. al., 2006).
Misconceptions/Alternative Conceptions

One potential benefit of utilizing informal learning opportunities for students is combating the misconception and alternative conceptions that students may have regarding content. Throughout a student’s life they will be exposed to sciences in many different ways. Unfortunately, the overlap of specific terminology and themes can often be confused by students. In a study conducted by Mann and Treagust in 2010, the researchers examined common misconception in biology; especially considering those that were conflicting with understanding in the realm of physics. Specifically, they observed that students understanding of energy and how it translates in the human body compared more physical science applications were the most profound. While the understanding of energy within each individual context became more defined and accurate as the students get older, the fact remained there was conflict in students when trying to understand and appreciate the dual-nature of science language (Mann et. al., 2010). This study revealed that the problem with these particular misconceptions was two-fold, both in the language understanding, but also having to do with the connections between various content areas. The use of informal learning opportunities could be a great tool to help combat these misconceptions. By utilizing informal experiences, the teacher can link together multiple content areas, whether it is science to science or even building on literacy and vocabulary. By presenting these themes in a different context than just traditional instruction, students will be able to make more valuable connections and potentially eliminate these harmful misconceptions altogether.

Another important consideration when dealing with student misconceptions is to also confront these alternate ideas that students possess as soon as possible. A study conducted in
2011 examined whether the confrontation of student preconceptions before instruction was a beneficial teaching strategy (Franke, et.al.). Specifically the researchers wanted to see if there would be any changes in the students’ mental effort and overall cognitive achievement by utilizing a system where the students’ preconceptions were identified and corrected before instruction in an external laboratory environment. In essence, this study also used an informal learning environment as the students conducted their laboratory work at an out-of-school facility. The results of this study revealed that confronting the student misconceptions before actually teaching the material led to greater mental effort by the students (Franke et. al., 2011). Confronting the students’ misconceptions meant that the all of the children were more engaged in the learning and had a greater interest in the material and learning experience alike. In addition, Franke and her colleague found that overall cognitive achievement by the students who confronted their misconceptions first was greater and more profound than those who did not (Franke et. al., 2011). The students who examined their thoughts about the material before diving into the material had greater scores on post-laboratory exams both immediately, and months after the lessons took place. This highlights the importance of eliminating misconceptions as early as possible to avoid later conflicts that could be detrimental to student learning in general. The use of informal learning experiences can be a great tool in order to confront these ideas that the students have entering a unit. By allowing students to focus on what they think they know from the beginning, the teacher has at least acknowledged a starting point. While what the student thinks may not be correct at the time, the important realization is that they at least have some thought to work off of. With that in mind, exposing students into informal learning where they can be more interactive with their thoughts and
experiences could be a very beneficial way of having students fix their own preconceptions. While this particular study had the teacher lecture about the preconceptions to correct them, there could be multiple ways to address the issues that students have.

The overall enjoyment of value of informal learning experiences can also be a great benefit towards combating these alternative conceptions that students have. Science in the informal realm relies on entertainment to keep students engaged and active in their learning endeavors (Stocklmayer et. al., 2010). Because these informal learning experiences are built around non-traditional activities, the students often benefit in several ways including motivation and interest. For example, the use of two different computer software programs centered on cell division was used in a study by Kara and Yesilyurt in 2008 to examine their effects on student misconceptions. More specifically, a tutorial program and an edutainment software were used in two different groups to analyze how misconceptions were affected. From their study they found that both programs were effective at eliminating many, but not all, of the misconceptions that students had prior to using the software (Kara et. al., 2008). In addition, it was found that the use of the edutainment software, which was far more informal than the tutorial software, developed greater positive reactions by the students in terms of the learning process itself. The students using the edutainment software were more engaged and enjoyed the learning process more through the use of the informal learning tool. This is consistent with much of the other reported research in that informal learning helps increase motivation, interest, and allows students to better connect to the content. Overall, the use of informal learning opportunities for students can be beneficial in combating the preconceptions
that students have by allowing them to confront their initial thoughts in ways that are different than typical formal instruction.

Inquiry

Another benefit of informal learning activities is the ability to include and focus on inquiry throughout the experience. Generally speaking, the term inquiry and its relation to science education as a whole is not very precise. A study conducted by Gyllenpalm (et. al., 2010) examined how teachers understanding of inquiry affected their instruction. Specific terms such as hypothesis and experiment were examined through interviews with teachers to develop an understanding of how inquiry is valued and portrayed to students. The results of the study revealed that a lack of understanding about inquiry and how it relates to education existed among a vast majority of the teachers interviewed (Gyllenpalm et. al., 2010). While the teachers in the study acknowledged inquiry and its value, there was never a clear definition of what inquiry entailed and how it related to their students. This then cascaded into other terms and approached such as experiments and laboratory work where although different, the teachers often didn’t make a connection of how the two were different and which was more linked to inquiry. The findings of this study relate to the necessity for students and teachers alike to have an understanding of the scientific language and how it relates to learning. As Gyllenpalm (et. al., 2010) stated, while there are attempts by teacher to have inquiry be a focus in the classroom, the drive for “true inquiry” in which students reflect on their initial predictions and seek explanations seems to be lacking. By including more informal learning activities into the curriculum, students would be able to tackle their initial conceptions, whether they are
right or not, and take place in a more genuine form of science where they actively search for answers through research means that have them at the center of the investigation.

One way of building a better understanding of inquiry for students and teachers alike was investigated in a study by Banerjee in 2010. In this particular study, the “Learn-Teach-Assess” inquiry model was adapted by teachers over a several year period. Throughout this professional development period, the teachers took previous labs and adapted them to fit this model in which the labs were the center of learning. The newly modified inquiry labs would be the hub from which concepts and skills would be built off of. These student-centered laboratory activities, while not completely informal, did exhibit some of the overlying characteristics of more non-formal learning. The implementation of this teaching model in the study revealed that the learning and experiences for teachers and students alike were far more beneficial (Banerjee, 2010). Students had a greater experience and enjoyed the labs better than the previous teacher directed activities. Consistent with other research, inquiry based activities were seen to be more beneficial than traditional learning methods. While informal methods were not directly used in this particular study, a similar teaching model in which students govern the learning process in a directed way could easily be translated into a more informal environment effectively. One important consideration that will be discussed in greater detail later on in the paper is that of teacher planning and preparation to carry on effective inquiry based activities within or outside of the classroom.

While informal inquiry learning is often considered within the external environment of the school itself, new technologies are allowing students and classes to introduce informal learning right from the computer. Scanton (2012) investigated the emergence of two new
OER’s, or open educational resources, that allowed students to bring inquiry into the classroom at both the formal and non-formal levels. One web-program entitled nQuire allowed teachers to post labs on the internet through a system that allowed the students to be guided in their investigations. This student-driven program had students carry out traditional laboratory procedures, but in a manner that organized their data, observations, and questions along the way (Scanton, 2012). In essence, this online program gave them structure for the experience, but didn’t direct them towards a given response or goal. Informal and non-formal learning are very much the same in that the student directed activities are meant for the kids to be the center and to conduct all of the thinking. This program only provided scaffolding for the research which is beneficial in almost any form of inquiry and investigation. The second resource that was examined was called iSpot which was a domain for anybody to pose questions and seek answers within a science community (Scanton, 2012). The creation of a social network of scientists, no matter what experience level, creates an environment that supports collaboration, thinking, questioning, and inquiry alike. This resource is also very much centered around informal and non-formal learning in that questioning and collaboration are appreciated and valued. The members of iSpot, while directly linked to a computer, can be linked to any environment around the world and not restricted to the classroom. Although these new technological resources can be used within the classroom, they allow the student to carry out inquiry in a context that removes them from traditional formal instruction and into a more informal realm of learning.
Implications: Teacher Beliefs

Similar to the teaching of evolution in biology, the utilization of informal teaching methods is often criticized and in one way or another. Specifically, how informal teaching strategies and instruction are implemented with respect to effectiveness is often directly linked to the comfort and abilities of the teacher. In a study conducted by Griffith and her associates in 2004 biology teachers were looked at in terms of their approaches to the instruction of evolution. Results from the interviews given to the teachers revealed three different types of teachers with respect to biology. These classifications however translate to the practice of informal learning by teachers as well. The elite branch of teachers named “Scientist” teachers are extremely comfortable with material and new approached in the classroom (Griffith et. al., 2004). While these teachers occasionally have a few minor concerns about their instruction and how it is viewed by others, they never stray from what they know and how it should be instructed. These teachers tend to be the oldest as they have had more experience and practice with how they present information to their students. This is the strongest class of teacher that should be strived for as they are willing to do what it takes to provide meaningful and appropriate instruction to their students. The next step down in the teacher classification for this study were “Selective” teachers who chose to emit particular aspects of instruction altogether in order to avoid any judgment by staff or students alike (Griffith et. al., 2004). These teacher trends should be avoided because the instruction provided should not be altered to do what is easiest. While informal learning opportunities can be more difficult to set up and implement, the benefits and experiences gained from them are worth the hassle, if any at all. The final classification of teacher identified were “Conflicted” teachers (Griffith et. al., 2004).
These teachers tended to be the youngest and most likely to alter their approaches because of their personal beliefs. Teacher should strive to not become this type of instructor as their biases affect the education that they provide to their students. While the beliefs in the context of evolution and religion are abstract compared to informal learning as a practice, the beliefs of teachers regarding what type of instruction they prefer can be seen as a similar bias and affect the type of learning that the students receive.

It is often seen that the lack of comfort that a teacher has with a particular approach often leads to inadequate instruction (Fowler & Meisels, 2010). Teacher want to provide the best possible experience for their students and in order to avoid potentially detrimental learning, teachers sometimes choose to omit particular information. By doing so however, the teacher is presenting a biased representation of the content and therefore making the instruction less valuable. As Kose (2010) discussed, it is important that teacher provide an unbiased representation of material through their instruction. While acknowledging one’s personal beliefs and ideals is important, it should be used as a resource to know where instruction might be unfairly expressed. One way that in which uncomfortable content may be addressed more easily is by making connections between various content areas (Fowler & Meisels, 2010). Using the strength in understanding of one area to assist an area of lesser strength can help assure that the information is portrayed in a way that is beneficial for student learning. Within informal education, providing students the opportunity to link various aspects of the curriculum together can be very beneficial for students and teachers alike. In addition, it is important to remember that how one teaches is just as important as what we teach (Kose, 2010). Providing effective instruction through the informal lens requires teachers to know not
only the content itself, but what approaches the students will take. This comes down to
effective planning and implementation which I will be going into greater detail in the following
section.

Use of Field Trips

One effective way of implementing an informal learning experience can be done
through the use of field trips. When planning a trip for one’s class, there are many
considerations that should be taken. A study conducted by Aykut Bozdogan in 2012 examined
how field trip planning was carried out by prospective science teachers and their thoughts and
feeling throughout the process. From the beginning many of the teachers were excited, yet a
little uneasy about planning the trip. As this was a new experience for them, the teachers were
expectedly a little nervous about the experience. When discussing the preliminary intentions
for the trips, a majority of the teachers stated that the intent of the trip would be primarily for
entertainment purposes (Bozdogan, 2012). While informal learning should have an emphasis
on an entertaining and enjoyable experience, it is also important to consider and educational
goals of the trip as a whole. Upon completion of the trips, these prospective teachers also
acknowledged this and said that in future trips they would try to incorporate a larger emphasis
on the educational goals alongside the entertainment (Bozdogan, 2012). In terms of the
stresses that the prospective teachers experienced, almost all of the teachers were concerned
about various aspects of the trip. The preliminary stresses as addressed by Bozdogan were
centered on non-instructional issues such as funding, transportation, and chaperoning (2012).
By the end of the study it was revealed that although there were a few minor stresses
remaining, almost the entire group of teachers felt more secure in their abilities to plan and conduct a field trip. This study highlights the importance of planning and practice with informal learning experiences. As informal learning experiences are not the norm for teachers it is essential for instructors to practice and gain experience with planning and implementing this type of instruction.

A valuable consideration for teachers when planning an informal educational field trip is to use their past experiences as a foundation for the instruction. In a study conducted by Bryan Rebar in 2012 teachers were interviewed about trips to an aquarium that they had planned. The purpose of this study was to investigate what experiences in their lives affected and impacted how they conducted field trips for their class. Based on the research it was found that informal mentoring, past experiences on trips, various outdoor education programs, and traditional education training were the most influential to teachers (Rebar, 2012). Informal mentoring was the most influential of the four experiences identified and came from seeking advice from other teachers, specifically those with more experience teaching and planning trips, in order to get advice and support. By gathering advice and assistance from those with more experience teachers can get alternative perspectives and be able to build off of what has worked in the past for other teachers. The experiences from past trips and outdoor education programs are in essence forms of experiential learning that the teachers are developing instruction off of. By utilizing what the teacher has learned from other trips and activities in the external environment, the teachers are able to create more beneficial and effective informal field trips. Finally, the training that teachers receive in the formal setting of the school can also translate into the field trips that they plan (Rebar, 2012). Professional development in schools
is going to be beneficial towards any form of instruction, whether it is formal or informal. Using the skills and abilities that teachers obtain through these types of meetings can be very helpful to the general effectiveness and delivery of material. When planning an informal educational trip it is important to take advantage of one’s strengths and abilities. Being able to take advantage of the resources and knowledge at your disposal is a very effective strategy when implementing informal learning opportunities.

With respect to the actual implementation of a field trip, a case study conducted by Susan Davidson and her colleagues in 2009 investigated two particular field trips to zoos. The aim of the study was to examine how the different members of the trip, including teacher, students, and zoo educators interacted with one another. In addition, the researchers wanted to investigate how the agendas and perceptions of the various members of the trip varied from case to case. The first case study outlined an informal field trip with several flaws. From a preparation standpoint, the teacher failed to get the students involved with the content prior to the trip and didn’t set clear expectations or goals for everyone involved. The trip was designed for entertainment purposes only and although this goal was met, the overall experience for everyone was conflicted as the trip lacked motive and direction. After the trip was completed, relevance to what was experienced and how it related to the class material was only glanced over. This lack of discussion and relevance was reflected in most of the student not having great recollection of what they had learned or experienced from the trip months later. The second case study revealed a far more effective field trip in which many of the negative attributes of the first were remedied. The teacher of this class made sure to make connections to the trip before and after the actual experience. In addition, the teacher made
sure that the students and zoo staff was aware of the goals and intentions of the trip so that it would be productive. Once at the zoo, the students were given time to explore the zoo with friends after traveling and learning as a group for some time. These experiences were beneficial both in terms of the educational value and motivation by students. Not only did the student have much more positive feedback about the trip and how it was conducted, but the students also had a greater recall of the information they learned and what they observed. The results of this case study reveal some major implication with respect to informal learning through field trips. First, the connecting of material throughout the process is essential to student learning (Davidson et. al., 2009). Just as learning is a life-long endeavor, the learning process on a small scale trip such as this should include relevance and reference before, during, and after the trip itself. Second, being well prepared with respect to expectations and goals of the trips was affective for the second case study teacher. Having a solid idea of what you want your students to accomplish during the trip along with some sort of scaffolding for time was beneficial for everyone involved. Finally, providing opportunities to be social and interact in a self-centered way was a key component to the effectiveness of the trip. The ability for students to work independently and within social groups of their choices was very important to the students in this case study (Davidson et. al., 2009). Allowing the students to take a self-regulated inquiry based approach at the zoo enhanced the experience and allowed the students to be more personally and actively involved in the learning that occurred at the zoo. Overall this case study highlighted some of the major application considerations of informal learning activities through the lens of a field trip.
Chapter Three: Capstone Project

Project Design

This project will include a compilation of four individual environmental themed units. These units will contain opportunities for learning to occur in locations within the Finger Lakes region of New York. Each unit will contain a collaboration of 10-12 individual activities that will incorporate multiple science learning standards and connections to additional content areas. In addition, each activity will include teacher instructions with potential modifications and considerations, as well as identification of all the necessary materials and potential safety concerns for each individual activity. Each unit in the compilation will include the following when applicable:

- Title of Unit Theme
- Individual Activities for Each Unit
- Teacher Instructions for Activities including:
  - Identification of alternatives to instruction (based on weather, availability of resources, etc.)
  - Necessary Materials
  - Introductory and Concluding Activities when appropriate

Significance of Project

While these particular activities are very specific to one particular area, the content which can be explored in each of units is extremely vast. While the activities are designed to work within a unit scheme, they could easily be broken down throughout the year or rearranged in order to meet the needs of the class. While these activities do not fall under the classification of state required labs, many of these activities are great reinforcers of content and science skills alike. While the need for traditional instruction is not to be undervalued, the presentation of the activities in these units is intended to provide students and teachers alike with alternatives to normal instruction both in and outside the normal classroom environment.
Brains Over Braun: Survival of the Smartest

Often times in nature it is not the strongest that necessarily are the dominant species, although it does help. It is usually the ability to adapt and overcome that truly defines the success of a species or type of organism. Generally there are three different categories of adaptation in which an organism is able to overcome and strive. These groups are hibernation, acclimation, and migration. Each of these changes in the lifestyle and choices of the organism adapting allow them to take particular advantage of the situation to ensure their survival.

In the tables below, fill in as many example of each adaptation as you can. An example is given to start you off and show how you should fill in the table.

### Hibernation

<table>
<thead>
<tr>
<th>Organism</th>
<th>Example of Adaptation for Survival</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bears</td>
<td>Before the months going into their hibernation, bears eat lots of food to put on large fat layers to use as food during their dormant period. During this period of sleep, the bears heart-rate and metabolism will drop drastically to decrease energy use while they slumber.</td>
</tr>
</tbody>
</table>

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</tbody>
</table>
### Migration

<table>
<thead>
<tr>
<th>Organism</th>
<th>Example of Adaptation for Survival</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sea Turtles</td>
<td>Some species of sea turtles will travel long distances and return to the very beaches they were born on in order to lay their eggs. As other turtles do the same thing, the hope is that the massive number of baby turtles will mean more of the offspring will survive against closely watching predators upon hatching.</td>
</tr>
</tbody>
</table>
## Acclimation

<table>
<thead>
<tr>
<th>Organism</th>
<th>Example of Adaptation for Survival</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bees</td>
<td>Bees will form massive comb structures within structures to meet many priorities of the hive. These combs will house offspring, provide storage for food, as well as provide a safe haven for all of the other bees in the group against weather, predators, etc.</td>
</tr>
</tbody>
</table>
Just as plants and animals around the world adapt in order to survive, we humans also adapt to our surroundings. Whether it is in the real world, or in high-intensity survival situations, our bodies and minds are also equipped with ways to overcome the obstacles put in front of us. In the space below create a chart similar to those used on the previous pages for animals in which you will identify multiple ways in which humans can also migrate, acclimate, and hibernate in order to survive in certain scenarios. Try to include at least one example of each of the forms of adaptation, however include as many examples (not limited to just the three general types) as possible.
Brains Over Braun: Survival of the Smartest

Teacher Instructions

Introduction:

Before handing out the materials for this activity begin the class by proposing the following question to your students: “What is the most valuable attribute in a survival scenario?” You may propose examples such as strength, intelligence, luck, speed, etc. in order to get their minds thinking about it. Have them perform a “Think, Pair, Share” for this in which the students first think about the question being asked for a couple of minutes. They can write down some notes about their thoughts and reasoning during this process. After a few minutes have each student pair up with another student and discuss what they thought was the most important skill with one another. Students should explain and justify their reasoning for picking what they did. After a few more minutes of the small group discussion, have two groups combine to make a larger group of four and once again discuss their choices and reasoning. After another few minutes have students return to their seats and go around the room calling on each student and have them reveal what they thought was the most important attribute. You may choose to consolidate ideas into more general categories (such as the ones previously proposed by you). Additional questions you may consider asking could include:

- Did any of you change what you thought was the most important attribute? Why?
- What debates were there among group members about the most important attribute?
- Does the saying “Brains over Braun” really make sense or is it just a saying? Why?

After collecting all of the student responses start to center the focus and attention on the idea of change due to a specific scenario. Introduce the three major concepts that will be the focus of the activity (hibernation, acclimation, and migration) and briefly describe each to the class so that they will have a basic understanding of the principle before beginning the activity. You may choose to provide an example of each type (examples provided in first section of each chart of student packet) to provide students with real-world relatable examples to connect concept.

Main Activity:

Hand out the student activity packet and go over the instructions with the students. Reinforce the basic idea that students will be working independently on this portion of the assignment in which they will be trying to think of more real-world examples of where specific animals carry out each type of adaptation for survival. Students can refer to their books and notes for assistance, however they should attempt to include as many examples as possible first. Have the class start by looking at hibernation first and work on only that section first. IF students are stuck and ask for assistance, you may help prod them in the right direction, but do not give the answers directly to them. One hint you may want to use is to tell them to think of animals that they don’t see year round; ask them to explain why and where they go. Some examples that you may hint towards could include:
- Bats
- Turtles
- Bees
- Snakes
- Snails

After about 5 minutes on their own, have them meet with another partner (preferably someone they have not yet worked with during the activity) to discuss the examples that they came up with and include any additional examples that they found. This should only take about 5 minutes as well, however more or less time can be given depending on your students. After students have completed the first chart on hibernation, instruct them to once again think about the second topic of migration and carry out the same steps and procedure for that adaptation. The same principles and procedures will also be carried out for the final adaptation of acclimation as well. The completion of these sections should take roughly 30 minutes to complete. Some notes about animals that use each type of adaptation for the second two sections are included below:

Migration
- Canadian Geese
- Whales
- Sharks
- Other Birds

Acclimation
- Sheep
- Domestic Pets (fish, cats, dogs)
- Hermit Crabs
- Trees/Plants

After all of the students have completed the three charts regarding the three types of adaptation, and then have students refer to the final section. Read and explain the directions to them so that they understand the purpose of relating adaptation to humans. Migration will likely be a difficult adaptation for them to include an example of so it may be helpful to think of how we use sleep in different scenarios to promote our health and well-being. Tell students to try and include examples primarily from a “survival scenario” perspective.

Conclusion

After the students have completed their charts human adaptations, as a “Ticket out the Door” activity, have each student reveal an example of a human adaptation. With their response the student will also have to identify what category of adaptation it would be considered and justify their response. Students should not repeat answers from other students, however if you have a large class, it may be allowed towards the end.
Survival Scenario Breakdown

The following activities that you are going to evaluate will help set the stage for the survival science unit. For each scenario you will be asked to grade certain materials that an individual in a particular predicament. We can then evaluate your ability to survive in particular conditions to some extent based off your choices in how you would rank the materials. Read each of the scenarios closely and answer all of the questions that follow. It may be helpful to make notes throughout each reading to better assess your situations. Be sure to include as many examples as possible and try to think outside of the box. Often those that can adapt and evolve are the ones that survive the longest!

Scenario #1: Lost at Sea

Lost at Sea Exercise
Scenario:
You and your team have chartered a yacht. None of you have any previous sailing experience, and you have hired an experienced skipper and two person crew. As you sail through the Southern Pacific Ocean a fire breaks out and much of the yacht and its contents are destroyed. The yacht is slowly sinking. Your location is unclear because vital navigational and radio equipment has been damaged. The yacht skipper and crew have been lost whilst trying to fight the fire. Your best guess is that you are approximately 1000 miles South West of the nearest landfall.

You and your friends have managed to save the following 13 items, undamaged and intact after the fire.
1. A shaving mirror
2. A quantity of mosquito netting
3. A 5 gallon can of water
4. A case of army rations
5. Maps of the Pacific Ocean
6. A floating seat cushion
7. A 2 gallon can of oil/petrol mixture
8. A small transistor radio
9. 20 square feet of Opaque plastic sheeting
10. Shark repellent
11. 15ft nylon rope
12. 2 boxes of chocolate bars
13. A fishing kit
In addition to the above, you have salvaged a four man rubber life craft. The total contents of your combined pockets amounts to a packet of cigarettes, three boxes of matches and 3 $5 bills.

Questions

1. In order from most pressing to least important, rank the following survival essentials in this scenario: Water, Shelter, Food, Fire, and Signaling Help. Explain why you would rank each survival essential as you did.

2. What do you think is the most valuable item in your possession and why? What is the least valuable item you have and why?

3. What materials do you have that could be used for food? How exactly would you utilize them for the greatest benefit?

4. What materials do you have that could be used for shelter? How exactly would you utilize them for the greatest benefit?

5. What materials do you have that could be used for water? How exactly would you utilize them for the greatest benefit?

6. What materials do you have that could be used for fire? How exactly would you utilize them for the greatest benefit?

7. What materials do you have that could be used for signaling rescue? How exactly would you utilize them for the greatest benefit?

8. What means of protection do you have from natural harm (weather, animals, illness)? What are the items and how would they be used?
After answering the questions above, go over the materials that you have in your possession (15 items total) and rank them from most important to least important (1-15). As a class we will go over what the experts say is the best ranking.

**Scenario #2:**

You and your companions have just survived the crash of a small plane. Both the pilot and co-pilot were killed in the crash. It is mid-January, and you are in Northern Canada. The daily temperature is 25 below zero, and the night time temperature is 40 below zero. There is snow on the ground, and the countryside is wooded with several creeks criss-crossing the area. The nearest town is 20 miles away. You are all dressed in city clothes appropriate for a business meeting.

Your group of survivors managed to salvage the following items:

1. A piece of steel wool
2. Cigarette lighter (no fluid inside)
3. A small ax
4. Small airline pillow
5. Can of Crisco shortening
6. Newspapers (one per person)
7. Cigarette lighter (without fluid)
8. Extra shirt and pants for each survivor
9. 20 x 20 ft. piece of heavy duty canvas
10. A sectional air map made of plastic
11. Packet of instant coffee
12. Compass
13. Family-size chocolate bars (one per person)

**Questions:**

9. In order from most pressing to least important, rank the following survival essentials in this scenario: Water, Shelter, Food, Fire, and Signaling Help. Explain why you would rank each survival essential as you did.

10. What do you think is the most valuable item in your possession and why? What is the least valuable item you have and why?

11. What materials do you have that could be used for food? How exactly would you utilize them for the greatest benefit?
12. What materials do you have that could be used for shelter? How exactly would you utilize them for the greatest benefit?

13. What materials do you have that could be used for water? How exactly would you utilize them for the greatest benefit?

14. What materials do you have that could be used for fire? How exactly would you utilize them for the greatest benefit?

15. What materials do you have that could be used for signaling rescue? How exactly would you utilize them for the greatest benefit?

16. What means of protection do you have from natural harm (weather, animals, illness)? What are the items and how would they be used?

Scenario #3: Unlikely, but fun to think about

You are a member of a space crew originally scheduled to rendezvous with a mother ship on the lighted surface of the moon. However, due to mechanical difficulties, your ship was forced to land at a spot some 200 miles from the rendezvous point. During reentry and landing, much of the equipment aboard was damaged and, since survival depends on reaching the mother ship, the most critical items available must be chosen for the 200 mile trip. Below are listed the 15 items left intact and undamaged after landing. Your task is to rank order them in terms of their importance for your crew in allowing them to reach the rendezvous point.

<table>
<thead>
<tr>
<th>Your Ranking</th>
<th>NASA Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>____ Box of matches ____</td>
<td>____</td>
</tr>
</tbody>
</table>
Once you have gone over the NASA ratings for the items on the list answer the following questions to finish up the activity:

17. Which of the first two scenarios do you think would have been more difficult to survive? Justify your response?

18. In any survival scenario, what do you think is the most important to maintain: your mind, your body, or your surroundings? Explain why you think so and why the other choices aren’t as important.

19. For each of the survival scenarios, identify what type of issues, specifically regarding to the human body, may have been encountered for each situation. Be able to explain why the issue would have been problematic to the survivor.
Survival Scenario Breakdown

Teacher Instructions

Introduction

This is the first activity that will be given for the unit, therefore grading and how well students do on this activity isn’t necessarily important. These scenarios however will enlighten the students about the issues that people in survival scenarios may face and relates to several of the topics that will be covered within the unit.

At the start of the class, ask the students about any shows or movies that they know or have seen relating to survival. Some example may include the movie Castaway, the TV show Lost, or potentially even horror survival movies (zombies, etc.) For each example that a student raises there hand to share, ask the student about what materials were most essential to their survival. This question is broad and the responses that students are likely to give will probably be numerous. This is a good thing to get the class’s minds interested. After some of the students have shared some examples and discussed the question that you asked, and then ask the class if they could bring three things in any survival scenario that they choose, what would it be? Give the students some time to think about the answer and jot down their answer. After a few minutes select some students to reveal what they chose and why they decided on those items. The point is to realize that certain items may be more beneficial in some scenarios than others, so your commentary should reflect that through the process. After going through some of the responses, then reveal to the students that they are going to read about some survival scenarios and evaluate the importance of certain materials in each.

Main Activity

Hand out the packets to the students and briefly go over the instructions. Explain that they will be doing each of these by themselves then collecting as a group to look over everyones’ responses, as well as see what the experts ranked each item as. Students should start with the first scenario, reading the paragraph about the setting of the event and what materials they have in their possession. After reading, the students will answer the questions that follow and the rank each of the items given in the scenario based on their usefulness and importance to survival. While the students are working on the questions and ranking, create a chart at the front of the room to show many students ranked each material where. The table should be 15x15 to showcase all of the possible ways materials may be placed and ranked. After all of the students have answered the questions and ranked all of the materials, gather the data from the students about how they ranked each item. After gathering the class data, you can then read off the “Lost at Sea Rationale” information on the following page of the teacher directions about how US Coast Guard experts ranked each item and why.
Lost at Sea Rationale

According to the experts (US Coastguard), the basic supplies needed when a person is stranded mid-ocean are articles to attract attention and articles to aid survival until rescue arrives. Articles for navigation are of little importance since even if a small life raft were capable of reaching land, it would be impossible to store enough food and water to survive for the requisite amount of time. Without signaling devices, there is almost no chance of being spotted and ultimately rescued. Furthermore, most rescues occur within the first 36 hours and a person can survive with only a minimum of food and water during that period. So, the following is the order of ranking the items in their importance to your survival:

1. Shaving Mirror Critical for signaling
2. 2 gallon can of oil/petrol mixture Critical for signaling. The mixture will float on water and could be ignited with one of the $5 bills and a match
3. 5 gallon can of water Necessary to replenish fluids lost through perspiration (that’s sweat)
4. One case of army rations Basic food intake
5. 20 square feet of opaque plastic Can be utilized to collect rain water and provide shelter from the elements
6. 2 boxes of chocolate bars Reserve food supply (what were you going to do with that much chocolate?)
7. Fishing kit Ranked lower than the chocolate as ‘a bird in the hand is worth two in the bush’ There is no guarantee you will catch any fish.
8. 15ft of nylon rope Could be used to lash people or equipment together to prevent it being washed overboard.
9. Floating seat cushion A life preserver if someone fell overboard
10. Shark repellent Enough said
11. One quart of 160 per cent proof rum Contains 80% alcohol, which is enough to be used as an antiseptic for any injuries.

12. Small transistor radio Of no use without a transmitter. You would also be out of range of any radio station.

13. Maps of the Pacific Ocean Worthless without navigation equipment. It does not matter where you are but **where the rescuers are!**

14. Mosquito netting There are **NO** mosquitoes in the mid-pacific ocean. As for fishing with it? – stick to the fishing kit.

15. Sextant Useless without the relevant tables and a chronometer.

The same procedure would then be taken for the second survival scenario in which the students would first read over the scenario and materials given. They would then answer the questions and once again rank the materials in terms of their importance and value in the situation. Again you can make a chart (or just erase some of the rows and column so that it is now a 13x13 grid and again collect the students responses about the materials and there ranks. Then reveal the following information about experts grade and rank of the materials available.

**Scenario #2 Rationale**
1. Cigarette lighter (without fluid)- The gravest danger facing the group is exposure to cold. The greatest need is for a source of warmth and the second greatest need is for signaling devices. This makes building a fire the first order of business. Without matches, something is needed to produce sparks, and even without fluid, a cigarette lighter can do that.

2. Ball of steel wool- To make a fire, the survivors need a means of catching he sparks made by the cigarette lighter. This is the best substance for catching a spark and supporting a flame, even if the steel wool is a little wet.

3. Extra shirt and pants for each survivor- Besides adding warmth to the body, clothes can also be used for shelter, signaling, bedding, bandages, string (when unraveled), and fuel for the fire.

4. Can of Crisco shortening- This has many uses. A mirror-like signaling device can be made from the lid. After shining the lid with steel wool, it will reflect sunlight and generate 5 to 7
million candlepower. This is bright enough to be seen beyond the horizon. While this could be limited somewhat by the trees, a member of the group could climb a tree and use the mirrored lid to signal search planes. If they had no other means of signaling than this, they would have a better than 80% chance of being rescued within the first day. There are other uses for this item. It can be rubbed on exposed skin for protection against the cold. When melted into an oil, the shortening is helpful as fuel. When soaked into a piece of cloth, melted shortening will act like a candle. The empty can is useful in melting snow for drinking water. It is much safer to drink warmed water than to eat snow, since warm water will help retain body heat. Water is important because dehydration will affect decision-making. The can is also useful as a cup.

5. 20 x 20 foot piece of canvas- The cold makes shelter necessary, and canvas would protect against wind and snow (canvas is used in making tents). Spread on a frame made of trees, it could be used as a tent or a wind screen. It might also be used as a ground cover to keep the survivors dry. It’s shape, when contrasted with the surrounding terrain, makes it a signaling device.

6. Small ax Survivors- need a constant supply of wood in order to maintain the fire. The ax could be used for this as well as for clearing a sheltered campsite, cutting tree branches for ground insulation, and constructing a frame for the canvas tent.

7. Family size chocolate bars (one per person)- Chocolate will provide some food energy. Since it contains mostly carbohydrates, it supplies the energy without making digestive demands on the body.

8. Newspapers (one per person)- These are useful in starting a fire. They can also be used as insulation under clothing when rolled up and placed around a person’s arms and legs. A newspaper can also be used as a verbal signaling device when rolled up in a megaphone-shape. It could also provide reading material for recreation.

9. Loaded .45-caliber pistol- The pistol provides a sound-signaling device. (The international distress signal is 3 shots fired in rapid succession). There have been numerous cases of survivors going undetected because they were too weak to make a loud enough noise to attract attention. The butt of the pistol could be used as a hammer, and the powder from the shells will assist in fire building. By placing a small bit of cloth in a cartridge emptied of its bullet, one can start a fire by firing the gun at dry wood on the ground. The pistol also has some serious disadvantages. Anger, frustration, impatience, irritability, and lapses of rationality may increase as the group awaits rescue. The availability of a lethal weapon is a danger to the group under these conditions. Although a pistol could be used in hunting, it would take an expert marksman to kill an animal with it. Then the animal would have to be transported to the crash site, which could prove difficult to impossible depending on its size.

10. Quart of 100 proof whiskey- The only uses of whiskey are as an aid in fire building and as a fuel for a torch (made by soaking a piece of clothing in the whiskey and attaching it to a tree branch). The empty bottle could be used for storing water. Can also be used as an antiseptic for
a wound. The danger of whiskey is that someone might drink it, thinking it would bring warmth. Alcohol takes on the temperature it is exposed to, and a drink of minus 30 degrees Fahrenheit whiskey would freeze a person’s esophagus and stomach. Alcohol also dilates the blood vessels in the skin, resulting in chilled blood belonging carried back to the heart, resulting in a rapid loss of body heat. Thus, a drunk person is more likely to get hypothermia than a sober person is.

11. Compass- Because a compass might encourage someone to try to walk to the nearest town, it is a dangerous item. It’s only redeeming feature is that it could be used as a reflector of sunlight (due to its glass top).

12. Sectional air map made of plastic- This is also among the least desirable of the items because it will encourage individuals to try to walk to the nearest town. It’s only useful feature is as a ground cover to keep someone dry.

You may choose to discuss some of the differences in the rank of certain materials from one scenario to another and the reasoning for the change. The final scenario is more for fantasy, but it is interesting and fun to relate to. Again the students would then read the scenario and the list of materials that are in the person’s possession. Then they would rank the items and answer the questions that follow. After doing so, then the teacher can reveal the NASA ranking of the items in this particular scenario.

<table>
<thead>
<tr>
<th>Answers to the Survival on the Moon Exercise Item</th>
<th>NASA Ranking</th>
<th>NASA’s Reasoning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Box of matches</td>
<td>15</td>
<td>Virtually worthless -- there’s no oxygen on the moon to sustain combustion</td>
</tr>
<tr>
<td>Food concentrate</td>
<td>4</td>
<td>Efficient means of supplying energy requirements</td>
</tr>
<tr>
<td>50 feet of nylon rope</td>
<td>6</td>
<td>Useful in scaling cliffs and tying injured together</td>
</tr>
<tr>
<td>Parachute silk</td>
<td>8</td>
<td>Protection from the sun’s rays</td>
</tr>
<tr>
<td>Portable heating unit</td>
<td>13</td>
<td>Not needed unless on the dark side</td>
</tr>
<tr>
<td>Two .45 caliber pistols</td>
<td>11</td>
<td>Possible means of self-propulsion</td>
</tr>
<tr>
<td>One case of dehydrated milk</td>
<td>12</td>
<td>Bulkier duplication of food concentrate</td>
</tr>
<tr>
<td>Two 100 lb. tanks of oxygen</td>
<td>1</td>
<td>Most pressing survival need (weight is not a factor since gravity is one-sixth of the Earth’s -- each tank would weigh only about 17 lbs. on the moon)</td>
</tr>
<tr>
<td>Item</td>
<td>Quantity</td>
<td>Description</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>----------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Stellar map</td>
<td>3</td>
<td>Primary means of navigation - star patterns appear essentially identical on the moon as on Earth</td>
</tr>
<tr>
<td>Self-inflating life raft</td>
<td>9</td>
<td>Bottle in military raft may be used for propulsion</td>
</tr>
<tr>
<td>Magnetic compass</td>
<td>14</td>
<td>The magnetic field on the moon is not polarized, so it's worthless for navigation</td>
</tr>
<tr>
<td>5 gallons of water</td>
<td>2</td>
<td>Needed for replacement of tremendous liquid loss on the light side</td>
</tr>
<tr>
<td>Signal flares</td>
<td>10</td>
<td>Use as distress signal when the mother ship is sighted</td>
</tr>
<tr>
<td>First aid kit, including injection needle</td>
<td>7</td>
<td>Needles connected to vials of vitamins, medicines, etc. will fit special aperture in NASA space suit</td>
</tr>
<tr>
<td>Solar-powered FM receiver-transmitter</td>
<td>5</td>
<td>For communication with mother ship (but FM requires line-of-sight transmission and can only be used over short ranges)</td>
</tr>
</tbody>
</table>
**WATER KWL**

Water tends to be one of those things that you think you know a lot about, but there is far more than meets the eye to it. Most people know typically the basics about water which is good because it is such an important compound and nutrient. However, there is a lot more to water than just H₂O. In order to see how much you know and what you can learn about water, we are going to conduct a KWL. This will allow us to identify what we already know, figure out what else we want to learn, and then learn more about the topic. Using the chart below, fill out the K and W sections before reading the article, then after reading and highlighting the article (highlight yellow information you already knew, green things that you wanted to learn more about, and pink additional things that you learned) finish filling out the L section of the chart.

<table>
<thead>
<tr>
<th>K</th>
<th>What you already know about water</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>W</th>
<th>What you want to learn about water</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>L</th>
<th>What else you learned about water</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Water Chemistry**

You probably know water's chemical description is H₂O. A water molecule consists of one atom of oxygen bound to two atoms of hydrogen. The hydrogen atoms are "attached" to one side of the oxygen atom, resulting in a water molecule having a positive charge on the side where the hydrogen atoms are and a negative charge on the other side, where the oxygen atom is. Since opposite electrical charges attract, water molecules tend to attract each other, making water kind of "sticky." The side with the hydrogen atoms (positive charge) attracts the oxygen side (negative charge) of a different water molecule.

All these water molecules attracting each other mean they tend to clump together. This is why water drops are, in fact, drops! If it wasn't for some of Earth's forces, such as gravity, a drop of water would be ball shaped -- a perfect sphere. Even if it doesn't form a perfect sphere on Earth, we should be happy water is sticky.

Water is called the "universal solvent" because it dissolves more substances than any other liquid. This means that wherever water goes, either through the ground or through our bodies, it takes along valuable chemicals, minerals, and nutrients.

Pure water has a neutral pH. Pure water has a pH, of about 7, which is neither acidic nor basic.

**Water's Physical Properties:**

Water is unique in that it is the only natural substance that is found in all three states -- liquid, solid (ice), and gas (steam) -- at the temperatures normally found on Earth. Earth's water is constantly interacting, changing, and in movement.

Water freezes at 32° Fahrenheit (F) and boils at 212° F. In fact, water's freezing and boiling points are the baseline with which temperature is measured: 0° on the Celsius scale is water's freezing point, and 100° is water's boiling point. Water is unusual in that the solid form, ice, is less dense than the liquid form, which is why ice floats.

Water has a high specific heat index. This means that water can absorb a lot of heat before it begins to get hot. This is why water is valuable to industries and in your car's radiator as a coolant. The high specific heat index of water also helps regulate the rate at which air changes temperature, which is why the temperature change between seasons is gradual rather than sudden, especially near the oceans.

Water has a very high surface tension. In other words, water is sticky and elastic, and tends to clump together in drops rather than spread out in a thin film. Surface tension is responsible for capillary action, which allows water (and its dissolved substances) to move through the roots of plants and through the tiny blood vessels in our bodies.

**Water temperature:**

Water temperature is not only important to swimmers and fisherman, but also to industries
and even fish and algae. A lot of water is used for cooling purposes in power plants that generate electricity. They need cool water to start with, and they generally release warmer water back to the environment. The temperature of the released water can affect downstream habitats. Temperature also can affect the ability of water to hold oxygen as well as the ability of organisms to resist certain pollutants.

**pH:**
pH is a measure of how acidic/basic water is. The range goes from 0 - 14, with 7 being neutral. pHs of less than 7 indicate acidity, whereas a pH of greater than 7 indicates a base. pH is really a measure of the relative amount of free hydrogen and hydroxyl ions in the water. Water that has more free hydrogen ions is acidic, whereas water that has more free hydroxyl ions is basic. Since pH can be affected by chemicals in the water, pH is an important indicator of water that is changing chemically. pH is reported in "logarithmic units," like the Richter scale, which measures earthquakes. Each number represents a 10-fold change in the acidity/basicness of the water. Water with a pH of 5 is ten times more acidic than water having a pH of six.

Pollution can change a water's pH, which in turn can harm animals and plants living in the water. For instance, water coming out of an abandoned coal mine can have a pH of 2, which is very acidic and would definitely affect any fish crazy enough to try to live in it! By using the logarithm scale, this mine-drainage water would be 100,000 times more acidic than neutral water -- so stay out of abandoned mines.

**Specific Conductance:**
Specific conductance is a measure of the ability of water to conduct an electrical current. It is highly dependent on the amount of dissolved solids (such as salt) in the water. Pure water, such as distilled water, will have a very low specific conductance, and sea water will have a high specific conductance. Rainwater often dissolves airborne gasses and airborne dust while it is in the air, and thus often has a higher specific conductance than distilled water. Specific conductance is an important water-quality measurement because it gives a good idea of the amount of dissolved material in the water.

Probably in school you've done the experiment where you hook up a battery to a light bulb and run two wires from the battery into a beaker of water. When the wires are put into a beaker of distilled water, the light will not light. But, the bulb does light up when the beaker contains salt water (saline). In the saline water, the salt has dissolved, releasing free electrons, and the water will conduct an electrical current.

**Turbidity:**
Turbidity is a measure of the cloudiness of water. It is measured by passing a beam of light through the water and seeing how much is reflected off particles in the water. Water cloudiness is caused by material, such as dirt and residue from leaves, that is suspended (floating) in the water. Crystal-clear water, such as Lake Tahoe (where they work hard to keep sediment from washing into the lake) has a very low turbidity. But look at a river after a storm -- it is probably brown. You're seeing all of the suspended soil in the water. Lucky for us, the materials that
cause turbidity in our drinking water either settle out or are filtered before the water arrives in our drinking glass at home. Turbidity is measured in nephelometric turbidity units (NTU).

**Dissolved Oxygen:**
Although water molecules contain an oxygen atom, this oxygen is not what is needed by aquatic organisms living in our natural waters. A small amount of oxygen, up to about ten molecules of oxygen per million of water, is actually dissolved in water. This dissolved oxygen is breathed by fish and zooplankton and is needed by them to survive.

Rapidly moving water, such as in a mountain stream or large river, tends to contain a lot of dissolved oxygen, while stagnant water contains little. The process where bacteria in water helps organic matter, such as that which comes from a sewage-treatment plant, decay consumes oxygen. Thus, excess organic material in our lakes and rivers can cause an oxygen-deficient situation to occur. Aquatic life can have a hard time in stagnant water that has a lot of rotting, organic material in it, especially in summer, when dissolved-oxygen levels are at a seasonal low.

**Hardness:**
The amount of dissolved calcium and magnesium in water determines its "hardness." Water hardness varies throughout the United States. If you live in an area where the water is "soft," then you may never have even heard of water hardness. But, if you live in Florida, New Mexico, Arizona, Utah, Wyoming, Nebraska, South Dakota, Iowa, Wisconsin, or Indiana, where the water is relatively hard, you may notice that it is difficult to get a lather up when washing your hands or clothes. And, industries in your area might have to spend money to soften their water, as hard water can damage equipment. Hard water can even shorten the life of fabrics and clothes! Does this mean that students who live in areas with hard water keep up with the latest fashions since their clothes wear out faster?

**Suspended Sediment:**
Suspended sediment is the amount of soil moving along in a stream. It is highly dependent on the speed of the water flow, as fast-flowing water can pick up and suspend more soil than calm water. During storms, soil is washed from the stream banks into the stream. The amount that washes into a stream depends on the type of land in the river's drainage basin and the vegetation surrounding the river.

If land is disturbed along a stream and protection measures are not taken, then excess sediment can harm the water quality of a stream. You've probably seen those short, plastic fences that builders put up on the edges of the property they are developing. These silt fences are supposed to trap sediment during a rainstorm and keep it from washing into a stream, as excess sediment can harm the creeks, rivers, lakes, and reservoirs.

Sediment coming into a reservoir is always a concern; once it enters it cannot get out - most of it will settle to the bottom. Reservoirs can "silt in" if too much sediment enters them. The
Volume of the reservoir is reduced, resulting in less area for boating, fishing, and recreation, as well as reducing the power-generation capability of the power plant in the dam.

**WATER KWL**

**Teacher Instructions**

**Introduction**

At this point in the curriculum the students will have heard a lot about water and what it is. Through the discussion of all the body systems, environmental science, and other content in Living Environment water is a key compound. This activity is primarily to bring back that prior knowledge, while also prepping the kids for another water activity that they will be completing.

Start the class by handing out the KWL chart and having each student write in what they already know about water. At this stage it can have anything to due with water, but towards the end of the class the focus should be shifted towards a survival scenario focus. After about 5 minutes of having the students fill in the K section of the chart, then have them go right to the W section in which they will write down some questions they would like to have answered about water. At this point you may start to suggest they start transitioning their mindset to water in a survival sense. While not every question has to deal with survival, they should try to include at least one thing they would hope to learn about water in survival scenarios.

**Main Activity**

After another 5 minutes of filling in the W section of the chart you can then hand out the accompanying reading that talks about the scientific principles around water. Students should read the article quietly by themselves. As they are reading they should highlight the information that is new to them related to water. After finishing the article, the class then fill in their L section of the chart in order to record the information that they gathered form the reading.

**Wrap-Up**

After the entire class has finished the reading and filled in their final column of the chart, call on students to have them share some of the important information that they were able to gather from the reading. The teacher should tell the class to record any additional information that they don’t have recorded on their charts that other classmates included. This will allow other students who may have missed some important details to collect them in their chart.
What’s In Your Water: An Interactive Experiment with Filtration

One of the biggest mistakes that can be made when in a survival situation is drinking unsafe water. While water is important and it is essential that you get water in your system for many reasons, in many cases the water contains contaminants that would be even more harmful if consumed. Therefore, taking care of the water through various means is an important consideration when in a survival situation.

One of the most general ways to improve the water that you may consume would be to filter it. By eliminating much of the dirt and sediment in the water, it becomes much cleaner. However, it is important to realize that this would only be the first step in the process and other things would have to be done to ensure it is safe to drink. Unfortunately filters for the traveling hiker or outdoorsman can be very expensive. Luckily for us, there are simpler ways to filter and eliminate some of the contaminants in water that we can easily test and explore right in the classroom.

http://www.epa.gov/safewater/kids/flash/flash_filtration.html

The link above contains a tutorial and directions on how to filter your own water source using some common household items. The tutorial reveals all of the necessary information and steps that must be taken in the filtration process; as well as discuss the science and terminology of each phase of the filtration process. Before you actually run the experiment being modeled, you are going to create a lab write-up for the process. Based off of all the information that is presented in the tutorial you will be able to write up the beginning portions of a lab experiment; similar to the things you typically receive in writing before any lab experiment. Based off this tutorial you will write up the following components:

- **Purpose:** Talk about the general science principles behind filtration, what terminology is common with this science concept and how it applies to the process, relating the material and practice to survival situations and what we discussed in the beginning of class.
- **Materials:** Create a detailed list of all the materials that would be needed for a person/s to complete the activity. Give recommendations or suggestions about specific materials when possible.
- **Procedure:** Include a step by step listing of the directions and what will have to be completed throughout the filtration process. Include information about each step from a scientific perspective and what is occurring when possible.

After constructing these components of a typical lab write-up, then you will then be carrying out the actual demonstration itself. By following the steps that you wrote down and shown in the tutorial you will create a water filtering device in order to clean a stagnant water source. As
you are performing the demonstration include your observations of the various processes of
the filtration. Create a table that identifies that various parts of the filtration process, the
purpose of each, as well as your observations (visual, smells, etc.) of the water sample that you
are testing.

In the end you will have a filtered water sample that should be much cleaner and clearer than
the beginning source. After completing the activity you will then answer the following
questions to be turned in with your lab write-up and observation chart:

1. Why do you think aeration of the water before starting is a crucial step?
2. What is the importance of alum in filtration?
3. Why is it important to let the debris settle before beginning the filtration step?
4. Why do you think the use of three different layers in the filtration process is used?
5. What would happen if we switched the layer of the filtration system around (fine sand
at the bottom and pebbles at the top)?
6. What are some chemicals that you think might be used for disinfection of water? Are
there any potential ways to disinfect without chemicals? If so, what?
7. Say you are in a survival situation and have no water. You created the same structure
you used today and filtered water out of a nearby stream. Would the water be safe
enough to drink in your eyes? What are the risks and rewards of drinking this water
that has been filtered, but not altered in any other way?
8. Assume the role of a lost hiker who does have all of these materials at hand. If you
didn’t have the plastic bottles, coffee filters, or clean sand and pebbles; what materials
might a hiker have that could be used in replace for each of these things?
9. What are other ways in which a hiker would be able to disinfect a water source? Hint:
What other things will kill off harmful bacteria and eliminate contaminants?
What’s In Your Water: An Interactive Experiment with Filtration

Teacher Instructions

Pre-Class Preparation

For the kids to complete this activity they are going to need the following materials. Each group will need the following:

- At least 2 liters of “Swamp Water”. This can either be grabbed from a stagnant area, or created by mixing water with 1 cup of dirt from outdoors and mixing
- 3-2 Liter soda bottles per group. 2 of them will be cut and altered within the activity.
- 1 larger beaker or mixing bowl
- Alum (Potassium Aluminum Sulfate). Can be purchased in baking aisle of grocery stores
- 1.5 cups of fine sand (play or beach sand works well)
- 1.5 cups of coarse sand (multi-purpose sand)
- 1 cup of small pebbles (aquarium rocks)
- 1 coffee filter
- 1 rubber band
- Stopwatch (optional) for recording time

The teacher should set up stations with these materials ahead of time or place them in designated areas so that groups can easily go and get them.

Modifications

If desired, this lab could be completed all outdoors. If a stagnant water source is close by to the school you could enhance this activity by having students go and collect their own water samples. Students can easily do all of the filtration steps with the materials needed in an external environment, just be sure that they all watch the video ahead of time before heading outdoors.

Introduction

To start the class, begin a conversation with the students about where their drinking water comes from. Based on location, the students may give multiple answers including lakes, wells, springs, streams, or even rain water. Make a list of all these types of water at the front of the room. After creating the list, then ask the class what the difference is between these water sources and what you would get out of bottled water. Based on the students’ responses, route the conversation towards identifying that there are impurities and other materials that are typically within most water sources including dirt, micro-organisms, wastes, etc. After discussing what types of impurities that exist in our water sources, then ask the question of
how these contaminants can harm us. Focus this conversation in survival scenario sense; identifying natural water impurities and what effects they can have. Examples to share with the class may include diarrhea, malaria, typhoid, and intestinal worms. After going over potential illnesses and their effects, then ask the class how we can prevent these water-based illnesses. Again, students will likely give multiple examples here potentially including boiling, filtration, purification, etc. For each example that the students give have them explain more about what each process does and how it works (teacher should add additional information when possible to enhance understanding). Finally after going over a few of the examples of water treatment, ask them from a survival scenario what is most likely the cheapest and easiest way to clean your water some. The response should be filtration which you can then lead into being the focus of the activity for the day.

**Main Activity**

Hand out the student activity packets and read through the directions together as a class. Enforce the important concepts that they will be creating a filtering device in order to “clean” stagnant water. Emphasize the various parts of the activity including:

- Watching the tutorial (Suggest that students take notes so that they can refer to them during later parts of the activity)
- Creating the lab write-up (Students will need their own paper and writing utensils for this portion. Directions and expectations are included in student handout)
- Creating filtration apparatus
- Using filtration unit (Be sure students know they will be creating a table with their observations and information about each part of the filtration process)

Once all of the directions have been reviewed, students will then get into small groups and go to a computer to watch the tutorial. As students are watching the tutorial the teacher should circle around each group to ensure that they are taking notes and staying on task. Once all of the kids have finished the tutorial they can log off the computers and find a work area for their group to start creating the lab write-up. Each group should have their write-up checked and reviewed by the teacher for completion before being able to go on to the interactive demonstration.

As students work to construct the filtration device and carry out the demonstration the teacher will continue to circle around to each group, addressing any questions that may arise through the process. After a group has finished the demonstration, they should clean their work area and return any materials back to where they cam from. After cleaning their area the groups can continue right on to the post-activity questions. With any remaining time left in the period the students can record their answers to the questions provided in their packet.
Living Off the Land: Food in a Survival Situation

Imagine for a moment that you were in a survival situation within a desolate upstate New York. Picture all of the prepared foods such as canned goods, pre-made pastas, and other nonperishable items had been used up and the only food sources that were available would be the ones that you could find in your own backyard and ones that you could grow or catch yourself. Sounds like the scenario behind a bad zombie movie or something, but if it actually occurred where you had to be sufficient off of a more “hunter-gatherer” food style, could you do it?

Fortunately for this region that we live in, the ability to crow crops and harvest game animals is relatively bountiful. Outside of the normal things that can be eaten, there is actually a wide variety of critters and plants that could be eaten in a survival scenario. For this activity, you are going to look into the resources available right here in upstate New York, evaluate them, and then create a couple of meals that could be realistically made from local ingredients.

Part 1: Identifying the Resources

As I previously stated, there is a rather large wealth of food resources that can be hunted and gathered from the wilds of upstate New York. While some are more common, some foods are typically left alone or even not considered a potential food source. Regardless, when it comes to a survival situation, any food you can get in your system means more calories, nutrients, and energy for you to work with.

The key thing with these resources in the wild is to be able to identify them as safe to consume. Plants especially can be very harmful to humans, but cooking and cleaning of certain animals can be just as hazardous if not done correctly. That is why classification and recognition are essential to the survivalist. In order to get a better understanding of the food sources available in your area, you are going to do some research into the natural surroundings and settings of the upstate New York area. Using any of the resources you have available to you including internet, magazines, books, and other informative sources you are going to create a brief catalog of some of the food sources in the area. For each food item you will create an identification card containing the following:

- Name of food (both common and scientific)
- Type of food source (fruit, vegetable, grain, protein, etc.)
- Details about identifying the food source in the wild
- Description of food (taste, smell, etc.)
  Include a picture of the food source
Total you will have to find 20 total food sources that would be found in the upstate New York area (fruits and vegetables that would be able to grow in nature e.g. corn, apples, etc. can be included). Of the 20, at least 5 of each much be from each of the following groups:

- Fruits
- Vegetables
- Meats

Where you place the remaining 5 between these groups is up to you. Therefore, in the end you will have 20 identification cards of food sources within the upstate New York area for you to continue the next section of the activity with.

**Part 2: Weighing the Options**

Not all foods are created equally. In multiple different ways, the benefits and drawbacks of different foods can play a huge role in what food sources you decide to eat in a survival situation. Factors such as nutritional value, abundance in the wild, hazards in retrieval, and other concerns have to be taken into consideration when deciding which food to eat. That being said, an understanding of the nutritional value of food is a key component to these decisions.

From your knowledge about the various nutrients that food can provide and the information from in class this year, fill in the background information about all of the nutrients groups below. Be sure to include information about their prevalence, where they come from, what types of foods possess them, how they help your body, and how much energy they provide. After breaking down each nutrient, give them a numerical ranking, 1 being most important and 6 being least, in terms of their importance in a survival situation.

_______ Carbohydrate

_______ Proteins

_______ Fats

_______ Vitamins

_______ Minerals
With a better understanding of the nutritional implications and considerations of the food that we eat, we can now start to evaluate the food from multiple perspectives. For each food card that you created you will now evaluate the pros and cons of the food from multiple viewpoints. Looking at the nutritional value, safety concerns, gathering limitations, and other factors you can think of, create two lists on the back of each identification card that will identify the benefits and drawbacks of this food in a survival situation. Each food item should have at least 3 benefits and 3 drawbacks included on the back of the card. This process will then be done for the remaining 19 foods that you have. After completing all of the cards, you will then rank the options from best to worst using the same scale as before. In survival situations it may be required to make choices based off of a simple survival ranking scale as well, so this situation is very applicable.

**Part 3: Making the Meal**

Now that you have identified your foods and weighed the pros and cons it is now time to think about how you would cook or arrange your food in meals. Again, in this scenario you would be working with limited supplies and materials so how you would eat various things is likely to vary. While eating many things raw is typically easy and time-saving, the morale boost a warm cooked meal can provide is also worth thinking about.

With the ingredients in upstate New York you were able to find (can include more than the 20 that you identified in your cards) your next job is creating some meals that could be realistic of a survival situation in this region. You will have to plan out 3 meals (breakfast, lunch, and dinner) that could be made in the wild using upstate New York ingredients. You will present this portion in a well developed essay. Your essay will include the following:

- Paragraph for each meal that you create. For each meal include:
  - Description of the meal you would prepare including the ingredients used
  - Considerations of the meal in preparing it (health, safety, etc.)
  - Benefits of the meal you created for a survivalist
- A concluding paragraph stating what you learned and any interesting facts about survival foods in the upstate New York area you discovered.

**Living Off the Land: Food in a Survival Situation**

Teacher Instructions

**Day 1**
Introduction

Hand out the student packets to the class and then start to read the first couple of paragraphs aloud. As you read, have the students really think about the questions being asked and the scenario being portrayed. After completing the first paragraph stop for a moment and have the kids talk with the person sitting next to them for a moment and discuss the questions and scenario that were described. Have the kids discuss whether they think they could survive and what foods they know they would be able to obtain and eat. After a minute of discussion continue on reading the next paragraph which reveal the goal of the lesson.

Continue reading the directions for the various parts of the assignment that they will be carrying out for the assignment. Explain to them that the first section will be done within the library of the school and will focus on the research component of the assignment. In this first section they will be collecting data on specific foods that can be found in the upstate New York area, as well as how to identify the food source in nature.

The second part of the project will have them start to evaluate the food source, both in the positive and negative contexts. The kids will examine the food from multiple perspectives, determine the pros and cons of the food, and then rank them. The final part of the project will have the students combine the knowledge they have gathered regarding the food and applying it towards the creation of “survival meals” that could be made from the resources available in our area. In a well developed essay the kids will create 3 square meals made from ingredients in the upstate New York area and describe the composition, benefits, limitations, and other considerations of the meal in a survival situation. After going through the instructions with the whole class open the floor for questions in order to help the students fully understand the project and tasks that will be completed over the next few days.

Main Activity

After going over all the information you will then take your students to the library so they can begin their research process. Each student is responsible for 20 identification cards containing information described in the instructions. Students should be working quietly and productively in the library to complete these identification cards. As the students are working the teacher should walk around the library and to each group ensuring that they are staying focused and answering any questions that may arise. Depending on the particular class this will probably take 1-2 days to complete. After they have completed their identification cards the teacher will inspect them to ensure they are all done properly and contain the appropriate information that meets the requirements identified.

After completing the cards, the students can then move on to the second part in which they are going to evaluate the food items that they have collected from the previous step. Students will
start by reading the first couple of paragraphs for that section and then filling out the basic knowledge and principles for each of the nutrients groups (previously covered in other material). This is merely a warm-up to get their prior knowledge to the surface and focus their next efforts appropriately. After including all of the information for each nutrient group and ranking all of the nutrients, the students will then create a pros and cons list on the back of each identification card for each of the twenty food items that they obtained from the previous section. Within their list they should consider not only the nutrients that each food may or may not contain, but also other considerations as identified in the paragraph of the student packet. After writing down the pros and cons for each food item they will then rank the food items on a scale from 1-20 of the best foods based off of the information they obtained and included and their own personal opinions. Once the students have completed portion of the assignment the teacher should once again check their list to ensure that they have ample information that meets the requirements stated in the student packet.

Conclusion

The final component of this project will have the students create an essay that describes and evaluates 3 meals (breakfast, lunch, and dinner) that they could create using the ingredients found in upstate New York. This will allow the students to be creative, yet also think of the resources and the knowledge they have obtained about them in a unique way. The description for the essay is included on the student packet in limited detail so be sure to emphasize to the class the use of proper writing mechanics, including as much detail as possible, and most importantly meeting the objective of the paper for each meal that they are going to create. This assignment can be assigned as a homework or project to be completed in the days following the completion of the first two parts of the assignment.

Name:______________________________     Date:_____________

What’s In Your Food: Determining the Calories Your Food has

Have you ever wondered how nutritionists know how many Calories a certain food contains? In this project you'll learn a method for measuring how much chemical energy is available in
different types of food. You will build your own calorimeter to capture the energy released by
burning a small food item and then be able to relate this data towards survival situations and
what food is best, from a calories perspective anyways, in a survival scenario. This project gives
a new meaning to the phrase "burning calories."

**Introduction**

You know that the energy that keeps your brain and body going comes from the food you eat.
Your digestive system and the cells in your body break down the food and gradually oxidize the
resulting molecules to release energy that your cells can use and store.

In this project you will learn a method for measuring how much chemical energy is stored in
different types of food. You will oxidize the food much more rapidly, by burning it in air. You'll
use a homemade *calorimeter* to capture and measure the heat energy released by burning. The
basic idea of a calorimeter is to capture the released heat energy with a reservoir of water,
which has a high capacity for absorbing heat. The temperature of the water reservoir is
measured at the beginning and at the end of the experiment. The increase in the temperature
(in °C) times the mass of the water (in g) will give you the amount of energy captured by the
calorimeter, in calories. We can write this in the form of an equation:

\[ Q_{\text{water}} = mc\Delta T \]

where:
- \( Q_{\text{water}} \) is the heat captured, in calories (cal);
- \( m \) is the mass of the water, in grams (g);
- \( c \) is the specific heat capacity of water, which is 1 cal/g°C (1 calorie per gram per degree
  Celsius); and
- \( \Delta T \) is the change in temperature (the final temperature of the water minus the initial
  temperature of the water), in degrees Celsius (°C).

Let's work through an example to make sure that the equation is clear. (We'll use made-up
numbers for the example. You'll have to try the experiment for yourself to get actual
measurements.) So let's say that we start out with 100 g of water in the calorimeter \( m = 100 \) g.
The initial temperature of the water is 20°C. After burning up some small piece of food, we
measure the water temperature again, and find that the final temperature is 24°C. Now we
have all of the information we need to calculate the amount of heat captured by the
calorimeter:
\[
Q_{water} = mc\Delta T
\]
\[
= 100 \text{ g} \times 1 \frac{\text{cal}}{\text{g}^\circ\text{C}} \times (24^\circ\text{C} - 20^\circ\text{C})
\]
\[
= 100 \times 1 \frac{\text{cal}}{\text{g}^\circ\text{C}} \times 4^\circ\text{C}
\]
\[
= 400 \text{ cal}
\]

Now you can see why the specific heat capacity of water has such strange units (cal/g°C). Notice that the grams (g) from the mass of the water and the degrees Celsius (°C) from the change in temperature cancel out with the grams (g) and degrees Celsius (°C) in the denominator of the units for specific heat. That way you are left with units of calories (cal), which is what you want.

Materials and Equipment

In order to create your own Calorimeter to measure the number of calories your food has you are going to the need the following materials:

- homemade calorimeter requires:
  - two tin cans, one larger than the other,
  - wood dowel, pencil or other rod-shaped support,
  - cork,
  - needle or wire,
  - hammer and nail,
- graduated cylinder,
- water (preferably distilled),
- thermometer (calibrated in °C, range 20–100 or greater),
- safety glasses,
- lighter or matches,
- scale
- food items to test (peanut, popcorn, potato chip)
- paper and writing utensil (for writing up data tables and charts)
Procedure

BE SURE TO READ ALL OF THE DIRECTIONS BEFORE STARTING AND CREATE ALL NECESSARY
DATA TABLES THAT YOU WILL BE USING

Part 1: Constructing the calorimeter (refer to the diagram above).

a. Select two cans to build your calorimeter. They should nest inside one another. The smaller can needs to sit high enough so that you can place the cork, needle and food item beneath it.

b. Remove the top and bottom from a coffee (or similar-sized) can, so that you have a cylinder open on both ends.

c. Use a hammer and nail to make holes in the bottom (to allow air to in to sustain the flame).

d. Punch holes at opposite sides of the smaller can for the support to pass through. The diagram labels the support as a glass rod, but you can use a wood dowel, a

Figure 1. Diagram of Homemade Calorimeter
pencil, or a metal rod for the support. Your support needs to be longer than the width of your large can.
e. Grasp the needle (or wire) and push its blunt end into the cork. You will impale the food to be tested on the sharp end of the needle. (If you use wire, you can wrap it around the food item to be tested. Don't use insulated wire!)
f. The smaller can will hold the water to be heated by burning the food samples. Use the graduated cylinder to measure how much water you use; the can should be about half-full. Put the supporting rod in place through the two holes. An example of what your calorimeter should look like is provided below.
g. After completing your calorimeter, have your teacher check it over before moving on to the tests.

You have now created your calorimeter and it will be ready to test the food items that you are being provided. Before continuing, be sure that you have read the directions ahead and have prepared data tables and charts for all of the measurements and calculations that you are going to be making and including.
2. Weigh each of the food items to be tested and record the weight. You will be using three different food items for testing (peanut, popcorn, potato chip/s). Be sure to include the weights of your samples within your data table.

3. Fill the small can about half-way with a measured amount of distilled water.

4. Measure the initial temperature ($T_i$) of the water. Record this temperature in your chart.

5. Impale the first food item on the needle (or wrap the wire around it).

6. Have your calorimeter pieces close at hand, and ready for use.

7. Place the cork on a non-flammable surface. Light the food item (Note: if you are using the nut, it may take awhile to catch fire).

8. When the food catches fire, immediately place the large can around the cork, then carefully place the smaller can in place above the flame.

9. Allow the food item to burn itself out. Make sure one of your group members is watching this process.

10. Carefully remove the small can by holding the ends of the supporting rod, and place it on a flat, heat-proof surface. The can will be hot, so be careful.

11. Carefully stir the water and measure the final temperature ($T_f$). Make sure the thermometer has reached a steady level before recording the value.

12. When the burnt food item has cooled, carefully remove it from the needle (or wire) and weigh the remains.

13. Repeat steps 2–13 an additional 2 sample of your first food group. In the end you will have completed 3 trials for each food type that you are testing. Try to ensure that all elements of the test are identical to those used in your first test (amount of water, size of food sample, etc.)

14. Once you have completed the 3 trials for your first food product, carry out the same procedure in order to get the data for your final two food items that you will be testing. Remember to test each food item 3 times and to gather all the data you have collected from each test.

Now that you have gathered and arranged all of your experimental data on your chart, it is now time to analyze your data. Calculate the energy released per individual food item (in
calories and Calories), and the energy per unit weight of each food item (in calories/gram and Calories/gram). From your individual results, calculate average values for each food type.

Conclusion Questions

1. Which food type released the most energy per gram?
2. Can you calculate the average energy (in Calories) for each type of food item you tested? Which food item had the greatest average energy?
3. Do you think the amount of Calories you measured is likely to be higher or lower than the true value for each food item? Why?
4. If caught in a survival situation, which type of food would be the best to eat in terms of energy?
5. What other considerations should be considered in a survival situation?
What’s In Your Food: Determining The Calories Your Food Has

Teacher Instructions

Materials

- two tin cans, one larger than the other
- wood dowel/pencil
- cork
- needle or wire
- hammer and nail
- graduated cylinder
- distilled water
- thermometer (calibrated in °C, range 20–100 or greater),
- safety glasses
- lighter or matches
- scale
- food items to test (peanuts, popcorn, potato chips)

Pre-Class Work

Before students enter the classroom, you should prepare work stations within the classroom (if possible) where students will be conducting the actual experiments. These workstations should contain all of the materials listed above for each group.

Introduction

Before handing out the materials to your students, ask all of your kids the following question: “What is a calorie?” Give them a couple minutes to think about the question (they may choose to talk with the person sitting next to them if they would like). After a couple of minutes bring the class back together and brainstorm the ideas and thoughts they came up with in the front of the class. As the students are giving their responses, try to bring together a consensus about the idea that food contains energy and that calories are a measure of that energy. You may have to assist in guiding this discussion.

After the general principles of what a calorie is have been investigated, then ask your students the following question “How does one measure how many calories something has?” Again give them a minute or two to talk with the person sitting next to them and see what they are able to figure out. Most likely the students will have more difficulty with this question so try to direct the conversation and discussion towards a burning or breaking down of the food into fuel for the rest of our bodies. Also focus on that this energy release from the “fuel” is what can be measured to determine how many calories something has.
Main Activity

Hand out the activity packets to the students and quickly read the first paragraph to them. Elaborate that they will be building their own calorimeters in this activity to measure how many calories certain foods have. Inform the class that they will be working in small groups (variable dependent on your particular class size and resources available). Have students get into their groups and then read over the introduction section of the packet. While students are reading, you may choose to write a calorie calculation problem up on the board that each group member will have to solve. This will allow you to check their understanding of the math principle behind the science and their understanding of the equation and how to use it.

Once the groups have read through the introduction and carried out a practice calculation (optional), have them go back to a work-station with their packet, writing utensil, and additional paper (for the creation of their data table/calculations). All of the groups should read through the entire packet, including all of the procedure sections, so hey are prepared and have an understanding of what they will be doing along the way. Students will then work to complete the lab activity including the creation of the calorimeter, testing their food items and completing the calculations and post-lab questions.

While students are working the teacher should go from group to group ensuring that they are staying on task, making sure all members of the group are participating, and that they are using the materials properly. The teacher may assist when necessary, however students should be able to follow directions to complete lab on their own. The teacher should also check each groups calorimeter before they begin their trials (refer to picture in student packet for model). After students have completed their tests and calculations, the kids will complete the post-lab questions. Each group member is responsible for their own lab to be turned in. Therefore, each student will turn in the following items upon completion of the lab:

- Lab Packet
- Data Tables (created on separate sheet/s of paper)
- Calculations (created on separate sheet/s of paper)
- Post-Lab Question Responses

Concluding Activity

After the students and their groups have completed all elements of the activity, they must clean up their work station. All unused materials should be placed neatly within the area in which they were originally placed. Students may keep their calorimeters they have created should they choose. If they do not desire to keep them, they may be placed in the garbage for disposal. As the “Ticket Out the Door” activity for the class, the teacher will go to each group and examine the work area. If clean and in order, the teacher will then take the completed materials from each student in the group and they will be able to leave.
Shelters and You: Looking at the Similarities and Differences

When you think about it, the human body is, in the most general of terms, a containment unit. Our bodies have multiple components, functions, and designs that allow each person to be unique, yet also perform similar functions. The same is also true for shelters that individuals use.

In this activity you will be looking at various types of structures, some old and some more recent, and review them against the human body. In particular, the functions and structure of the various lodgings will be the focus of analysis. For each of the types of structures below create a diagram that compares and contrasts them to a human body. Some areas you may wish to consider evaluating may include:

Function: What is the purpose of the shelter/body? Are there any specific benefits to one of them/abilities the other can't conduct?

Arrangement: How are your bodies and the structure arranged similarly/differently to achieve a certain purpose?

Longevity: How does the body/shelter perform in the long-term? Short term? Under specific elements (weather, illness, etc.)

Composition: What materials make up the body/structure? Benefits and limitations of those materials?

SHELTER TYPES

1. Cave dwelling
2. Teepee
3. Sleeping Bag
4. Log Cabin
5. Standard House (with amenities)

After completing the diagrams for all of the shelter types, I want you to answer the following question: What would be the ultimate anytime shelter? In your response you should address many of the components you evaluated in the previous section and justify your reasoning with comparisons to what makes our bodies so effective for sheltering our insides.
The Shelter Analogy Continued

Now that we have examined the how a shelter in general can be similar to the body in terms of structure and function, let us look deeper into what actually makes up the shelter in terms of building materials. Obviously there are many different types of resources which could be used to be shelters based on the needs and conditions in which the place will be constructed. Just like these structures, the human body is made of unique materials, each with a specific purpose and role towards the survival and maintenance of the body as a whole.

Here you will examine several different building materials and analyze there benefits and drawbacks towards the function and success of structures. Once you have done that you will then write a brief response as to what the material could be compared to for human bodies. For your responses you must include at least 2 pieces of evidence back up your claim. An example of what is expected is included below:

**Building Material: Roof Shingles- Related to Skin Cells**

<table>
<thead>
<tr>
<th>SIMILARITIES TO HUMAN BODY</th>
<th>DIFFERENCES TO HUMAN BODY</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Provide protection from the elements (rain, snow, etc.)</td>
<td>- Held into place by unnatural means</td>
</tr>
<tr>
<td>- Relatively lightweight</td>
<td>- Cannot react to environmental conditions</td>
</tr>
<tr>
<td>- Layered</td>
<td>- Cannot be removed involuntarily</td>
</tr>
<tr>
<td>- Can be shed off and replaced</td>
<td>- Costly to repair</td>
</tr>
<tr>
<td>- Flexible, malleable</td>
<td>- Removal is time consuming and messy</td>
</tr>
<tr>
<td>- Capable of letting extrusions out (E.g. chimney, hair)</td>
<td></td>
</tr>
</tbody>
</table>

Roof shingles can be compared to the skin cells of a human body in many ways. For instance, shingles acts as a natural barrier to many of the natural elements just like the skin. Also, roof shingles are often replaced over time in order to ensure the stability of the whole layer covering the structure. The shingles, although singular units or sheets in most cases, work together with the other shingles, just like skin cells that work with one another to create a solid and generally impenetrable surface. Finally, the fact that shingle are flexible and can be formed to fit the various needs of a roof is another similarity that this building material has with the skin cells which also work with the form of the body and allow materials and other body components to be exposed.

For all the building materials on the next page, construct a chart that identifies the similarities and differences that these building materials have with the human body. Follow each chart with a brief explanation of your reasoning in paragraph form.
Building Material: Wooden Frames
Building Material: Metal Piping
Building Material: Fiberglass Insulation
Building Material: Electrical Wiring
Building Material: Security System
Building Material: Doorways/Doors
Shelters and You: Looking at the Similarities and Differences

Teacher Instructions

Introduction

To start the class, have all of the students take out a sheet of paper and brainstorm as many types of shelters as they can. After a few minutes have students raise their hands and give some of the examples that they came up with. Multiple different answers are likely to be given including houses, tents, caves etc. After creating a good list (8-10 types of shelters), have students break into groups and then make a Venn diagram to compare and contrast two of the shelters. To assure that all of the shelters get used it may be beneficial to split up the shelter types that are on the list. After a few minutes have each group share some of the traits that characteristics that the shelters had in common. List these general similarities towards of the front of the room. Do the same thing with the differences that the different shelter types have. After creating the list of both the similarities and differences, have student combine with another group (making groups of 4) and have them try to brainstorm general categories that shelters might share or differ in. Give the example of function and explain that it can mean what the purpose of a structure is to protect or what benefits a specific shelter may have in certain conditions. Allow the groups a few minutes to think of some of these general categories. As students are thinking and working together the teacher can go around to the groups and center their thinking if they need assistance in thinking of these broad categories. After a few minutes have each group share one or two categories that they came up with and record them on the board, along with what each category would encompass. At this point the list should include most, if not all, of the categories that the first activity is going to focus on. At this point the teacher can hand out the activity packet and get ready for the main activity.

Main Activity

After all the kids have the packet, read over the directions on the first page with them. Be sure that they understand the purpose of the first part is for each student (working alone) to create a table or diagram that will compare and contrast the five different shelter types against the human body. Using the categories identified on the page, as well as some of the categories that were mentioned in the warm-up activity, the students will relate how the human body shares similar functions to various structures. Students should work quietly to complete the chart. After finishing the chart they can go on to answer the question at the bottom of the page, however make sure they do not advance any further. This portion of the activity should only take 15 minutes or so, after which you can stop the students who haven’t finished (tell them to finish that section for homework) and move on to the next page.
While the first part of the activity looked at shelters and the human body in a broad sense, this second part of the activity is aimed at having the students make connections to various building materials and different parts of the body. Go through the directions with the class and review the example of what is expected. In essence, they are going to replicate the chart given on the student copy for each of the building materials provided on the last page. Within the chart they will provide specific examples of how the building material is related to a body part of their choice. The students should attempt to pick a body part that is most similar to the building material so that they have a lot of comparisons that can be made between them (Example: Don’t have students compare a foundation to windows). In addition to the chart the students will also have to include a paragraph describing at least two of the similarities and differences that the building material and the body parts have in common with more specific details. Again an example is provided in their packet for what is expected. The kids should work by themselves for this portion of the activity as well; however they can seek assistance or help from classmates if they need it. This activity should take up the remainder of the class to finish. If any students who didn’t complete the first part of the activity have time at the end of the class to finish it, they may go back and complete it at the end.

**Conclusion**

At the end of class as a “ticket out the door” activity you can have each student create another comparison between some part of a shelter and how it is similar to a part of the human body. The examples must not be the same as those used in the activity itself. As the students leave the teacher can collect the activity packet and any charts and writing that they had from the activity for grading.
SHELTER CHALLENGE

Now that you have explored the benefits, creation, and construction of shelters in emergency situations, it is now time to test your abilities to survive. In this activity you and a partner will take on the role of two hikers who get caught in a severe thunderstorm with very little materials to work with. The storm is quickly approaching and you and your friend have limited time to construct a shelter and settle in for the storm to pass. The storm will be approaching from the west so consider this in your construction. You will each be given a few supplies that would have been on your person at the time, but it will be up to you to forage and search for materials to complete your survival structure. In the end your shelter will be put to the test against a gauntlet or artificial conditions to see how well your shelter would stand up during a bad weather situation.

Materials

As previously stated, you are taking on the role of two hikers that get caught up in a severe storm. Judging by what materials they had, you were likely amateurs. However in a scenario like this everything counts and could be used in one way or another. For your materials, each of you shall receive the following:

- One 5x5 piece of standard tarp
- One wooden walking stick
- 3 feet of .5 inch diameter rope
- One pair of heavy duty camping shears
- One white t-shirt
- One set of travel cutlery (fork, knife, spoon, cup)

Other than these materials, you will have to search and scavenge from the local wooded area for other supplies to build your shelter with.

Judging Criteria

Once you have completed your shelters, your shelter will be tested under various conditions to mimic those found under a wilderness storm. Your shelter will be tested in order to assess how supportive it is of the following conditions:

- High Winds: While the trees will block some of the wind, could your shelter stand up to the gust of a severe thunderstorm?
- Rain Prevention: With thunderstorms obviously comes rain. Will your shelter be able to keep you dry on the inside?
- Ground Elevation: Getting of the ground in your shelter could be helpful for various reasons. Especially during a storm, are you able to get off the ground?
- Fire availability: Granted the rain might hinder fire ability in this situation, however any shelter should typically be made with a fire source close by. We will look to see how fire accepting and safe your shelter is.
- Comfort: Obviously your shelter isn't going to be as welcoming as home, but given that you and your partner would have to stay in it, how comfortable would the experience be for both people in the shelter given the situation.

You will have approximately one class period to build your shelter with the resources and materials available to you and your partner. Establishing a solid plan and effective teamwork will be essential to succeed in this challenge. Make sure to manage your time effectively and try to build the best shelter possible. During the next class period all of the classes’ structures will be tested and you and your partner will be able to see how effective they are as an emergency shelter.

After the activity you will be responsible for answering the following questions about the experience. Using complete sentences, answer the following:

1. What was your strategy going into the challenge? What criteria did you think would be the easiest and hardest to achieve?
2. Looking at the criteria in which your shelter was graded (wind prevention, rain prevention, etc.) why are these elements important in the creation of shelters? Explain with at least one example why each of these grading criteria is important to consider when building a shelter.
3. In terms of the structure of your shelter, why did you choose the layout that you did? What were the benefits of using certain materials as you did in this structure?
4. With respect to the teamwork aspect, how well did you and your teammate work together? Were there any struggles or situations where working together was very beneficial?
5. How happy were you with your final shelter? If you could have changed one thing about your shelter what would it have been and how would you have made the change?
6. If you could have had one additional item within your possession to build your shelter what would it have been and why?
SHELTER CHALLENGE

Teacher Instructions

Pre-Activity Preparation

For this activity students are going to be creating emergency shelters off of limited supplies. Several of these supplies will have to be purchased ahead of time in order to make the kits that the student groups will receive. Each kit for a group should contain the following items:

- One 5x5 piece of standard tarp (you may choose to buy a large piece and cut them into smaller sections if you choose)
- One wooden walking stick (as simple as a large stick roughly chest high)
- 3 feet of .5 inch diameter rope (can be purchased at any hardware store)
- One pair of heavy duty camping shears (can be purchased at any home and garden department)
- One white t-shirt
- One set of travel cutlery (fork, knife, spoon, cup available at sporting goods/camping stores)

In terms of the location in which the students will be building their shelters, you should go through the area ahead, picking up any garbage or harmful materials that could cause injury to the students. You could rope or tape off the specific area in which students are allowed to build their shelters if you choose as well.

As this activity would be conducted outside, it is important that students are aware of the exact date of the activity so that they can come prepared for the outdoor lesson. Appropriate footwear, clothing, and safety discussions about harmful wildlife and vegetation should be provided prior to the activity.

Modifications

Any of the materials on the list could be changed or altered depending on availability of resources. Ropes and tarps could be made shorter or longer and the addition of other materials in the kit can also be introduced.

Scavenging for resources in survival situations is also a common beneficial trait. You could go into the area in which they were going to build their shelters ahead of time and place random materials that might be found in the wilderness as an added perk to the shelter challenge. Things such as empty bottle, random clothing or fabric, cans, or other hiking materials could be scattered in the area and modified by the students to aid in the construction of their shelters.
Should bad weather be an issue with the construction of their shelters, this activity should be changed so that the students must make blue prints of their shelters that they would have constructed. Students would need to include measurements of all the components of their shelters from multiple viewpoints (overhead, straight forward, behind, etc.) in order to display the shelters. Students would also have to identify where all of the various parts of the kit were used and what other resources from nature would be added to the shelter.

Introduction

Before handing out the activity packet and the materials have students determine who their partner for the project will be. Partners may be assigned by the teacher if needed, however to keep with the realism of the scenario they will be working with, a friend with whom each student is familiar with will work best. Once students are in their groups you can then hand out the student activity packets and go over all of the directions as a class. Students should understand the scenario in which they are going to be building and that these elements (thunderstorm, rain, etc.) should be considered when planning and creating their shelter. Students also should remember the criteria in which they will be tested. Although how the tests are going to be assessed is going to be a secret to them, they need to keep in mind the various criteria when they are building.

After going through the directions and expectations with the students allow them 5-10 minutes to meet with their partner and start planning and discussing their thoughts on the shelter. After the planning time take your class out to the building section and let them begin. As groups are working the teacher should be scanning visually each group; ensuring that they are staying on task and using all of the materials appropriately. As time goes by through the class be sure to give the students reminders of how much time is left in the class so that they are acting accordingly. At the end of the class have the entire students stop working, gather all of the materials that they did not use, and return back to the classroom. Once back in the classroom tell all the students that they will conduct the testing of their structure the next class period.

Day 2 Testing

Pre-Class Preparation

For the testing you are going to need the following materials if possible. Electricity and water are going to be used so having extension cords and hoses or buckets available would be beneficial

- Industrial Fan: For the wind tests. Extension cords likely needed for this
Water Faucet/Handle: Preferably with multiple settings of water release to simulate different types or rain. Additional hose may be needed to reach structures.

To start the class, have students get into their groups and sit quietly as you give the testing parameters. Explain how each of the criteria will be evaluated and assessed. Descriptions of each are shown below. When testing the shelters, test them in the order given below to allow for certain characteristics to not be affected by other:

**Comfort**- Teacher will sit in the shelter with another student. Grade on a scale of 1-3 how comfortable the shelter was. Full points should be awarded for those that have enough space and have some sort of cushioning or support. 2 of three points should be awarded for having 1 of the criteria for comfort above. 1 point awarded for not meeting the comfort requirements.

**High Winds**- Each shelter will be subjected to a heavy duty industrial fan. As the scenario stated, the storm will be approaching from the west, so apply the fan facing in that direction. Apply for 1 minute, moving the fan closer and further to the shelter during that time, and then out of a scale of 5 (1 destroyed, 5- unchanged) assess the shelters.

**Rain Prevention**- Have two students from a different group sit within the structure being tested. Apply water to the outside surface of the shelter (in same direction the wind was applied). If students remain dry, then they will receive 5 points. If the students inside get wet at all, have them assess how wet off of the remaining 4 points in the scale.

**Ground elevation**- Students sitting in shelter from previous test can judge whether they are off the ground or not. If they are off the ground, they will receive 3 points. If not, they will get 1 point.

**Fire availability**- Teacher will assess the shelter and surrounding for ability to maintain and support a fire by the shelter. Teacher may ask students questions about the shelter to get a better understanding if fire preparedness was considered in their design and building. Use the following grading criteria to award points for this category:

1 point- Place in which fire could be made close to shelter considered

1 point- Clearing of flammable materials from fire area

1 point- Fire area is covered in a way to at least protect from the rain and wind somehow

**Conclusion**

After grading all of the shelters, teacher can add up the sores and present the results outdoors to all the groups. After revealing the results, have students break down their shelters completely. Any materials that were used in their shelter and could be reused (tarp, rope, etc)
should be collected by students and returned back to the teacher once inside. All other materials used should be either thrown out, or if natural to the area (leaves, branches, etc.) placed back into the woods. After all of the shelters have been deconstructed, take the class back inside, gather all of the remaining materials and wrap-up the activity by assigning the follow up questions and talking about the experience as class.

Name:__________________________     Date:_____________

**FIRESTARTER SCIENCE**

In this activity you are going to look at, and experiment with multiple different ways to start a fire; one of the most important resources and skills in a survival situation. In this investigation you will examine and read about multiple different ways, including non-ordinary methods, of starting a flame; as well as discovering the science behind them. After reading, thinking, and experimenting with all of the types of fire starting methods you will then rank the options according your experience with an explanation of how the fire-starting method should be ranked against the others and why.

**Method #1: Standard Matches**

This is by far one of the most familiar ways to start a fire in a survival situation. Matches can be a vital tool in survival situations for many reasons.

1. What are some reasons as to why a book of matches is a valuable fire starting resource to a traveler/hiker? What characteristics about the matches make them an effective tool?

Behind these very simple matches is a chemical reaction that makes it all possible. Read the information below about the reaction that makes flames for a match possible and then answer the questions that follow:

Although you may not know it, striking a match starts a chemical reaction. There are two types of matches: safety matches and "strike anywhere" matches. A safety match can only light when someone strikes it against the striking surface on the side of the match box. A "strike anywhere" match can be lit by striking the match on anything solid. A "striking surface" is made of sand, powdered glass, and a chemical called "red phosphorus". The head of a safety match is made of sulfur, glass powder, and an oxidizing agent. An oxidizing agent is a chemical that takes electrons from another chemical. When a chemical loses electrons we say it has been oxidized. An oxidizing agent is necessary to keep a flame lit. Oxygen gas is a common oxidizing agent. A
simple test for oxygen is to hold a red hot (no flame) piece of wood in a tube of gas that might be oxygen. In oxygen things will burn much faster than in air, and the wood will burst into flame.

When a match is struck on the striking surface of its box, the friction caused by the glass powder rubbing together produces enough heat to turn a very small amount of the red phosphorus into white phosphorus, which catches fire in air. This small amount of heat is enough to start a chemical reaction that uses the oxidizing agent to produce oxygen gas. The heat and oxygen gas then cause the sulfur to burst into flame, which then catches the wood of the match to catch on fire.

A "strike anywhere" match works in a similar way, but instead of phosphorus being on a striking surface, it is added to the head of the match. You can tell the difference between the two types of matches by looking at the colors of the match heads. A safety head is only one color, but a "strike anywhere" match is two colors: one for the phosphorus, and one for the oxidizing agent.

1. What is in a “striking surface”? Why is this element important to safety matches?

2. Describe the ignition of the match from an atomic level. Once the flame has been built, what is the oxidizing agent for the reaction?

3. How do “strike anywhere” and safety matched differ? How can you tell the difference between the two?

No that you have gathered a better understanding of the two types of matches, now you can try them out first hand. You will be given one of each types of match and it is our task to create a chart to help compare the two styles of matches. Think about the various characteristics of the matches and there effectiveness. Aspects such as length, ease of use, duration of fire, and other characteristics that you can think of that would be valuable to know in a survival situation should be examined and measured. Based off of the evaluation that you conduct, then compose a brief paragraph explaining which match type you feel is the best in an outdoor survival situation. Be sure to provide evidence and reasoning fro your decision.

**Method #2: Friction Fires**

The use of friction to create fire has been used for a very long time. The following article discusses the science behind this method as well as some practical information about the process. Read the following paragraphs and then answer the questions that follow:
Starting a fire by rubbing two sticks together. Why do I always get a thrill out of doing it? Is it because there are probably less than 500 people in the United States who can consistently start a fire with a hand drill? Is it the entertainer in me? I don't know. I assure you that the thrill is not diminished by knowing more about the scientific events that go on during the process.

The objective of this article is to provide some scientific insight into the events which happen when two sticks are rubbed together to start a fire. In particular, why is it that some woods don't work at all, some work with great effort and others with relative ease. The principals discussed apply equally well to the fire saw, fire plow, hand spun drill or bow drill. Will it help you start a friction fire more easily or quickly? Probably not. Will it give you a deeper appreciation of the process? I hope so.

**Basic Principles**

You have to get the char, powder that is rubbed off the wood, heated up to about 800 degrees Fahrenheit before it will start glowing (ignite). I measured this by sprinkling char generated with a bow drill on a soldering iron heated up to a known temperature. Below 800 degrees the wood dust would give off a little smoke but that's all. Above 800 it would smoke and then start to glow. Anything that prevents the char from reaching 800 degrees will interfere with fire making.

**Composition and Structure**

By this I mean what kind of molecules is the material composed of and how are the molecules arranged? If there is any volatile resin or tarry substance in the wood, then as the friction heats the wood the tarry stuff will take heat away from the char (heat of evaporation) or will condense on the char and form it into a coarse gritty substance, preventing ignition. If the correct molecules are present and all the wrong molecules are absent, there is still a problem if the molecules are not arranged properly. Imagine your best hearth board and hand spun spindle which will twirl up an ember with very little effort. The wood will be very light, a very poor thermal conductor (a good insulator). Now put your hearth board and spindle in a vice and compress the wood to 1/2 its original thickness. It will be twice as dense and its thermal conductivity will be doubled. You can still twirl up an ember but you will have to work twice as hard because you have altered the structure of the wood. You have made it a poorer insulator and you have doubled the amount of muscle power needed to reach ignition. For a person with limited muscle power attempting to start a fire by friction, the use of low density wood is critical.

The simplest test for whether a particular piece of wood will twirl up an ember is the most obvious: try it and see if it works. A quicker test is to examine the char that is ground off as you twirl the spindle on the hearth board. The rule of thumb, literally, is to rub the char between thumb and forefinger. If it is coarse and gritty then reject that particular piece of wood. If it is very fine, like face powder, then you have a good chance of twirling up a fire. Both Kochansky and Graves mention this. What is the difference between these two classes of wood? Those that work and those that don't. We know that in the category of "good" woods there are soft
woods, such as yucca, which can be easily dented with the thumbnail and hard woods such as sage brush which are much more resistant to the thumbnail test. Could it be that the "good" woods ignite at a lower temperature than the "bad" woods? That should be easy to measure. The straightforward way would be to measure the temperature of each tiny little particle of char as it is ground off the spindle or hearth board. Trouble is that it is very hard to measure the temperature of something that tiny without disturbing what is going on. The next best way is to measure the ignition temperature indirectly. Sprinkle some char on a piece of metal which has been heated to a known temperature. See what temperature the metal has to be heated to in order to ignite the char. As a practical manner I used a thermostatically controlled soldering iron as a source of known temperature. Tips with two different temperatures, 700 degrees F and 800 degrees F were available. I had observed previously that the char ground into the notch in a "good" hearth board would start glowing (ignite) if a pinch of it was placed on the 800 degree soldering iron tip but would not ignite if placed on the 700 degree tip. The conclusion from this was that if friction heats the char above 800 degrees it will ignite.

What about "bad" woods?

I used a piece of local willow sapwood, a material on which I have wasted countless hours in the past trying to light a friction fire. Never any luck. Always produces a coarse gritty char. This time I did a different experiment. I charred some of the willow with a match and then ground it off with a file. It was now very fine, much finer than the results of a bow drill. This very fine willow char would ignite almost instantaneously at 700 degrees. Conclusion: the more finely the char is divided the lower the ignition temperature. This hypothesis was tested further by grinding off some un-charred mule fat wood with a fairly fine file. This material was slightly gritty feeling compared with the char that falls into the notch of a mule fat hearth board. The coarser mule fat char failed to ignite at 800 degrees. I did the same thing with char cloth, the favored tinder for flint and steel. Char cloth failed to ignite, even at 800 degrees.

Conclusions

The miracle of fire by friction is that you don't have to heat the char up to the temperature of a glowing ember to make it ignite. You only have to raise its temperature up to the point where it takes off of its own accord. When powdered charred wood is heated up to some critical temperature it begins to spontaneously oxidize. When it starts oxidizing its temperature rises, causing it to oxidize even faster. Eventually it reaches an equilibrium temperature limited by how much air is available and starts to glow, ignition. The critical temperature where this process begins depends on how finely the char is pulverized.

Fire by friction works only because these two events, pulverizing and heating, happen simultaneously. Woods that don't work disintegrate before they reach this critical condition.
**Things that can cause problems:**

a. If you don't have enough muscle power then you won't be able to raise the temperature high enough. Remedy: teamwork. Have someone else help you. Even if the helper can only get the wood temperature elevated to 300 degrees, then it will make the job easier. Remember that a bow drill is the easiest in that it uses your muscle power most effectively.

b. If the structure of the wood is such that it disintegrates before it reaches 800 degrees then it is a wood that should not be used. I strongly believe that some softwoods such as willow and aspen don't work because they fall apart before they reach the critical temperature.

c. Volatile substances such as water or resin in the wood. Evaporative cooling will prevent the char from reaching the critical temperature.

---

1. What are some benefits and drawbacks of this fire starting method?

2. Talk about the science behind this fire starting method. What is friction and why does it allow for a fire to be started?

3. What are some concerns/considerations that you should take with this fire starting method? What are some qualities of the tools used that could hamper your ability to start a fire?

After having answered all of the questions, now it is your turn to attempt to make an ember using a simple hand drill method. You will be given a wooden dowel and a piece of wood as a base. Using simply these tow materials you will attempt to create an ember that could potentially be used to start a fire in a survival situation by rotating the dowel between your hands as fast as you can. Some hints that might aid you in the process are listed below:

- Work as a team: Have one person hold the platform wood in place while the other spins the dowel between their hands.
- Make a starting notch: It may be difficult to keep the wood in place at first. If you make a notch in the wooden base so that the dowel has a place in which it can spin better it might be helpful.
- Start towards the side of the wood: Remember that oxygen is a necessary component for fire. Think of ways in which you might be able to get more oxygen to the friction point.
- Be safe: If at any point this starts to hurt you or cause any burning sensation on your hands stop immediately. Your safety is more important than the objective of creating an ember.
After attempting to create a fire create a list of Pro’s and Con’s for this fire starting method. Your results should be organized based against the effectiveness of matches used in the previous section when possible.

**Method #3: Use of Sunlight**

Today the use of solar energy as a renewable energy source is a big topic. While campers can create solar cookers to heat food, the same principles of science are applied to starting fires as well. Below is an article about solar cooking and the science behind it. Read the article and then answer the questions that follow:

Using stoves and ovens, we can coo foods like meat, vegetables, beans, rice, bread and fruit in just about any way. We can bake, stew, steam, fry and braise. Using a solar cooker, we can do the same things, but by using sunlight instead of gas or electricity.

Sunlight isn’t hot in and of itself. It’s just radiation, or light waves -- basically energy generated by fluctuating electric and magnetic fields. It feels warm on your skin, but that’s because of what happens when those light waves hit the molecules in your skin. This interaction is similar to the concept that makes one form of solar cooker, the box cooker, generate high temperatures from sunlight.

At its simplest, the sunlight-to-heat conversion occurs when photons (particles of light) moving around within light waves interact with molecules moving around in a substance. The electromagnetic rays emitted by the sun have a lot of energy in them. When they strike matter, whether solid or liquid, all of this energy causes the molecules in that matter to vibrate. They get excited and start jumping around. This activity generates heat.

1. Describe the science behind solar cooking/heat. What is it that allows the temperature to be raised?

2. What are some benefits and drawbacks that you could see form using this fire starting method?

3. What type of items that would be readily available do you think could be used to convert sunlight into fire? Why?

Once you have answered the questions, you will use very basic materials to attempt to start a fire outdoors. You and your partner will be given a simple magnifying lens and some paper to
try and ignite the paper using strictly the sun. In the event of bad weather, the following video can be watched instead that shows a person using this method and attempting to start a fire.

http://www.youtube.com/watch?v=7om0E3B7xjk

After attempting to start a fire, create a Pro’s and Con’s list for this fire starting method. Use the results from the matches section as a baseline for the ease and effectiveness of the method.

The Final Verdict

Now that you have investigated a few different ways to start fires in a survival situation, it is time to be the judge and answer the question of which method is the best. In a well developed and organized essay (at least 4 paragraphs), write a paper that analyzes 3 different types of fire starting methods. For each type of method you will want to discuss the science behind it, the pros and cons of the method, as well as a ranking among the other types of methods. This essay will sum up the knowledge and experience you have gained form the activity and help to answer the questions of what style of fire starting is best.

FIRESTARTER SCIENCE

Teacher Instructions

Pre-Activity Preparation

Before the students arrive for this activity you should have the following materials available to hand out for the various fire starting methods that they are going to be carrying out:

- Strike on box matches
- Strike anywhere matches
- Wooden Dowels
- Pieces flat wood (any length will work, at least 1 inch thick)
- Magnifying lens
- Scrap Paper
These materials will all be used at various parts of the lesson by the students so be sure to prepare them from a safety perspective about the dangers and precautions of the fire and heat they will be examining. This activity can be run completely outdoors if you choose, or all of the activities (except for the solar igniting). Should you choose to carry out these activities indoors because of weather or by choice, a video link is provided within the student handout that shows how to start a fire with a magnifying lens in the outdoors.

Introduction

To start the lesson, start by asking the entire class to brainstorm a list of different ways to start a fire. You can record all of these methods that are suggested by students on a board at the front of the room. After creating this initial list, then ask them to brainstorm a list of characteristics that should be consider when it comes to camping and hiking and materials that are brought with them. Aspects such as weight, size, and environmental friendliness are likely to be on this list along with other student ideas. After this list has been created ask the students to get into small groups and using the two lists that were created, have a discussion about what fire starting methods would be best in a survival scenario and why. After a few minutes of group discussions, center everyone’s attention back and introduce the activity of the day and hand out the student packets.

Main Activity

After all of the students have received a copy of the packet read over the introductions paragraph at the top of the page with them. After reading, outline the lesson for them by revealing the three fire starting methods that they are going to be using and reading about. Talk about the safety concerns (as identified in the prep section on the previous page) and restate the expectations of student behavior that should be used throughout the activity. Allow students to find a partner and then they will be able to start the activity.

For the first part the students will read an article about matches and how different types of matches work to create fires. After each group has finished the reading, the students will have to answer questions before being able to proceed to the experimentation process. You can check for the completion of these questions before handing out 1 of each match type to each group. Be sure that they take time to think of, and record the different characteristics that they are going to look at before using their match. After they have gathered the data from their test of the match types the groups will then record their results and write a brief response of what match type was better and why.

Following completion of the matches, the students will then read about friction fires and answer questions after completing the reading. Again, the completion of the reading questions can be used as a checkpoint before handing out the wooden dowel and base wood to attempt
and create a friction ember. Students should not get held up on this activity for too long as it is likely that they will not be able to make a very strong ember. Limit students to only 5 minutes or so of trying this activity before having each group move on to the writing section for this fire starting method.

For the final method and experiment, the students are going to read about the use of sunlight to start fires and answer questions about the reading. The answers to these questions can once again be the pass for them to receive materials for the experimentation part. If the conditions outdoors are right for this activity it is likely that they will be able to focus the sunlight to ignite, or at least smolder, the paper. Therefore, be sure to have the groups place the paper on the ground so that it can be extinguished by stepping on the paper to smother the flame. If the weather conditions that day are not conducive to actually carrying out the method, a video link has been provided in their packet which shows a person using this method effectively. You could have each group watch the video or show it to the entire class at once. After completing either the demonstration or the video, the students will have to create a pro’s and con’s list of this method compared to the matches.

Wrap-Up and Conclusion

After each group has completed the three sections, they should return all of the materials back up to the instructor. As a final component of the activity, the students will have to write a paper that analyzes each fire starting method and rates them against each other. This paper will be finished at home so with any extra time left in the period, groups that have finished early can start to plan out this paper and what they are going to say and include in it.

Name:_____________________________     Date:_____________

The Inner Flame: How Are People Similar to the Fires they make

Fire, especially during a survival situation can be one of the most valuable resources that a survivor can have. Not only can the presence be a physical or medical benefit in certain scenarios, but it can also have many other affects in the mental and psychological realms. Using the chart below, try to list as many advantages as you can for how fire could benefit you in a survival situation for each of the general categories:
<table>
<thead>
<tr>
<th>Physically (How can a fire help a person in terms of their physical body)</th>
<th>Emotionally (How can a fire improve the mood and mindset of a person in a survival scenario)</th>
<th>Motivational (what are some benefits that the creation of fire can have in a survival scenario)</th>
</tr>
</thead>
</table>

No matter how you look at it, fire can be a major source of energy in multiple ways. When broken down further, the flame itself only needs a few main components to be supported and maintained. The three components that are required for combustion (the start of a fire) are fuel, oxygen, and energy.

If one thinks about it, we as humans are just energy sources as well that also rely on the very elements that a flame is dependent on. We require fuel for our bodies along with oxygen; and these things combined help us to produce energy which we need to function. How we get these resources and use them however is different among people and fires though.
Another comparison that can be made between fire and people is that different types of each exist. Just as there are good and bad individuals in this world, although it may be due to a matter of perspective, fires can also be seen or used as a positive or negative force. Whether created naturally or set off by another human interaction, fires and individuals can both be harmful or uncontrollable in certain scenarios yet predictable and beneficial in others. The same goes true for fires in nature as well in which the flames can have either positive or negative effects.
In the space provided below you and your partners will be filling in the grid with examples for each of the scenarios for fires. Each member of your group is responsible for one of the following scenarios below:

1. Fire/heat being beneficial for humans
2. Fires/heat having negative consequences for people
3. Fires/heat being used for the good of nature
4. Fires/heat being a destructive force

After a few minutes of writing down as many examples as you can think of on your own, you will share your findings with the rest of the group so that they can include the examples that you have provided, as well as include additional examples that they may be able to think of.

<table>
<thead>
<tr>
<th>Beneficial for Humans</th>
<th>Harmful for Humans</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Beneficial for Nature

Harmful for Nature

The Inner Flame: How People Are Similar to the Fires we Make

Teacher Instructions

Pre-Activity Preparation

Before your students enter the classroom, be sure to close down all of the shades and block any ways possible in which light may enter the room. You can have the classroom lights on as the students enter for safety reasons, but when you begin the introduction activity you are going to want it to be as dark as possible.

Introduction

Have the class sit down in their seats and close their eyes. Make sure that all of the students are not looking as it will add to the experience that is about to happen. As the students sit in their seats read the following dialogue to the students as you quietly begin to light a candle towards the front of the room:

*Picture yourself in a deserted place. It could be an empty cave, in the middle of a space dessert during a cold night, or even lost within a forest. Besides potentially some stars or the moon above you, darkness surrounds you and you are exposed to the eerie silence and darkness of your situation.*
With your kids still having their eye’s closed, ask them to raise their hands and share what they are feeling. What else are they picturing in their heads? What else do you feel or sense in whatever situation that they are picturing? As the students are giving their responses quietly make your way to the light switches and turn off the remaining light in the room so that the only source of illumination is coming from the candle. After some of the students have given their responses, continue reading the following dialogue:

*It is likely that many feelings and emotions are being brought out even thinking about the situation that you are imagining. Add to it that this may be a survival situation in which you are envisioning and the emotional senses of fear, sadness, and despair might be linked to the situation. From a physical perspective you may be cold, damp, or feeling bad in other ways. Often is the case among these survival scenarios that morale goes down and a person’s determination and motivation are negatively affected as well.*

Tell the students to open their eyes and they will be revealed to the candle light in front of them. Briefly talk about the presence of fire in a survival scenario now. Bring up that the presence of fire can be beneficial for many reasons in a survival scenario. Hand out the student packets and introduce the first part of the activity in which they will create a list of the benefits from a physical, emotional, and motivational perspective that fire can have to an individual in a survival situation. Turn the lights on and then have the kids work independently on this section for a few minutes. Make sure that the kids don’t flip over their packets to the next page. After about 5 minutes have students give examples of benefits fro each category so that other kids can enhance their lists if they did not have the suggestions other students mentioned.

**Main Activity**

After completing the first part of the activity ask the students the following question “What is needed for a fire?” Give the kids a minute to think about the question and then have students raise their hands to reveal what they came up with. Based on the responses given by the students, group the requirements needed for fire to occur into the groups of fuel, oxygen, and energy (or ignition source). After centering the student’s responses to these components ask them if they would consider the source of energy from fire to be similar or different than the energy we make and use in our bodies. Ask students to explain what they think, eventually trying to mold their responses to an understanding of our bodies needing the very same elements in order to function.

Tell the students to flip over the page and explain the next section of the packet. Students will be making Venn Diagrams to display the similarities and differences that fire and our bodies have when it comes to making or creating energy for survival. Students can work on this section with a partner or alone if they choose. Upon completion of the diagrams, they will then
combine with another group in order to share their findings and include any additional similarities of differences that the other group found.

After meeting with another group, have students return to their seats and begin the instruction for the next section. Read the directions and introduction paragraphs that identify how students will be examining how like people; fires can be good and bad in different contexts. The students will create groups of four (different than the people they have worked with in the prior parts) and each member of the group will be responsible for one part of the chart. After filling in their section with as many examples as possible, the group members will meet back up to share their findings and allow other group members to contribute with additional examples that they can think off. In the end each group member will have filled in all of the sections of their chart.

**Conclusion**

Have all of the students return to their seats and hand in their completed activity packets. Once all of the packets have been collected have the students take out a separate sheet of blank paper and write a brief writing (1 paragraph or so) recalling what they learned from the activity. After writing down their response, they will swap their paper with somebody else in the room and write a brief response of 2-3 sentences regarding what the other person learned.

Name:__________________      Date:________________

**Harmful Rain: Measuring and Evaluating Acid Rain**

Acid rain is a topic of much concern in today’s world. As carbon dioxide gas, chemically named CO₂, dissolves in water droplets of unpolluted air, the following reaction occurs:

\[ \text{CO}_2 + \text{H}_2\text{O} \leftrightarrow \text{H}_2\text{CO}_3 \]

H₂CO₃ is a weak acid that causes the rain from unpolluted air to be slightly acidic. This source of “acid rain” is not usually considered to be a pollutant, since it is natural and usually does not alter the pH of rain water very much. Oxides of sulfur dissolve in water droplets to cause more serious problems. Sulfur dioxide dissolves to produce sulfurous acid, H₂SO₃, by the equation:

\[ \text{SO}_2 + \text{H}_2\text{O} \leftrightarrow \text{H}_2\text{SO}_3 \]

This source of sulfur dioxide can occur naturally, as from volcanic gases. More often, however, sulfur dioxide is considered a pollutant since it is a by-product of fossil-fuel combustion. The acidity of a solution can be expressed using the pH scale, which ranges from 0 to 14. Solutions with a pH above 7 are basic, solutions with pH below 7 are acidic, and a neutral solution has a pH of 7.
In Part I of this experiment, you will study how the pH of water changes when CO₂ is dissolved in water. In Part II, you will study the effect sulfuric acid has on the pH of different water types.

OBJECTIVES
In this experiment, you will
• Use a computer to measure pH.
• Study the effect of dissolved CO₂ on the pH of distilled water.
• Study the effect on pH of dissolving H₂SO₄ in various waters.
• Learn why some bodies of water are more vulnerable to acid rain than others.

MATERIALS
computer
dilute H₂SO₄
Vernier computer interface
ring stand and utility clamp
Vernier pH Sensor
straw
LoggerPro
wash bottle with distilled water
250 mL and 100 mL beaker
water from a lake
buffer solution water from the ocean (optional)

PROCEDURE

Note: After completing each part of the lab, have your teacher come over to check your progress and data. Do not move on to the next section without getting the approval of the teacher first.

Part I: CO₂ and Water

As carbon dioxide gas, CO₂, dissolves into water droplets suspended in the atmosphere, it changes the rainwater’s pH. Here you will test to see if CO₂ will affect the pH of distilled water. The source of CO₂ will be your breath.

1. Obtain and wear goggles.
2. Connect the pH Sensor to the computer interface. Prepare the computer for data collection by opening the file “18a Acid Rain” from the Biology with Vernier folder of LoggerPro.
3. Use a rinse bottle to thoroughly rinse the pH electrode. Should you need assistance with this part of the activity be sure to seek your teacher for help. Catch the rinse water in a beaker.
4. Wash a 100 mL beaker with tap water and dry it with a paper towel. Note: All glassware must be clean in this experiment! Put 50 mL of distilled water into this clean beaker. Lower the pH electrode into the distilled water and swirl the water around the electrode briefly.
5. Begin data collection by clicking. After the computer registers the initial pH, use a straw to blow your breath into the distilled water for 1 minute. Your breath contains CO₂. The computer will save readings as you blow.
6. Click the Statistics button to determine the maximum and minimum pH values. Record the maximum and minimum pH in Table 1.

Part II Simulating Acid Rain Using H₂SO₄

7. Rinse the pH electrode thoroughly with distilled water.
8. Wash and dry the 100 mL beaker. Get a new 50 mL portion of distilled water. Place the pH electrode into the distilled water and secure in place with a ring stand and utility clamp.
9. Prepare the computer for data collection by opening the file “18b Acid Rain” from the Biology with Vernier folder of LoggerPro.
10. You are ready to begin the measurements. Start measuring the pH by clicking. Note that a new button is available.
11. Click to take a pH measurement. A text box will appear. You should enter the number of drops of acid you add to the water in the beaker. Since you didn’t add any acid yet, type 0 in the text box and press ENTER.
12. Add 1 drop of H₂SO₄ (sulfuric acid) to the water. Stir thoroughly, until the pH is stable. **CAUTION:** Handle the sulfuric acid with care. It can cause painful burns if it comes into contact with skin.
13. Enter the number of drops of acid added to the beaker. Type 1 in the text box and press ENTER.
14. Repeat Steps 12–13, adding 1 drop at a time, until you have added 10 drops of acid.
15. Click when all measurements have been made.
16. From the table, record the pH values in Table 2.
17. Store your data by choosing Store Latest Run from the Experiment menu.

H₂SO₄ and Water from the Ocean

18. Complete these steps:
   a. Clean the pH electrode.
   b. Wash and dry the 100 mL beaker.
   c. Get a 50 mL portion of “Ocean Water” in the 100 mL beaker, lower the pH electrode into this water, and then briefly swirl the water about the electrode.
   d. Repeat Steps 10–17 for this sample.

H₂SO₄ and Lake Water
19. Repeat Step 18, using “Lake Water” from your teacher.

H₂SO₄ and Buffer Solution
20. Repeat Step 18, using “Buffer Solution” from your teacher.
21. Use the Text Annotation feature from the Insert menu to label each of the plots on the graph with the water type used. Adjust the position of the arrow.
22. Print a graph with the four types of water tested. Enter your name(s) and number of copies of the graph. Use your graph to answer the discussion questions at the end of this experiment.

PROCESSING THE DATA

Part I

Table 1
Adding CO\textsubscript{2} from your breath to water

<table>
<thead>
<tr>
<th>Maximum pH</th>
<th>Minimum pH</th>
<th>ΔpH</th>
</tr>
</thead>
</table>

Part II

Table 2
pH of Different Water Types and Drops of Acid

<table>
<thead>
<tr>
<th>Distilled</th>
<th>Ocean</th>
<th>Lake</th>
<th>Buffer</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>ΔpH</th>
</tr>
</thead>
</table>

POST LAB QUESTIONS

1. Calculate the change in pH ( ΔpH ) for the water in Part I. Subtract the final pH from the initial pH. What conclusion can you make about your breath?

2. Why does the pH change rapidly at first, and remain stable after a time?

3. Calculate the change in pH ( ΔpH ) for each of the Part II trials. Subtract the final pH from the initial pH.
4. Compare the ∆pH values. Which test gave the largest pH change? Which test gave the smallest pH change?

5. Water from the ocean is said to be “naturally buffered.” From the result of this experiment, what does this mean?

6. How does water from the ocean become buffered?

7. Many aquatic life forms can only survive in water with a narrow range of pH values. In which body of water—lakes or oceans—would living things be more threatened by acid rain? Explain.

8. There are numerous coal-burning electric power plants along the Ohio River in Southern Indiana. The river and lake waters are naturally buffered. However, air pollution produced there is more harmful to water life in Upstate New York, where the river and lake waters are NOT buffered than in Southern Indiana. A similar situation exists in Europe where air pollutants from highly industrialized Germany are more harmful to Scandinavian water life than to water life in Germany. Use the results of this experiment to explain these situations.

9. Summarize your conclusions about this laboratory experiment. Use your data to answer the purposes of this experiment.

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**Harmful Rain: Measuring and Evaluating Acid Rain**

**Teacher Instructions**

**Pre-Activity Preparation**

Before doing this experiment with the kids you are going to want to make sure that they have experience using Vernier probes that are compatible with either the computer or graphing calculators. As these resources are typically expensive and somewhat fragile, it is in the best interest of the kids and teacher alike to train them in their use ahead of time. Modeling the expectations and steps of this lab along the way may be beneficial so that the students get a visual of the processes before using the techniques on their own.

The following items are going to be needed for each group in order to complete the activity:

- computer
- dilute H₂SO₄
- Vernier computer interface
- ring stand and utility clamp
- Vernier pH Sensor
straw
LoggerPro
wash bottle with distilled water
250 mL and 100 mL beaker
water from a lake
buffer solution water from the ocean (optional)

These materials may either be gathered by the students from within the room, or you could make kits that each group would grab with all the necessary materials ahead of time. From a safety perspective, be sure that students are aware of the dangers of chemical burns from H₂SO₄. Precautions and safety steps should be taken with this harmful chemical to prevent injury to self or others while using any harmful chemical.

**Introduction Activity**

At the start of the class, ask all of your students to write down what they know about acid rain and then have the students share their thoughts aloud. It is likely that they will probably know very little about this natural occurrence. They may be able to infer that it could be harmful due to the name. In order for the students to get a slightly better understanding of the formation and impact of acid rain, play the video from this link below. It depicts how acid rain is formed and the causes of it in general terms.

[http://www.youtube.com/watch?v=9aEx067YkDE](http://www.youtube.com/watch?v=9aEx067YkDE)

At the 46 second mark stop the video and discuss the basic principles that were shown. Ask students how acid rain is formed. They should be able to answer based off the animation and information in the video. After answering the question, then ask the class what they think the affects would be of acid rain to plants. Have each student talk to the person sitting next to them about what they think the effect of acid rain would be on plant life and why? Allow the students a minute to talk about the question then play the video up to the 1:52 mark. At this point you can ask the kids the following questions about the video:

- What character of the soil in particular do you think changes? (Here you can introduce the concept of pH)
- Do you think this process of acid rain destroying trees goes fairly fast or pretty slow? Why?
- Why would “Global Warming” be a concern associated with acid rain? Explain?

After going over these questions with the students, then ask them what they think would be the effect of acid rain on organisms that live in water? Again have them briefly talk about the question with the person sitting next to them. After a minute of discussion, play the rest of the video. After the video you can then ask the class the following questions:

- What fish are more at danger due to acid rain: those living in small bodies of water or those living in large bodies of water? Why?
- What causes and effects of acid rain could there be on the plant life within bodies of water?
- How could acid rain affect other wildlife such as birds, mammals, reptiles, etc?

After going through the questions you can then introduce the lab activity for the day in which the students will be able to measure the differences in pH that acid rain has.

**Main Activity**

Hand out the student activity packets and go over the introductory reading on the first page. Once you reach the objectives part of the directions, have student break up into groups (dependent on number of probes and computers available). All of the students should read through the rest of the instructions so that they get a general sense of what they are going to be accomplishing through the lab activity. Once each group has read through the instructions have them gather the materials needed and move to an open work space within the room to complete the lab. The steps of the activity are all located in the packets, however the teacher may model certain parts of the activity if necessary if unclear to the students. While the groups are working the teacher should circle the room ensuring that they are doing all of the steps correctly and answering any questions that may arise with the use of the probe. Students should be recording all of their data in the tables provided within the packets. After completing each part of the lab, each group should be raising their hand to have you check the data and numbers that they gathered. If any of their data is off, assist the group in fixing the problem so that the data they gather will lead to accurate conclusions at the end of the activity.

**Conclusion**

After completing all of the measurements and parts of the lab, groups should clean up their work area. All of the glassware that they used should be thoroughly rinsed and placed in a location identified by the teacher if additional cleaning is necessary. Make sure students collect all samples that contained H<sub>2</sub>SO<sub>4</sub> into a disposal container. The materials should not be dumped down the drain due to the acidic their acidic nature. The teacher can neutralize this material later and safely dispose of it. After all of their materials have been cleaned and put into the appropriate places, the groups can then answer the post-lab questions. Once the groups have completed the questions, or complete them for homework if they run out of time, they can hand in the packets to be graded. Before the students leave the class for the day, have two different groups of partners get together and discuss the results that they obtained from their experiment. These groups should also discuss the answers that they put for the questions that were given at the end of the activity.
Hot, Hot, HOT!!: Heat Waves and How they Affect Others

While the summer months can be an enjoyable environment and refreshing compared to other seasons, sometimes the sunlight and heat during this time period can become overwhelming. Occasionally, and varying over different parts of the country, heat waves can be a serious concern to not only the environment, but also human beings. The continued duration of above average temperatures can have multiple effects on people depending on various factors and can lead to several medical issues potentially. In the following article you will be reading about heat waves, what they are, and how they affect people. While reading the article highlight important information, statistics, and facts to refer back to when answering the questions that follow:

1. How many heat-related deaths were there in the United States in the 20 years leading up to 1999?
2. What is the most common response to long-term heat exposure? What are the symptoms?

3. What other types of medical illnesses and concerns can develop due to over-exposure to the sun?

4. How does the human body react to help regulate temperature during warm weather? Be specific.

5. What age groups of people should be the most careful to heat exposure? What factors about that age group are the reasons for the concern?

6. What types of things that people consume may affect their ability to adjust to higher temperatures? Include a couple of examples and why they are dangerous during heat waves.

7. What factors regarding health and well-being are important factors as to whether a person will be able to handle and adjust to higher temperatures?

8. What types of factors regarding where a person lives can affect a person’s ability to cope and handle the change in temperature?

9. What are a couple of the active definitions used by some people and groups to define heat waves? How are they similar and different?

10. Based on the heat-wave modeling and tracking discussed in the article, what types of effects might we see happen in the future for areas that are used to heat waves?

11. Based on the heat-wave modeling and tracking discussed in the article, what types of effects might we see happen in the future for areas that are not accustomed to the increased heat from heat waves?

12. From a weather and meteorological perspective, what are some of the characteristics that are common during a heat wave other than increased temperature?

13. What are some of the trends that we are seeing now that will likely lead to higher heat related mortality, or deaths, in the future?

14. What changes and modifications can be made now to the general population in order to reduce the risks and concerns associated with heat waves and their effects?
Applying the What You Have Learned

With a better understanding of what heat waves are and how they affect people in particular, let us now consider how this phenomenon could apply to other organisms. Below is a list of organisms that just as easily could be affected by heat waves. For each of the organisms listed, write down at least 3 examples of effects that heat waves could have on each. Think about the effects that we as humans experience and how these experiences may be similar, different, or enhanced because of characteristics in that organisms environment or being. An example of a response for each type is provided.

TREES/PLANT LIFE
*Due to increase temperature and evaporation of groundwater, plants might start to wilt due to lack of water.*

FISH
*Fish living in small ponds and streams may have to relocate because of their homes being dried up.*

LARGE MAMMALS
*Availability of some food sources may change as plants and other small animals may dwindle in numbers.*
The Heat is On: Climate Change & Heatwaves in the Midwest

A. Introduction

Heatwaves affect human health through heat stress and exacerbate underlying conditions that can lead to an increase in mortality. Over the period 1979–1999, 8,015 deaths in the United States were recorded as being heat-related, 3,829 of which were attributed to weather conditions (Donoghue et al., 2003). Populations in the Midwest are particularly at increased risk for illness and death during heatwaves, as evidenced during events occurring in the 1980s and 1990s. A heatwave in July 1980 caused a 57 percent increase in mortality in St. Louis and a 64 percent increase in Kansas City (Jones et al., 1982). The 1995 Chicago heatwave is perhaps the most widely known; it caused an estimated 696 excess deaths (Whitman et al., 1997; Semenza et al., 1999). A heatwave of similar magnitude in 1999 resulted in 119 deaths in Chicago (Palecki et al., 2001).

B. Heat-Related Illnesses

Illnesses caused by exposure to high temperatures include heat cramps, fainting, heat exhaustion, heatstroke, and death (Kilbourne, 1997). Heat exhaustion is the most common response to prolonged exposure to high outdoor temperatures; it is characterized by intense thirst, heavy sweating, dizziness, fatigue, fainting, nausea or vomiting, and headache. If unrecognized and untreated, heat exhaustion can progress to heatstroke, a severe illness with a rapid onset that can result in delirium, convulsions, coma, and death (Lugo-Amador et al., 2004). Heatstroke has a high fatality rate. Non-fatal heatstroke can lead to long-term illness. For example, about one-third of the patients admitted with heatstroke during the 1995 Chicago heatwave exhibited severe impairment and those who survived showed no improvement after one year (Dematte et al., 1998). In addition to heatstroke, many causes of death increase during heatwaves, particularly cardiovascular and respiratory disease (Kilbourne, 1997).
Except for heat cramps, heat-related illnesses are the result of varying degrees of the body's failure to regulate its internal temperature. To keep its internal temperature within healthy limits, the body's responses to hot weather include an increase in blood circulation (to move heat to the body surface) and an increase in perspiration. Heat loss is reduced when air temperature and/or humidity increase. To compensate, the body further increases circulation, but may be limited by its ability to increase heart rate and blood volume (because of loss of body fluids). For less fit subjects, heat illness can occur at low levels of activity, or even in the absence of exercise (Havenith et al., 1995).

C. Populations at Increased Risk

*Although the risk of heat illness exists for the entire population, some factors increase the risk:*

- **Older and younger age.** Older adults are more vulnerable to heatwaves because a natural part of the aging process is a decrease in the body’s ability to control its internal temperature. Also, age correlates strongly with reduced fitness and increased illness, disability, and medication use. Most studies have found that heat-related mortality is highest in those over 65 years of age (Kovats and Koppe, 2005).

  Babies and infants also are at increased risk during a heatwave because they are at higher risk of dehydration, due to the relatively higher volume of fluid in their bodies compared with an adult (King et al., 1981). During 1979-2002 in the United States, 6 percent of the 4,780 deaths classified as heat-related occurred in children (LoVecchio et al., 2005).

- **Use of certain drugs.** Certain drugs interfere with the body’s ability to cope with high temperatures (such as stimulants, beta-blockers, anticholinergics, digitalis, and barbiturates) (Koppe et al., 2004). For many individuals, a side effect of these drugs is that they may not be aware that high outdoor temperatures are making them ill and therefore may not take appropriate actions.

- **Dehydration.** Sufficient nonalcoholic fluid intake during a heatwave is a critical factor in reducing illness and death, particularly in those who are more vulnerable (Kilbourne, 1997).
Chronic dehydration, which is common among older adults, can increase susceptibility to heatwaves. The presence of multiple diseases and/or drug treatments also increases the risk of dehydration (Hodgkinson et al., 2003).

- **Low fitness.** A low level of fitness, due to reduced physical activity, increases vulnerability due to a reduction in the ability of the body to adjust to high outdoor temperatures (Hayes, 2001). Reduction in fitness can result in a vicious circle, as the increased strain experienced with activity may itself result in further activity reduction, which may further decrease fitness.

- **Excessive exertion.** Excessive exertion during a heatwave is dangerous for everyone, regardless of age or fitness. Outdoor workers and those who maintain a vigorous exercise regimen during a heatwave are particularly at risk.

- **Overweight.** Being overweight increases the risk of heat-related illness and death. Fatty tissues are poorer conductors of heat than are other tissues in the body, thus providing an insulative barrier to heat flow (Koppe et al., 2004). Because a higher heart rate is needed to dissipate heat for an obese person, reduced fitness increases their risk further.

- **Reduced adjustment to high outdoor temperatures.** Although people physically adjust to the weather in the region in which they live, living in areas with relatively high daily temperature variability increases risk partly because adjustment is more difficult (Chesnut et al., 1998). Short-term adjustment to a change in outdoor temperature usually takes 3–12 days, but complete adjustment may take several years (Babayan, 1966; Frisano, 1991). Short-term adjustment gradually disappears over a period of several weeks after a heatwave ends. Avoiding heat exposure leads to a reduction in the body's adjustment to higher temperatures, placing individuals at increased risk during a heatwave. This factor may add risk for people living in the Midwest where summer temperatures are highly variable and extreme heat occurs rarely.

- **Urban populations.** A number of studies suggest that urban populations suffer more illness and death during heatwaves (e.g., Smoyer et al., 2000; Sheridan, 2003). Urban populations may be more vulnerable because of higher underlying rates of cardio-respiratory disease. Also, a heatwave causes higher daytime and nighttime temperatures in cities than in rural areas because buildings and asphalt absorb more heat than do trees and plants. While rural areas
cool after the sun goes down, this additional urban heat keeps temperatures high around the clock. Exposure to heat stress is higher in housing that is not designed to effectively insulate occupants from high outdoor temperatures.

- **Lower socio-economic status.** Studies have indicated that lower socio-economic status is a risk factor for heat-related mortality (Kovats and Koppe, 2005). For example, heatwave deaths in St. Louis in 1966 were the highest in inner city areas where population density was higher, open spaces were fewer, and where socio-economic status was lower than in surrounding areas (Henschel et al., 1969; Schuman, 1972). However, it is not clear whether the increased risk is due to differences in housing, neighborhood, access to air conditioning, or the underlying prevalence of chronic disease.

- **Living alone.** Studies designed to investigate why some people died during the 1995 and 1999 heatwaves in Chicago found that the strongest risk factor was living alone, particularly for those who did not leave home daily (Semenza et al., 1996; Naughton et al., 2002). O’Neill et al. (2003) found a nearly ten-fold increase in heat-related deaths for deaths occurring outside of a hospital compared with those in hospital, suggesting that people living alone without someone to check on them regularly are at particular risk. Similar risks were found in the 2003 heatwave in Paris and other regions of Europe, with many deaths of elderly adults occurring outside of a hospital (Kosatsky, 2005).

D. Projected Changes in the Frequency and Intensity of Heatwaves

*There are a number of ways to define an extreme heatwave, most related to some kind of impact.* We analyzed results from a global coupled climate model using two definitions of a heatwave.

The first definition comes from analysis of the Chicago heatwave of 1995. Mortality increased dramatically after three consecutive nights of very hot temperatures; in total, nearly 700 more people died than expected (Karl and Knight, 1997). Therefore, one definition of a heatwave is the warmest average minimum temperatures over three consecutive nights in a given year. This definition was used to quantify heatwave intensity for comparing observations and model results to determine how well the model simulates present-day events.

4. **Heatwaves & global climate change**
The National Center for Atmospheric Research/Department of Energy Parallel Climate Model (PCM) was used for the analysis. It is a global coupled climate model incorporating atmosphere, ocean, land surface, and sea ice components. Simulations of 20th century climate start in 1870, then run forward with time-evolving factors that affect the climate system, including natural (solar and volcanoes) and anthropogenic (greenhouse gases, sulfate aerosols, and tropospheric and stratospheric ozone) climate drivers (Meheu et al., 2004). The model was run four times from slightly different initial conditions, providing simulations for present-day heatwaves. Observations of past climate were analyzed in a similar fashion and compared to the model results (Figure 1a,b). The model did a good job of simulating the amplitude and the geographic pattern of observed heatwave intensity over North America. Both the model results and the observations show that heatwaves are most severe over the Eastern Seaboard, the southern and upper Midwest, and the southwestern United States. This model simulation of heatwave intensity is similar to a number of other models, as depicted by Tebaldi et al. (2006).

To project changes in future heatwaves, we used a “business as usual” future climate change scenario that assumed little policy intervention to mitigate greenhouse gas emissions in the 21st century (Dai et al., 2001). The model was run five times with slightly different initial conditions. We defined the “present-day” reference period as 1961–1990, and “future” as the time period from 2080–2099, and computed differences between these two periods. Future changes in heatwave intensity show a distinct geographical pattern (Figure 1c). Although differences were projected to be positive in all areas—indicative of the general increase in nighttime minimum temperatures—heatwave severity shows a greater increase in the western, upper midwestern, northeastern, and southern United States. Throughout much of the Midwest, the model projects future increases in nighttime temperatures of more than 2 °C (3.6 °F) during the worst heatwaves (Figure 1c).

Many of the areas most susceptible to heatwaves today (greatest heatwave severity in Figures 1a and 1b) are projected to experience the greatest increase in heatwave intensity in the future. But the model projects that other areas not currently as susceptible, such as northwestern North America, also could experience increased heatwave severity in the 21st century. These patterns of projected future heatwaves suggest different types of impacts. Regions already adapted to heat extremes (e.g., the southern, eastern, and southwestern parts of the United States) could experience negative effects...
related to increased power generation to run the
greater use of air conditioning. In areas such as the
northwestern United States, where heatwaves are
not severe at present and where use of air
conditioning is less common, future increases in
heatwave intensity could result in more heat-related
illnesses and deaths. As more people install air
conditioning, the health impacts could lessen, but
the region may then face an increased strain on
power generation. The pattern of projected future
changes is therefore important for assessment of
vulnerability and adaptation.

Heatwaves also can be defined to occur
when weather conditions exceed a particular
threshold; this definition identifies changes in
heatwave frequency and duration. We examined
model outputs for grid cells near three Midwestern
cities (Chicago, Cincinnati, and St. Louis), to
illustrate future projections of heatwave
characteristics using three criteria to define
heatwaves: (1) maximum temperature exceeding the
97.5th percentile (i.e., an event happening one out
of 25 times) for at least three days, (2) average
minimum temperature above the 97.5th percentile
for at least three days, and (3) maximum
temperature above the 81st percentile for the entire
period (Huth et al., 2000).

Figure 1

Heatwave Severity

(a)

(b)

(c)

Using the definitions of heatwave severity as the average
annual 3-day warmest nighttime minimum temperatures (°C)
from Karl and Knight (1997), a) observations for the
"present-day" (1961-1990) from NCEP/NCAR reanalysis data
for the United States, b) model simulation for the same
period; c) model simulation for the "future" (2080-2099)
minus model simulation for the "present-day" (1961-1990)
for North America. Results in (c) indicate how much hotter on
average heatwaves are projected to become by the end of the
All model scenarios projected future increases in the average frequency and duration of heatwaves (Figure 2). For all three cities, the observed frequency fell within the range of the present-day (1961–1990) frequency simulated by the model, indicating that the model mimics the observed climate effectively. In contrast, all of the observed values for heatwave frequency fell outside of and below the frequency range simulated by the model for the future (2080–2099), thus projecting future increases in heatwave frequency for all three cities. The model results were similar for average heatwave duration, with the exception that the observed value for Cincinnati fell slightly below the range of the model-simulated present-day values. This one inconsistency suggests the model may overestimate the absolute duration of heatwaves near Cincinnati, but it does not challenge the relative increase in duration projected for the future.

The model projected an increase in the average heatwave frequency of about 24 percent for Chicago—from 1.7 to 2.1 heatwaves per year; 50 percent for Cincinnati—from 1.4 to 2.1 heatwaves per year; and 36 percent for St. Louis—from 1.4 to 1.9 heatwaves per year. The average duration of heatwaves was projected to increase by 21 percent for Chicago—from 7.3 to 8.8 days; by 22 percent for Cincinnati—from 8.8 to 10.7 days; and by 38 percent for St. Louis—from 10.3 to 14.2 days.

These analyses show that the model simulated the present-day number and duration of heatwaves within or near the range of the observations, and that the range of projections lies well beyond the present-day observations (i.e. more and longer-lived heatwaves). On average, the frequency of heatwaves for all three cities increased by 36 percent and the duration of individual heatwaves increased by 27 percent. Combining these two effects implies an overall increase of about 70 percent in the annual number of heatwave days for the Midwestern region by the late 21st century. Moreover, as shown in Figure 1, these extreme days will be hotter on average than at present.

Heatwaves generally are associated with semi-stationary “domes of high pressure” that produce clear skies, light winds, warm air, and prolonged hot conditions at the surface (Kunkel et al., 1996; Palecki et al., 2001). These conditions were present during the 1995 Chicago and 2003 Paris heatwaves (Meehl and Tebaldi, 2004), with significant domes of high pressure over Lake Michigan and over northern France for the duration of the heatwaves. The model projections simulated comparable patterns during heatwaves. One reason for the intensification of future heatwaves is that the high pressure associated with a given heatwave is projected to be amplified due to anthropogenic emissions.
Figure 2

Present and Future **Frequency and Duration** of Heatwaves

Based on the threshold definition of heatwaves from Huth et al. (2000), this figure shows the observed and model-simulated average number of heatwaves per year and the average duration of heatwaves for the "present-day" (1961–1990) and the "future" (2080–2099) climate near Chicago, Cincinnati, and St. Louis. In each panel, the green diamond marked "NCEP" indicates the observed value for the "present-day" base period of 1961–1990, computed from NCEP/NCAR reanalysis data. The green segment shows the range of values obtained from the four model runs for the "present-day" (1961–1990) simulation and the blue segment shows the range of values obtained from the five model runs for the "future" (2080–2099) simulation. The values for individual model runs are marked by individual symbols along the green and blue segments. Dashed vertical lines mark the endpoints of the simulated ranges for the "present-day" (green) and "future" (blue) and facilitate comparisons of the simulated ranges and observed values. (Results for Chicago are from Meehl and Tebaldi, 2004; results for Cincinnati and St. Louis are unique to this study).
of greenhouse gases (Meehl and Tebaldi, 2004). The average future climate shows higher pressure over the upper Midwest, which is directly associated with more intense heatwaves.

This pattern of increased high-pressure events results in an increase in summer nighttime minimum and daytime maximum temperatures (Meehl and Tebaldi, 2004), consistent with increased variability of temperature extremes in addition to a shift in the average (Schar et al., 2004). Thus, such events as the 2003 Paris heatwave could become common in the future climate (Stott et al., 2004). A study by Tebaldi et al. (2006) shows that such results are typical, with all models indicating an increase in heatwave intensity in a future warmer climate.

E. Projected Health Impacts of Future Heatwaves

*Projections of an increase in the frequency and intensity of heatwaves are insufficient to estimate future illness and death.* Projections of the health impacts of future heatwaves need to incorporate a variety of factors, including the degree to which the population is acclimatized to higher temperatures, the characteristics of the vulnerable population, and the extent to which effective adaptation strategies and measures have been implemented. These factors need to be estimated for the geographic region and time scale of interest, acknowledging that estimates of these factors become more uncertain for longer time frames.

A few studies have projected that health impacts of heatwaves could increase under various climate change scenarios (Kalkstein and Greene, 1997; Keatinge et al., 2002; Dessai, 2003; McMichael et al., 2003; Hayhoe et al., 2004). When the model includes assumptions about adjustment to higher outdoor temperatures and adaptation measures, estimates of heat-related deaths attributable to climate change are reduced but not eliminated. Because of incomplete understanding of how future populations might respond to heatwaves, these studies could either over- or under-estimate possible health impacts. Also, studies have not included changes in the frequency or intensity of severe heatwaves, such as occurred in 2003 in Europe and as projected to occur in this study (Figures 1 and 2).

Hayhoe et al. (2004) projected the implications of low and high greenhouse gas emission scenarios (Nakicenovic et al., 2000) for extreme heat and heat-related mortality in California. Taking some acclimatization into account (but no change in the prevalence of air conditioning), assuming a
linear increase in heat-related mortality with increasing temperature, and assuming no change in the population, expected heat-related deaths in Los Angeles were projected to increase (from a baseline of about 165 excess deaths annually) two- to three-fold under a low emission scenario and five- to seven-fold under a high emission scenario by 2070-2099.

Trends that are likely to increase vulnerability to heat-related morbidity (prevalence of disease) and mortality in the next few decades include an increased number of elderly people (Hobbs and Damon, 1996), increased urbanization, and increased frequency and intensity of heatwaves.

Overall, in the Midwest, the health burden of heatwaves is likely to be relatively small for moderate heatwaves, because most deaths will occur in persons who are already ill and because implementation of effective heatwave early warning systems has increased. Moreover, the prevalence of air conditioning in cities in the Midwest is high and can reasonably be expected to increase further, which should further reduce population vulnerability. Extreme heatwaves present greater risk and are likely to become more frequent if manmade greenhouse gas emissions continue to rise unabated. Greater adaptation measures will be needed to manage these risks.

F. Adaptation Options

**Short-term adaptation options include development of effective heatwave early warning and response plans, increasing appropriate use of air conditioning, and better education.** Heatwave early warning systems can be an effective approach to reducing the illnesses and deaths associated with heatwaves (Palecki et al., 2001; Weisskopf et al., 2002; Ebi et al., 2004). Because heatstroke has a fast onset and a poor survival rate, prevention efforts must begin when oppressive weather is forecast, rather than when it arrives. The principal components of an early warning system include identification and forecasting of the event (including consistent, standardized weather criteria guiding the activation and deactivation of warnings), prediction of possible health outcomes that could occur, effective and timely response plans that target high-risk populations, and ongoing evaluation and revision of the system and its components (Ebi and Schmier, 2005; Bernard and McGeehin, 2004). Longer-term adaptation options focus on infrastructure changes, such as establishing building codes designed to reduce urban heat islands.
Considerably more education is needed of the public and of the responsible agencies about the dangers associated with heatwaves and about the appropriate responses. For example, in the review of heatwave response plans in the United States, five of the plans reported fan distribution programs, despite evidence that fans may increase heat stress if used improperly (Bernard and McGeehin, 2004). In addition to general messages detailing ways to lower body temperature to prevent the onset of heat stress (including drinking more fluids, going to an air-conditioned place, wearing light-colored and loose-fitting clothing, and limiting outdoor activity; CDC, 2007), messages should be targeted to vulnerable groups—such as those with low incomes, the elderly, the disabled, children, and ethnic minorities (Ebi and Schmier, 2005). A review of 18 U.S. heatwave response plans found that although people with mental or chronic illnesses and the homeless constitute a significant proportion of the victims in recent heatwaves, only one plan emphasized outreach to disabled persons, and only two addressed the shelter and water needs of the homeless (Bernard and McGeehin, 2004).

Air conditioning is frequently promoted as a key adaptation option to reduce heat-related illness and death. There is evidence that increased air conditioning coverage in the United States has reduced vulnerability (Davis et al., 2003). More than 80 percent of homes in the United States have air conditioning (U.S. Census Bureau, 2002). On the other hand, centralized cooling centers have not proved effective in reaching the most at-risk seniors (Naughton et al., 2002; Palecki et al., 2001). Hence, increased prevalence of air conditioning alone does not necessarily address the needs of those at greatest risk.

A key constraint to reducing the health impacts of heatwaves is that a normal part of the aging process is a reduction in the ability to thermoregulate. Many of the elderly at increased risk during a heatwave have underlying diseases that cause them to feel ill on most days. During a heatwave, feeling hot in addition to feeling ill is insufficient motivation for many of the elderly to take actions to reduce body temperature, such as visiting a cooling center, opening windows, drinking additional water, changing into more appropriate clothing, or turning on an air conditioner.

Better understanding of how to motivate appropriate behavior during a heatwave will reduce current and future vulnerability, no matter what the future climate brings.
Hot, Hot, HOT!!: Heat Waves and How they Affect Others

Teacher Instructions

Introduction

At the beginning of the class ask all the students to recall a time when they were in the heat or sun for a very long time. You may suggest a possible vacation that they went on, or even using a sauna. Have them write down on a separate sheet of paper a recollection of the event and how it made them feel. The writing doesn’t have to be long (about a paragraph or so) but is aimed to have them remember the affects that the heat had on them. After giving the kids a few minutes to recall and write down their thoughts, ask for volunteers to share their experience with the class. As the students are recalling their experiences, the teacher should record some of the key words dealing with the effects that they experienced towards the front of the room for the rest of the class to see.

After having a few students share their experiences, ask the class what they think would have happened if the temperatures in these particular events they experiences continued to stay at that level. Additional questions that the teacher can ask to get the classes’ thoughts centered around the effects of severe heat could include:

- What would some of the long term effects of heat/sun exposure be? Compare those to the short term effects we discussed earlier.
- Which age groups do you think are most affected by extreme heat over a long period of time?
- How big of an issue do you think heat waves are in the United States? Compared to other things such as general illness? Crime? Etc.?

The purpose of these questions is to get the students’ minds focused on the issue of heat waves. After discussing these questions with the class, hand out the reading and activity sheet. Explain that the purpose of today’s activity is to investigate what heat waves are and how they affect others.

Main Activity

After handing out the activity sheets and reading, have the students go over the directions and questions that they are going to be answering. Once each student has read through the directions and questions they may begin reading silently by themselves. As an added modification to this activity, if done early during the school year or towards the end on a hot day you could take the students outside in order to create a personal connection with the warm weather that they are reading about. After completing the reading and the comprehension
questions for it, there is a section at the end that will have the students apply the effects that heat waves have on humans towards other organisms. Students are responsible to include at least 3 additional examples of how each organism group might be affected by increased temperatures over time. An example of what is expected is included for each group.

**Conclusion**

Upon completing all of the questions and the final responses, the students may turn in the finished assignment. Once all of the students have turned in their packets have the students regroup their attention back to the teacher at the front of the room. Ask the class how they think heat waves might affect other types of organisms. The teacher can initiate the conversation by suggesting a specific type of animal (fish, birds, etc.) and then have the students consider the effects that prolonged heat could potentially have on those and other organisms. The teacher can also have the students compare and contrast those effects against those that they revealed from humans through the main activity.
All Dried Up: Examining the Effects of Droughts

Water is the most essential nutrient and material on the planet. Water is the often considered the fluid of life because it is essential to all living things. Despite water covering almost three-fourths of our planet, the availability of the resource in fresh and useable quantities is sometimes hard to come by. One example of this scenario would be when an area is experiencing a drought. These droughts can have extremely devastating effects on all the living things in the area.

What is a drought?

In order to gather a better understanding of what a drought is, you are first going to conduct a scavenger hunt on the website http://drought.unl.edu/DroughtBasics.aspx. This website is hosted by the National Drought Mitigation Center and is a premiere authority on everything about this natural occurrence. The site itself contains lots of information about droughts including how they have affected our past and present, historical droughts from the past, and lots of other valuable information. Using this site only, search around and record your answers to the following questions below:

1. Provide the site's general definition of what a drought is.

2. What is the definition between a conceptual and operational definition of a drought?

3. What are the four types of droughts? Provide a definition and example of each type.

4. What is some of the work that this organization is currently doing?

5. Pick one of the recent news stories that this site is covering. Provide a one paragraph summery of the news and how it relates to droughts.

6. How do scientists try to predict where droughts will occur? Name and explain at least two examples.

7. Read about the drought that occurred during the Dust Bowl years. Answer all the related questions below:

   a. How long did the Dust Bowl drought last for (give a year range)? How many droughts was this actually made up of?

   b. What were some of the economic and social effects that the drought had on people during this time?
c. What were some methods that were implemented in order to cope and recover from the damage caused by the droughts?

8. Looking at the drought indemnity maps, how much in losses did where we live report in 2009?

Examining the Effects

With a better understanding of what a drought is and the potential for disaster that it possesses, let us now examine how these droughts affect us. Like most harmful things in life, the damage can usually be categorized into different groups or levels. In the case of droughts, the damage could be categorized into economical, environmental, and social. In the space below, provide a very general definition for what each of the three types of impacts would cover:

Economical:

Environmental:

Social:

With a general idea of what each type of impact is then, let us now examine more specific examples of what droughts can do. In the chart below, fill in as many examples (at least 3 of your own for each impact group) of each style of impact that you might see occur from a drought. I have provided an example in each to get you started.
<table>
<thead>
<tr>
<th>Economic Impacts</th>
<th>Environmental Impacts</th>
<th>Social Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Loss of money to farmers due to destroyed crops.</td>
<td>- Loss of aquatic habitats for fish and other aquatic organisms.</td>
<td>- Loss of human life due to lack of water.</td>
</tr>
</tbody>
</table>

**Depicting the Drought Issues**
As you probably saw when reading the section about the Dust Bowl on the website, visuals often are a great way to express the turmoil and overall negative conditions that exist within certain scenarios. The use of visuals allows a person to see the hardship and change that occurs in these situations from all of the perspectives including economic, environmental, and social. In order to connect these impacts that we have investigated with the visual benefits of pictures, you are now going to create some sort of art to help express and show the effects that droughts can have on living organisms.

For this portion you can choose from one of the following styles to discuss and depict the issues behind droughts:

**Create a Cartoon Strip:** For this style of project you would be creating multiple panels depicting a drought and the various effects that they can have. For each panel that you create you would have the picture that you draw, as well as a description underneath the image. In this description you would write a brief commentary about what is happening in the picture, and an example of each group of impacts of the drought that would apply from above.

*Ex. (picture of dried up swimming hole with kids around it) Description: The drought has dried up this swimming hole that the local kids usually use. Economically, money will have to be spent elsewhere in order to cool the kids down. Environmentally, any organisms that were living in the water would have to travel elsewhere to find water. Socially, the kids will be upset that they aren’t able to swim in their usual spot.*

In the end you will have to have at least 5 different cartoon panels with descriptions for each one.

**Create a Collage:** If you don’t know what a collage is, it is basically a collection of images all combined together in a very close grouping. Usually there is overlapping and not necessarily any real pattern to where and why the images are placed together. The use of printed words can also be included into you collage for extra effect.

Should you choose this style of presentation you will create a collage with at least 15 images that make up your piece. These images should be representative of or related to an impact from one of the three groups (previous section) related to drought. Alongside the actual piece that you create you will also have to write a description of your collage. In this description you will talk about each image in your collage and how it relates to an impact experienced by a living this during a drought. Be sure to identify what type of effect that the impact belongs to (economic, social, environmental)
Create a Mural:

For this style of presentation you will create a large picture in which multiple interactions and events will be occurring. You may choose whatever media you like for this art (paint, colored pencils, etc.) Within your mural you will have to include at least 5 different examples of effects that droughts can have on individuals. This mural should represent a scene during or after a drought has occurred and the interactions (both human and other living things) that would also be happening. This project must be produced on a piece of paper larger than just regular white paper (use of a poster board or large piece of construction paper)

Alongside the mural that you create you will also have a brief description of the events occurring within your work. Describe each individual event that you have included and how each event will impact those individual/individuals in social, environmental, and economic ways.

In the end whichever method of presentation you choose should depict and display the hardships and issues that coincide with droughts in nature. Everyone will briefly present their projects to the class when they are due so that everyone can appreciate and enjoy the works that you have created.
All Dried Up: Examining the Effects of Droughts

Teacher Instructions

Pre-Activity Preparation

For the first part of this activity you are going to need computers with internet access. Based on the availability of the computers at your school, you can either assign the first part individually or in groups based off of the number of computers. For the final part of the activity in which they will create “drought art” it would be helpful to have old magazines, newspapers, or other collections of photos around for the students to use if they choose the collage option. Art materials (paints, markers, colored pencils, etc.) should also be available for the other project options as well.

Introduction

At the beginning of the class hand out the student activity packet and inform them that they are going to be investigating droughts in today’s class. Start by asking the class each student and the person sitting next to them to come up with a definition of the word drought in their own words and to record it on a sheet of paper. After each group has come up with a definition, have them share their definitions to the class as you write down some of the key words or concepts that each definition contains. After going through all of the definitions that each group gave, go over with the class the key words that you extracted from each definition and why they are important to droughts as a weather condition. These words will be the base of their developing understanding of what a drought is.

Main Activity

Have the kids look at the first page of the activity packet and read the directions along with you as you describe the three parts of the activity. Explain that in the first part the students will be doing an online web-quest in order to build a better understanding of what droughts are and what they do. In the second part of the activity, the kids will think about the effects that droughts can have on people and other organisms in different contexts. The final part of the activity will have each person create a piece of “Drought Art” that will express their knowledge and what they have learned about this natural occurrence.

After going through all the directions and expectations, take your class to the library or computer lab so that the students can begin the online web-quest. The web address is listed on their activity packet and all the information that they will need to answer the questions can be found among the various tabs that the page has. Students do not need to go to any other site in order to answer the questions so as you circle from person to person to check on their
progress, make sure that they are staying on task and not browsing the web for other sites or non-related material. After completing the web-quest portion of the assignment, the kids can start to work on the second part of the activity while other finish up the questions from the first part. Once all of the students have finished up the web-quest, have everyone grab their things and return back to the classroom for the remainder of the activity.

The second portion of the activity will have the students relate to the knowledge they have obtained from the first part of the activity in order to determine the different types of effects that droughts can have on individuals. To start this section, have each student should come up with a general description of the types of damage that would be categorized under each of the three effects. After defining these parameters, the kids will then create lists of different effects that droughts would have for each of the groups. The table already contains an example of what one impact may look like and should be mimicked for the additional examples that students come up with. Each column should consist of at least 3 more examples of each type of impact variety. If students are stuck on examples, the following list may be able to assist you with ideas that you can hint to the students:

**Economic Impacts**

- Farmers may lose money if a drought destroys their crops.
- If a farmer's water supply is too low, the farmer may have to spend more money on irrigation or to drill new wells.
- Ranchers may have to spend more money on feed and water for their animals.
- Businesses that depend on farming, like companies that make tractors and food, may lose business when drought damages crops or livestock.
- People who work in the timber industry may be affected when wildfires destroy stands of timber.
- Businesses that sell boats and fishing equipment may not be able to sell some of their goods because drought has dried up lakes and other water sources.
- Power companies that normally rely on hydroelectric power (electricity that's created from the energy of running water) may have to spend more money on other fuel sources if drought dries up too much of the water supply. The power companies' customers would also have to pay more.
- Water companies may have to spend money on new or additional water supplies.
- Barges and ships may have difficulty navigating streams, rivers, and canals because of low water levels, which would also affect businesses that depend on water transportation for receiving or sending goods and materials.
- People might have to pay more for food.
Environmental Impacts
- Losses or destruction of fish and wildlife habitat
- Lack of food and drinking water for wild animals
- Increase in disease in wild animals, because of reduced food and water supplies
- Migration of wildlife
- Increased stress on endangered species or even extinction
- Lower water levels in reservoirs, lakes, and ponds
- Loss of wetlands
- More wildfires
- Wind and water erosion of soils
- Poor soil quality

Social Impacts
- Anxiety or depression about economic losses caused by drought
- Health problems related to low water flows and poor water quality
- Health problems related to dust
- Loss of human life
- Threat to public safety from an increased number of forest and range fires
- Reduced incomes
- People may have to move from farms into cities, or from one city to another
- Fewer recreational activities

Once the students have completed their chart, check them for completion before letting them continue on to the final component of the assignment.

Final Activity

The last part of this assignment will have the students create an artistic representation of the knowledge they have gained about droughts during the process. The students have the choice to complete one out of three styles of presentation: cartoon strip, collage, or a mural. Each of the choices has a description of the expectations and requirements needed within the student packet. No matter what style the student chooses, the creation of a visual accompanied by a written description of some sort is required. Any remaining time left in the period can be given to students to finish their drought art. Whenever everyone has finished, you can then have each student present their piece to the class either verbally, or have them put them around the room and conduct a gallery walk of the students work.
Catching Fire: Understanding the Principles Behind Forest Fires

Part 1: The Basic Flame

In front of you is a simple candle that has been lit. It is funny to think that even such a small flame as this has so much potential power and potential for destructions in the outside world. But where does the fire come from and why can it be so powerful? In order to get these answers it is important to breakdown the science behind not only the flame, but its surroundings as well.

So the first important question to ask is how does a fire start? Obviously it doesn’t just appear out of thin air. There has to be some components that are needed for the fire to work. In the space provided below with your partner, brainstorm a list of the things necessary for a fire to start.

Now that you and your partner have created a list, we will have a class discussion to breakdown and identify all of the main components. Once we have identified the components as a class, write down the important variables in the space below.

Part 2: What causes these Forest Fires?

Now that we know the basics behind what every fire starts with, it is time to investigate the reasons why they occur in the outside environment. Now forest fires would imply that trees are somehow involved. For the first test, the teacher is going to put an open flame onto a living plant sample. If I were to apply a flame to this tree what do you think would happen? Right your prediction in the space below:

Your teacher will now apply the flame to the wood material for a few moments. As this is happening be sure to observe what is happening. Record what all of your senses picked up during this test including sight, sound, and smell. Record your observations in the space below.
After seeing the demonstration by your teacher, was your prediction right or wrong? Why did the tree not catch on fire? What factors (from the previous section Part 1) were not met, and therefore the fire did not continue? Write your answers to these questions in the space below:

Now your teacher will take a piece of non-living wood material and put a flame directly to it. Make observations of what happened to the wood material. What factors (from Part 1) were met in order for the fire to occur? What elements did this “dead” wood material possess that the living material didn’t, therefore allowing it to catch fire? Write your responses in the space below.

So if the tree in your teacher’s demonstration didn’t catch fire, what causes these fires in the real world? With your partner start to brainstorm a list of all the reasons why a forest may have started or what it originated from. It may be helpful to organize your thoughts into a graphic organizer of some sort. Also, remember that there could be natural and man-made reasons for why a forest fire could start. Make your list/organizer below:

After you have created a list/organizer with all of the reasons that you and your partner can think of, combine with another group to share your findings and thoughts. Include any additional information and reasons that the other group has found and add them to the list that you have created.
Part 3: Types of Forest Fires

With a better understanding of the reasons why these forest fires are developed, it is important to next investigate the fires themselves. Not all forest fires are the same. Depending on a couple of factors such as how high they reach and what levels of the environment they affect, the fire would be classified as a specific type. Below is a chart that identifies the three different types of forest fires: **ground, surface, and crown**. Along with each type of fire is a picture that shows what it looks like in nature. Complete the chart by filling in what causes might start each particular type of fire, and the type of wildlife (both plant and animal) that may be affected by each type of fire:

<table>
<thead>
<tr>
<th>Fire Type</th>
<th>Ground Fire</th>
<th>Surface Fire</th>
<th>Crown Fire</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image</td>
<td><img src="image1.png" alt="Ground Fire Image" /></td>
<td><img src="image2.png" alt="Surface Fire Image" /></td>
<td><img src="image3.png" alt="Crown Fire Image" /></td>
</tr>
<tr>
<td>Causes of this type of forest fire</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Types of Wildlife (plant and animal) affected by fire type</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Once you and your partner have completed your table, combine with another group (different than the first group you met with) and share your thoughts and findings together. Again, if there is any information for any of the sections that you did not have, be sure to include it within your table.

Part 4: Which Areas are at Risk?

Now that we have a better understanding of the types of fires and what a fire needs, next we should examine how those factors apply to where these natural fires can occur. As we have investigated and seen, fires can start for many reasons and in many places. From a geographical perspective, not all areas of the country are as likely to experience forest fires compared to others. Generally speaking, areas can either be classified as low-risk or high-risk in terms of forest fire likelihood. Below is a chart in which you will identify different states you believe are high or low risk for forest fires. Be sure to include reasoning for your placement:

<table>
<thead>
<tr>
<th>Forest Fire Risk</th>
<th>Example States and Reasoning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-Risk</td>
<td></td>
</tr>
<tr>
<td>High-Risk</td>
<td></td>
</tr>
</tbody>
</table>

Once again, collaborate with another group you have not worked with yet and discuss your thoughts and reasoning. If any new states or reasoning can be included or updated to your information, be sure to do so during this time.

Part 5: Affects on Humans and Animals

At this point you should have a pretty good understanding of what causes fires, their types, as well as how different regions are affected by them. Finally, it is time to examine how these
fires affect not only us, but the other living organisms that once inhabited the woods as well. Below is a Venn Diagram which you will use to compare and contrast the various effects that wildfires can have on humans and animals. After you and your partner have completed the diagram, you will meet with another group to compare your findings and add any additional information that they may have been revealed during the process.
Catching Fire: Understanding the Principles Behind Forest Fires

Teacher Instructions

Pre-Activity Preparation and Modifications

For the first part of the activity you are going to need a candle and some way to light it. Matches or a hand lighter will work just fine for this beginning part. While this first part of the activity could be done outside, I would conduct it inside the classroom so that you can more easily control the fire to ensure it continues to burn as the students complete the first section. The teacher should make sure to clear off an area at the front of the room for this activity for fire safety within the classroom.

The second part of this activity will either require you to have some sort of living plant (preferably a small tree or open bush) in the classroom, or you can take the class outside. In addition, you will need a flammable piece of dead wood for the second part of the activity. The wood should not be large or uncontrollable when ignited for safety reasons. For additional safety you should also have some way to extinguish the fire of the wood when the demonstration is complete. Regardless of where this second part occurs, you will once again need a lighter or fire source for this second part to hold up against the living and non-living plant material.

The remaining parts of the activity can be done by the students indoors or outdoors as the students will be working to fill in the various parts within their activity packet. Allowing them to work outside could enhance the activity by creating better connections to the physical environment itself.

Introduction

As the students enter the classroom, hand them each a copy of the student activity packet and have them sit in their seats for instructions. Write the word “Fire” at the front of the room and have students raise their hands to give examples of different contents areas in which fire can be seen or used and write them on the board in some sort of organizer. As students give examples (Biology, Chemistry, Math, or any content area) have them justify their response with reasoning. If students don’t suggest content areas such as English or Math, the teacher should include these content areas to the list and have the students come up with reasons as to why they are related to those areas. After creating the organizer start a class discussion about the multiple implications and connections that fire has to everyday life. Inform the class that although fire is very important in multiple realms, the focus of fire for today’s activity will be in the areas of chemistry and biology.
Main Activity

Have the students look at the first section of the packet and follow along with the reading as you light the candle at the front of the room. Read through the first two paragraphs and then give the students a few minutes to think and respond to the first prompt with the person sitting next to them. After giving each group a couple minutes to brainstorm ideas, re-center everyone’s attention to the front of the room and have groups share the elements that they were able to come up with. As the students are giving their responses, the teacher should write down their thoughts into three different groups (Fuel, Ignition Source, and Oxygen). After you have collected the students’ responses into the three different groups, have the students come up with a title for each of the three requirements for fire. Generally they should be fuel, ignition source, and oxygen so the teacher may have to mold the classes’ ideas a little to have them come to the right conclusion about names for the requirements.

For the second part of the activity, the teacher is next going to run two demonstrations for the class. In the first demo, the teacher will put a flame onto the outside of a living plant specimen for around 10 seconds. Before applying the fire, have the students write down their prediction in the space provided. As you apply the flame, students should watch what happens and record any observations that they saw, heard, or sensed. The kids can then continue onto the next paragraph which has them respond to the test and their initial predictions; as well as relate what happened to the elements necessary for fire. For the second demonstration, the same procedure is conducted; however the teacher will put flame to a non-living piece of plant material. Again the students will record their observations, what elements the wood had that allowed the fire to catch, and then relate the demonstrations to real-life forest fires. In the final section of this part of the activity, the students in their groups can create some sort of list or organizer that discusses the reasons why forest fires start. Emphasize that both natural and man-made reasons should be considered. Allow the partners to work on their lists for a few minutes, and then have partners combine with another group in order to share and expand upon their ideas.

The third part of the activity will have students investigate the three different types of forest fires by having them fill in the different regions of a chart. For each type of fire the students will have to think of and write down the causes of each and the types of wildlife that would be most affected by each type of wildfire. These tables should be completed in their partner groups at first, then have each set meet with a different couple to share thoughts and include information with one another in order to enhance their charts. The fourth part of the assignment will have the partners look at forest fires in terms of risk areas. They will fill in the chart with states that they feel would be considered high or low risk for forest fires and also include reasoning for their choices. Once a group has finished this potion of the activity they
once again will combine with another group in order to talk about what states might be considered high risk or low risk and why. The final part of the activity will then have each group compare and contrast the impacts that forest fires can have on humans and animals. Using the Venn Diagram provided to them, each group of students will create a list of the effects that forest fires has for each group and how they are similar and different in the impacts.

Wrap-Up/Conclusion

At the end of the class the teacher can collect the students’ packets and grade or review them. Before the students can leave for the day, as a “ticket out the door” concluding activity have each student state one fact or aspect of fires or forest fires that the learned through the activity. Students should not be able to repeat responses so that a greater collection of information and understanding is expressed. All of the students should be listening to their classmates’ responses so that they don’t repeat answers and can hear any information that may not have been revealed to them through the activity itself.
Friendly Fire: The Use of Fires for Good in Nature

When people think about fires in nature, there is often a negative connotation regarding damage and destruction being caused to the environment. This is typically the case; however, would you believe that sometimes fires are started by people in nature for good? All around the country as a matter of fact the use of “controlled burns” are being implemented for the benefit and conservation of the natural plant life in an area.

The following article contains information regarding the practice of controlled burns. In the article it discusses what controlled burns are, how they are carried out, how it helps with the wildlife in the area, and the dangers of it. As you read the article you should highlight or indicate specific information that you will need for the creation of an informational brochure. The informational pamphlet that you will make should be arranged and created in a way that could be handed out to people wanting to know more about the topic. This pamphlet will inform the person reading it of all the important information and facts regarding controlled burns and their importance to the environment. Your pamphlet when completed will contain all of the following:

- Definition of a controlled burn
- Examples of why fire is important
- What are some reasons for why a controlled burn would be carried out
- What affects does a controlled burn have on the wildlife (both plant, animal, and human)
- What are the risks and dangers included with a controlled burn
- Include at least 2 pictures on your pamphlet (use of hand drawings or images printed online are acceptable)

How you organize and arrange your pamphlet is up to you. You may choose to make a 3-fold pamphlet, 2 sided handout, or some other arrangement of the information. Regardless of what type of brochure you make, the information that you include and how it is arranged are the most important characteristics. Just be sure to include all of the information and requirements in an organized and appealing fashion that an unknowledgeable person would be able to read and understand.
Prescribed Burning: A Vital Tool in Restoration

Fire is as natural a force as wind, water, drought, floods, blizzards, and insect infestations. Before Europeans settled in North America, fires regularly occurred naturally due to lightning strikes, but were also started accidentally and intentionally by man.

Deliberately set fires were an important tool of Native Americans who used fires to hunt, improve visibility, protect themselves and their villages from wildfires, make traveling through the tall grass prairie easier, and for many other reasons.

As the continent was populated and developed, fire was widely suppressed because of its inherently destructive impact to many human interests and its potentially deadly affect on human life. The "Smoky the Bear" campaign reflects this perspective.

As a result, it is natural to have questions about the Forest Preserve District of Will County's prescribed burning practices, and we hope to answer those questions here.

Why is Fire Important?

In recent times, biologists have realized the benefits of fire in natural areas. Today we understand that our ecosystems and the plants within them evolved with fire, and many species are dependent on fire to maintain the habitat in which they live.

For example, the key growing part of most prairie plants is below ground, where the heat of the fire does not penetrate, allowing the grasses and wildflowers to flourish once again following a fire event. Many native trees such as oaks and hickories have evolved adaptations to protect them from fire injuries such as thick bark. There are species of evergreen trees which cannot germinate until the cones are exposed to the heat generated by fire.

Historically, the landscape of Will County was dominated by prairie and wetlands, with scattered areas of timber that supported a wide variety of wildlife. While this landscape was molded through millennia by geology, topography, hydrology, and climatic factors, it was also strongly influenced by fire.

Explorers and early settlers remarked on the awesome power of the nearly annual prairie fires, and how in the absence of fire, trees became more common across the landscape. Fire so profoundly influenced the landscape that trees could only persist in areas sheltered from intense fire by natural firebreaks such as rivers and hills.
These firebreaks provide opportunities for the fire to go out or burn around and skip some areas. These skips and areas of reduced fire intensity allow saplings to grow large enough to withstand the fires and grow into the next generation of mature trees, sometimes forming woodlands or more sparsely timbered savanna communities.

In the absence of natural firebreaks where fire could burn most intensely, tree growth was prevented and prairie was maintained. The different plant species that dominated the prairie, woodland, or savanna landscapes provided the diversity of habitats which supported the large array of animal species we know today.

**What is Prescribed Burning?**

Prescribed (or "controlled") burning is a means of reintroducing this natural process. A controlled burn involves identifying the area to be burned (the "burn unit"), establishing control lines in order to prevent the fire from burning unintended areas, and intentionally setting the burn unit on fire.

Areas within the county are managed by the District with controlled burning when there are reasonable assumptions that wildfire was an important ecological process that shaped composition and structure of a particular ecosystem type, and that maintenance or restoration of that community type cannot be achieved without its use.

Fire can also be an important tool to attain specific maintenance objectives such as controlling tree and shrub growth along the embankment of a flood control reservoir where the roots systems can threaten structural integrity. The disturbance created by periodic fires is important in maintaining our remnant oak/hickory forests and savannas.

The Public Land Survey (1821-1837) recorded almost 1,500 trees while surveying Will County to establish the system of townships and sections that is still used today. Over 90% of those trees were oaks and hickories. Less than 1.5% of the trees recorded were ash, sugar maple, hackberry, or black cherry.

Now these once uncommon trees have rapidly colonized our landscape, threatening to overwhelm the oak/hickory woodlands and the plants and animals that have evolved with them. The one factor that these native invaders have in common is
that their saplings are much more easily harmed by fire than those of oaks and hickories. Experiments have shown that reintroducing fire into oak/hickory ecosystems is an effective means of reestablishing oak and hickory sapling dominance.

Controlled burning is also an important tool providing many benefits for restoring our natural plant communities to lands that have been disturbed. Fire is used to clear the ground of existing vegetation in preparation of seeding and planting more desirable plant species. Burning allows the seeds to make better contact with the soil and therefore improves the chances of successful germination.

Fire is used to reduce the competition between weedy species and native species as a restoration area matures to encourage better establishment of the native vegetation which slowly displaces the weeds. Controlled burning also returns nutrients to the soil, making them readily available for the next generation of vegetation growth.

**How is Prescribed Burning Done?**

Controlled burning requires extensive planning, training, personnel, and equipment. Planning is often required six months or more prior to implementation.

An open-burn permit from the Illinois Environmental Protection Agency must be obtained. Adjacent landowners and the appropriate local Fire Chiefs are notified by mail well before the day of the burn. Dispatch centers, fire chiefs, and Forest Preserve District Police are also notified on the day of the burn.

All participants of our controlled burns have received special training, which involves learning fire behavior, methods of ignition and suppression, proper use of equipment, and more. The burn boss and some of the fire crew leaders also have extensive training in modeling fire behavior to assist with understanding expected and observed conditions.

A written plan is developed for every area to be managed with controlled burning. This burn plan identifies the limits of the burn unit and control line needs, potential hazards and safety issues, procedures for ignition, acceptable weather and fuel conditions, personnel and equipment needs, as well as the management goals and objectives of conducting the burn. Before every fire, burn plans are reviewed and updated as needed.
Fire control lines are installed prior to the day of the burn and checked immediately before ignition. If necessary to protect site visitors, access to portions of a preserve may be restricted or the preserve may be closed for the duration of the burn.

Data is recorded during and at the conclusion of each burn, including weather conditions, observed fire behavior, and extent of burn coverage, in order to help staff evaluate the effectiveness of the fire in achieving site management objectives, as well as safety and operational procedures. The controlled burn season spans mid-October to mid-April when most vegetation and many animals are dormant.

**How are Injuries to Wildlife Avoided?**

For those who have never seen the aftermath of a controlled burn, it may appear shocking at first. A blackened and smoking landscape greets the eye, and it appears as if all life has been destroyed. The reality is far different.

We carefully plan and time our burns to minimize harm to wildlife. Whenever practical, sites are divided into multiple burn units so that there is always unburned habitat within the preserve. While an occasional mouse or snake may be harmed in a burn, it is far more common to see a mouse, rabbit, or deer dart through the flames to safety than to see one actually harmed.

Controlled burn participants routinely walk through the burn units afterward to look for injured animals and have learned to burn in a manner that results in very few injuries or mortalities. Most insects are underground during controlled burns, but some species are in the plant litter and are thus consumed in the flames. However, leaving unburned areas ensures there are enough insects to accomplish the pollination and decomposition needs of the next growing season.

**Is it Dangerous?**

Of course, any fire can be dangerous if not kept under control. Prior to a controlled burn, variables affecting fires are carefully studied. Our ecologists and fire control crews who are trained to meet National Wildfire Coordinating Group (NWCG) standards monitor wind conditions, humidity, temperature, and the amount of moisture in plant material.

Through training and experience, the controlled burn crews are able to anticipate problems and take remedial actions that have allowed this program to effectively manage our natural lands while maintaining public and burn participant safety for over 25 years without a single significant incident.
We strive to implement our controlled burn program with the greatest attention paid to the safety of the general public. An important element of this is smoke management. Common smoke management considerations include excessive smoke on roadways which creates visibility concerns for motorists, and individuals with health conditions which can be aggravated by smoke such as asthma or allergies. Facilities with important fresh air intake systems like hospitals and schools are also vulnerable.

Several strategies exist for minimizing impacts resulting from smoke, including monitoring weather conditions which influence smoke dispersal, altering ignition strategies, and proper site selection the day of the burn.

We constantly update our burn plans to identify the location of these smoke sensitive receptors. If you or a family member has a health condition which could be triggered or aggravated by smoke, or could otherwise be negatively impacted by controlled burn activities, please contact us so that we can include your information in the appropriate burn plan(s). We will be sure to give you advance notification of planned controlled burn activities so that exposure to smoke or other impacts can be avoided.
Friendly Fire: The Use of Fires for Good in Nature

Teacher Instructions

Introduction

At the start of the class ask all the students to write down some words that they think of when they hear the word fire. Give them a minute or two to record some words down on a separate sheet of paper. After the students have recorded their thoughts, ask the class what types of words they thought of that related or reminded them of the word “fire.” The teacher should record these responses at the front of the classroom so the students may see them. After gathering a collection of these words, then ask them to do the same thing, except while thinking about fires in nature. Again give the kids a couple of minutes to record some words and then pick some students to share their thoughts with the rest of the class as you write down their responses next to the previous question’s responses. After doing so start a brief discussion of how the lists are similar and different. Also ask the kids why they were thinking the words that they did. At this point most, if not all, of the word related to fires in nature are going to have a negative connotation. Add the following words to the list (restoration, growth, germination) and tell the students to talk about the words that you included. This might evoke some confusion; however mold the class conversation so that the students can see how elimination of certain plant life may lead to the growth and development of new plants.

Main Activity

After you have completed the introductory conversation with the class, hand out the student project sheet and the accompanying reading. Go over the directions with the class and explain the objectives of the assignment. Explain that they will be first reading and informational article that discusses the use of controlled burns within wildlife. Before beginning the reading, the students should know that based off what they read they will be creating an informational pamphlet designed to inform people who don’t know what controlled burning is. The student sheet identifies all of the components that the students’ pamphlet must contain so the teacher should emphasize that the students refer back to it for the project. Each student is responsible for their own pamphlet by the end of the class, however if students want to read together and collaborate with one another that is allowed. The teacher should suggest the use of planning pages or organizers before starting the creation of their projects to ensure that they meet all of the requirements for the assignment. As the students are reading and organizing their data, the teacher should move from group to group; ensuring that everyone is on task and meeting the requirements of the assignment.
Conclusion

At the end of the class each person will hang their pamphlet around the perimeter of the room. The students should spread the work out to provide as much space as necessary for all of the projects to be displayed. All of the students will then do a gallery walk around the room in which they will take a few seconds to look at their classmates’ pamphlets and appreciate the work that they have done. At the end of the class you can then call on students to have them make positive comments about certain pieces that they observed throughout gallery walk. No negative criticism should be given so the teacher should reinforce the types of responses that are expected from the students before having the class share.
Eye of the Storm: Mapping Out Hurricane Biological Effects

One of the most devastating and dangerous natural occurrences within the United States, especially along the East coast are the massive tropical storms known as hurricanes. While some of these storms tend to dissipate before reaching land and just bring rain and some wind, the more severe storms are capable of causing havoc to those in the path of the storm. The effects are wide reaching and can result in years upon years of rebuilding to recover.

In terms of the media coverage, most of what we see with regards to damage and suffering comes from the human perspective. Obviously as we are the ones reporting on the issue it is only logical that the greatest concern and attention would be placed on us. However, these massive storms have drastic effects on much of the other living world as well, sometimes going unnoticed or not receiving the attention that it truly deserves.

In order to investigate and better identify with everything that is affected by these massive storms, you are going to be creating your own Hurricane Graphic Organizers. Just as hurricanes are tracked and modeled with different layers or regions, our study of the effects hurricanes have, especially the biological ones, can also be arranged in a similar fashion. Just like a hurricane storm cell, everything surrounds a central location or idea. For the hurricane this is known as the eye of the storm, whereas for our organizer it will be the main idea. From there multiple bands start to circle out and around from the central point. These bands tend to get larger in diameter and cover a much larger areas than the inner segments of the storm. The same will also hold true with our organizer as we branch out from the main idea, our thoughts and connections will get broader and expand over more areas. In the end we will create a storm shaped organizer that will resemble the look of a radar view of a hurricane.
**Constructing and Organizing Your Organizer**

Below are the general guidelines and branches that you will take in order to create your organizer. Generally each branch of your organizer will follow the same pattern, but the amount of information that you include for each may vary. The steps below should be done a few different times to assure that as much information and detail for all things that are affected by hurricanes is included.

**The Eye of the Storm- Hurricane Effects**

- This part you will only have to construct once for your graphic organizer. Just as the hurricane only as one eye, there is only one main idea from which all the rest of our thoughts will spin off of. Obviously “Hurricane Effects” is our main idea for this organizer.

**Groups Affected**

- As our focus of this organizer is to examine and record how these storms affect the living environment and components of it. The first stem of your organizer then should include general groups of organisms that would be affected by hurricanes.

**More Specific Groups**

- Once you have come up with the specific classifications, you then want to branch out into smaller categories within that group. Don’t go so specific as to run out of space for your organizer, but try to branch off one of your initial groups into at least three sub-groups.

**Types of Effects**

- For each of the specific groups, then start to think about the various types of effects that these organisms may experience. As you are going to be breaking these down further, try not to get to specific quickly. You may consider identifying with the essential survivals (food, shelter, environment, etc.) for this section.

**Expand on the Effects**

- In this final part of the organizer, you want to include as many more specific types of effects that fall under each of the effect types. These are going to be your specific example of types of damages or changes that are made to the ecosystem that affects the organism.
You will create your organizer individually on a large piece of paper. Be sure to write small enough to include all of the information, but large enough so that it fits the entire sheet of paper. It may be helpful to plan and map out your thoughts ahead of time before going to create your final project. I have included and example thread of my hurricane outline so that you have an idea of the expectations and what should be included for each part. While my example only has one piece at each level, **yours will have to increase by threes**. For example, after hurricane effects, you will have to have 3 groups affected. For each of those groups you must have 3 sub-groups that would fall into that group. This process of three items for the previous level will continue until you have completed the organizer.
Eye of the Storm: Mapping Out Hurricane Biological Effects

Teacher Instructions

Introduction

To start off the activity, play any news report covering a hurricane in the last year or so (YouTube is a good place to go for these videos) in the United States. Preferably you would want to have a video that focuses on the human population as many of these newscasts tend to do. Show the video that you decide on at the beginning of class and have the students think of all the different ways, either discussed in the clip or inferred, that the hurricane would have on the human population. Give the class a few minutes to record their thoughts on a piece of paper as you write the following categories up on the board: Economic, Emotional, Physical, and Sociological. After giving the students a few minutes to record their thoughts, ask for volunteers in the class to share some of the ideas that they came up with. As they reveal each of their ideas, also ask them what category of effects it would go under. If there in confusion, go over the basic definitions of each of the categories that you listed on the board. As each student discusses their choice and what it would fall under, record their information under the appropriate group. If the students do not provide an example of a specific category, provide one for them in hopes to spark further effects that they had originally not thought of.

After adding the students thoughts and responses to the list, start a general discussion with the class about how hurricanes in particular, but other storms as well, are often put into different categories based on their severity. Ask the kids what criteria they know of that goes into the scaling of various storms. Correct responses could include wind speed, size of the storm, amount of damage done, comparison to other storms, etc. After talking about the scaling of storms, then have the students scale the effects of hurricanes that you listed at the front of the room. For convenience of the class discussion that will follow, have all the students use the same scale (Ex. 1-5) in terms of the severity to humans. Allow the students to think about the questions and record their scales on the same sheet of paper from before. As the kids are determining how they would rank the various effects, the teacher should create a chart at the front of the room that will allow you to collect and record the ranks that the class had for each of the effects for each category. After all the students have ranked the effects, gather all of the data about each effects and how the students ranked them. This is most easily done by stating an effect and then go through each number of the scale; having the students raise their hands on the number that they ranked it as so that you can count the responses and then record the totals. After gathering all of the data, then briefly talk about the conclusions that the class came up with and what they thought were the most harmful effects of hurricanes.
Main Activity

After going through the introduction on the human effects, refer back to the video clip that you showed and ask the class how much information about the effects on other species, like plants and animals, was discussed in the clip. Students should come to the conclusion that not much was talked about if any. Discuss how this is usually the case, however that humans are not the only ones that are affected by the damaging power of hurricanes. Hand out the student activity packet and go over the introduction and instructions. Reinforce that the focus of the day’s activity is to think about the impacts that hurricanes can have on other life forms as well. In order to do this, they are going to be creating a graphic organizer that is in the shape of a hurricane storm cell. The premise of the organizer is to have the “eye of the storm” be the main idea, or in this case hurricane effects. Then unlike other organizers that branch out in one liner direction like a tree branch, this organizer will have the students arrange the information in a circular rotation pattern, similar to the rotation that can be seen in a radar scan of a moving hurricane. Just as the storm gets wider and covers more area as it gets away from the eye, the organizer will also cover more topics and spread out as the students create it.

The second page of the activity packet contains the different levels that the students will have to include for their organizer. In essence, it is composed of five layers: the eye (Hurricane Effects), groups affected (plants, animals, humans), sub-groups of the previous groups (Ex. Plants: Trees, Flowering Plants, Animals: Mammals, Reptiles), the types of effects for each sub group (food, shelter, environment, etc.), and finally specific examples for the type of effect (Ex. Reptiles > Food> Hurricanes may force insect in hiding, providing less food for small reptiles). While an example of one train of thought for this organizer is provided in the student handout, it may be helpful to model the organizer for humans in particular so that they see exactly what is expected. After going through the directions, modeling the activity, and ensuring that the students don’t have any additional questions, the students may begin to work in pairs and complete the organizer. As the students are working the teacher should go from group to group ensuring that they are on task and assisting with any questions or issues that may develop. Upon completing the organizer, the teacher should check the completed product before accepting the submission.

Conclusion

To wrap up the activity have each student meet with another individual from a different group and go over the organizers that they developed. Each student should try to ask at least 2 questions to the other students about their diagram. This process can continue until each student has viewed and discussed a diagram from each of the student groups that were within the class.
Going with the Flow: Comparing and Contrasting Sliding Disasters

Not all natural disasters are the same; however there are quite a few similarities between some of them. In particular, those in which some sort of material flows over the previous landscape and taking out whatever is in its path tend to have a few things in common. In this activity you first are going to research various types of natural disasters in order to answer the various questions about each type to fill out the chart below. After you have gathered a better understanding about each of the natural disasters, you will then create a project from the list provided about ONE of the types of disasters to complete and then present to the class as at a later date.

Part 1: Researching the Disasters

In order to develop a better understanding of how each of the types of natural disasters are similar and different, you are going to research each from multiple sources in order to answer the questions provided in the chart at the end of the packet. These questions in the chart will help guide your search and allow you to make connections between the natural occurrences. When researching, be sure that you are using reliable sources. Google and Wikipedia are not necessarily the best or most accurate ways to gather information so be sure to check the reliability of your sites and sources when possible. For each answer that you give, also make sure that you provide a brief citation telling me about where you got the information:

- Type of source (book, article, website)
- Name of source (title of book or article, name of website)
- Any authors given/ number of other resources referenced

Once you have filled in the chart for all of the types of disasters, you will then be ready to complete the second part of the assignment.

Part 2: Expressing More on One Disaster

Now that you have gathered a better understanding about all of the types of disasters, you will next be completing some style of project to express your knowledge about one of the specific types in a different way. Below is a list of multiple different types of projects that you may create in order to share and show your understanding of a specific natural disaster. The different types and styles of projects will allow you to create a final product that fits your style the best; while still accomplish the same learning goals. The projects types are as follows:

- Create a Model: This model that you create will allow you to simulate the type of disaster that you have chose. Along with this type of project, you will also have to give a
brief presentation in which you talk about the effects of this disaster to the ecosystem/s, how they are started, and which areas of the world tend to experience the most of them. You will also be required to run a demonstration with your model and explain how it works and what it shows.

- Create a Poster/ Pamphlet: For this project you will create some sort of visual presentation that will showcase all of the information from the chart in the previous section. In addition, you will be required to include visuals onto your project to help make connections and show the damage that this type of disaster can cause. Finally, you will have to research different locations that offer services to those affected by your specific disaster type and what they do. You will then present this poster to the rest of the class and talk about the disaster type and how it is similar and different to other types of natural disasters.

- Creative Writing: For this project you will write about the disaster type that you have chose in a creative and unique way. Some appropriate styles for this assignment include the following:

  • Journal Entry: Talk about the event as if you are experiencing it first hand
  • Opinion Letter: Write to a local official about your concern over the issues in your area
  • Newscast Script: Create the monologue or dialogue used in a news report for the TV about the disaster of your choosing
  • Some other writing style: Must be approved by teacher

If you choose this style of presentation be sure that you include all the information from the table in the previous section as well as additional information relevant to the style you have chose.

If you have any questions about what this may mean, feel free to ask your teacher. After you have completed your writing you will then present your writing to the class, or have somebody else (should they agree to) read your piece for you.
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<thead>
<tr>
<th></th>
<th>Avalanches</th>
<th>Mud/Land Slides</th>
<th>Tsunami Waves</th>
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<td>How is this type of</td>
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<td>natural disaster</td>
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<td>Include multiple</td>
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<td>examples.</td>
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<td>Question</td>
<td>Answer</td>
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<td>-------------------------------------------------------------------------</td>
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<tr>
<td>How are native animals affected by this type of natural disaster? Be sure to include specific examples and types of wildlife.</td>
<td></td>
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</tr>
<tr>
<td>How are the native plants and trees affected by this type of natural disaster? Include multiple examples.</td>
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<tr>
<td>From a biology standpoint, what other effects can the occurrence of this type of natural disaster have on the ecosystem in which it occurs?</td>
<td></td>
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</tbody>
</table>
Pre-Activity Preparation and Modification

For the first part of this activity the students will be doing research about three different types of disasters. The class will need enough computers or resources to go from in order to answer the various questions. Therefore, the teacher should reserve a computer lab or the library for the first day of this activity so that the students can do the research. For the second part of the activity in which the kids are going to create a project about one of the specific types of disasters, certain materials may need to be available for the kids. The teacher should have various art materials (markers, colored pencils, construction paper, and poster board) available for the students to use if they would like for the second option of the project. If a student chooses to make a model, they will probably have to get most of the materials for themselves. As a modification for this second part of the activity, you can have the students either make their projects in class, or assign it to them to be completed at home.

Introduction

At the students come into the classroom, the teacher should write the words “Avalanche, Mud/Land Slides, and Tsunami Waves” towards the front of the room. After all the class has come in and is seated, ask the class what they know about each of the words at the front of the room. Have each student take out a sheet of paper and write down their thoughts and prior knowledge about each of these natural disasters. After a couple of minutes, have them turn to the person sitting next to them and share what they know about each topic. After another couple minutes of discussion, regroup the class and have each set of partners share something that they know about each type of natural disaster. After the class has shared their background knowledge, ask the group whether they think these disasters are similar to one another. There is likely to be mixed responses for this question including those that will think they are not alike. Have some student’s share their thoughts for the disasters both being similar and different, then introduce the focus of the activity that they are going to be completing. Inform the class that they are going to research these natural disasters to investigate how they are similar and different to one another. Then after all of the students have researched all of the types of disasters, they will then create a presentation on one of the types to share with the rest of the class.

Main Activity

Hand out the student activity packets to the class and then go over all the directions together. Emphasize on the Part 1 instructions as those will be the primary focuses for the first day of the
activity, however also briefly introduce the three types of projects that the kids will be able to choose from in the end. Spend a majority of the time explaining the criteria for the answers that they have to provide in the charts that they are going to be filling out. After going through all the directions and clearing up any questions that the students may have, allow the class to start their research. As the kids are looking up the answers to the questions and filling in their responses in the appropriate format, the teacher should walk from person to person ensuring that they are staying on task and answering all of the questions correctly. If a student finishes answering all of the questions, the teacher should check over their answers before going on to planning the next part of the activity.

**Conclusion**

Once all of the kids have completed the first part of the activity, each student will be responsible for completing a project of their choice on an assigned type of disaster. How the class is assigned what disaster is up to the teacher, however all of the types should be represented as equally as possible. Be sure to go over the direction and expectations for each of the assignment types with the class before they are given time to work. On the day that the projects are due, each kid will be required to present their project to the class. For each of the presentation types there is a description of the verbal speech component they will have to do in the student handout. After the students’ present their projects, the teacher should collect them in order to grade the answers from the first part of the activity, as well as the project that each one made individually.
Create Your Own Ice Storm Lab

While not very common, ice storms can be an extremely devastating and potentially lethal environmental disaster. The combination of lots of water, during and followed by freezing temperatures can lead to ice covering everything that the water touches. While often beautiful to look at, the combination of these elements can destroy whatever it covers; especially the plant wildlife of an area. Tree branches in particular are susceptible to both the freezing temperature that chill the wood to the core, as well as the massive weight the strains the branches. Either of these forces can, and likely will cause older or weaker branches to break off, potentially leading to the death of the tree.

One question that a person could ask about this natural disaster is what is more harmful, the cold itself or the ice weight? When a tree branch snaps off during an ice storm is it because the integrity of the wood is weakened from the plant fibers being stiffened, or is that the pressure and weight exerted by the ice and gravity it to much? This is an interesting question that you and a partner will investigate within a lab setting now.

The Lab

In order to answer which factor is more of a factor when it comes to branches snapping off of tree and limbs during an ice storm, you and your partner are going to conduct your very own experiment. How you set-up and run the tests will be up to you, however your teacher will be checking your progress and planning at several points to ensure that you are going on the right track. Alongside actually carrying out the experiment, you will also be creating a lab write-up to go along with the experience.

Day 1: The write-up will be just like all of the other lab write-ups that we have conducted and will include the following:

- Purpose
- Hypothesis
- Materials List
- Procedure
  - Data Collection
  - Data Analysis
  - Conclusion
All of the parts that have been highlighted will be completed prior to actually testing and will require you to have your teacher check off on their completion before moving to the next step. The writing down of these highlighted parts will occur on the first day of the activity.

Day 2: Once you and the rest of the class have completed all of the preliminary components, you will then travel outside to the close wooded area in order to gather branch samples to use for your testing. Important considerations when gathering these samples should include:

- Type of wood used (same tree type)
- Length and width of branch as close as possible
- Fresh limbs (not decomposed or old)

Upon gathering your wood samples, we will return to the classroom so that you may commence your testing. Some important considerations for your testing will include the following:

- Record all variables used (weights, temperatures, lengths, etc.)
- Have a baseline test for comparison (not affected by any variables)
- Collect and arrange your data in a clear and organized way (chart, table, etc.)

Once you have run your tests you will then take your results and analyze them against one another. Again, how you do this is up to you; however keep in mind your original hypothesis and the question that you are trying to answer. The use of graphs may be helpful in doing this. Finally you will write your conclusion for the whole lab in which you wrap things up, discuss your findings, and talk about the experiment and how it was conducted.

After completing all of the elements of your lab write-up, answer the following questions to be turned in with your completed lab:

1. Having now completed your experiment, what changes or modifications would you make if you were to redo the experiment? Why would the changes be beneficial?

2. Do you think if you had tested smaller or larger diameter branches within your test you may have come up with a different conclusion? Why or why not?

3. Do you think the fact that you were using broken limbs versus those on a tree affected the conclusions that you reached? Why or why not?

4. What adaptations might trees develop in areas that experience more freezing rain conditions that could help protect branches from breaking in these conditions?

Your completed lab write-up and all other information will be typed and turned in the following class period. If you have any questions along the way feel free to ask.
Create Your Own Ice Storm Lab

Teacher Instructions

Introduction

Start off the class by having the students think about the following riddles/questions. While they aren’t necessarily relevant to the topic of environmental storms/disasters, the point is to think about and consider multiple perspectives to certain issues:

- What came first the chicken or the egg?
- If a tree falls in the woods and nobody is around to hear it, does it make a sound?
- Do we eat to exercise, or exercise to eat?

Introduce each question to the class and then have a general discussion about the principles. Remind the kids that this is not a debate, but rather to see how different sides and perspectives can lead to different answers. After discussing each answer, have the students get into pairs and from a scientific perspective, try to create a general testing principle that could be used to see what the true answer of the question would be. Examples for each may include:

- Chicken: Test whether a chicken egg could survive without the hen around or if it would be necessary to have it there.
- Tree: Place recording equipment next to trees that is close to falling over, and then review the evidence after the tree has fallen down.
- Eating: Run an experiment in which each variable is tested to see which is more important to the other in terms of health

Students may come up with other ideas so discuss the thinking and strategy that would have to go into implementing each research plan and the experiment that would be carried out. Focus on elements such as hypothesis, materials, procedures, and the data that would be collected as these will link to the elements of the experiment that they will be creating. After discussing these questions and the potential experiments that could be conducted to test them, reveal that the students are going to be creating their very own experiments in order to test a similar question relating to ice storms.

Main Activity

Day 1

Hand out the activity packets to the students and start to go over the directions as a class. In essence, the students are going to be creating their own experiment, along with a lab write-up, over a two day period in order to test what element is more damaging during an ice storm: the
freezing of the wood material making it more brittle, or the additional weight that is exerted on
the branches because of the additional ice. The first day of the lab will have the student groups
figuring out the basic elements of their research. This will include the purpose, hypothesis,
materials, and procedure for the experiment. Therefore the first day is all about planning and
thinking about the questions at hand. They will write a paragraph purpose statement
identifying the elements and question of interest, along with the perspective of both choices
for the answer. After writing the purpose they will then create a hypothesis statement in which
they will make their prediction of what element they think will be most important. The
materials and procedure will be recorded as they start to think of how they could test these
variables to determine which element is more influential to branches breaking during an ice
storm. Throughout the materials and procedure portions of the planning, emphasize the
importance of testing each condition fairly. Some suggestions are provided on the top of the
second page of the activity packet; however also hint the use of a control within their
experiments as well. Briefly go over what will happen on the second day; however you will
want to allow the groups as much time as possible in order to meet and collaborate about the
experiment they are going to create and run.

After reviewing the directions and expectations, allow the students to work in their groups and
begin planning the lab and composing the required parts for day one. Although they will end
up typing their lab reports at the completion of the lab, all of the group members must be
writing down all of the components of the lab-write up throughout the experiment. Each group
should be checking with the teacher before moving on to the next section, so be sure to meet
with groups frequently and confirm that they are on the right track. You can also assist groups
who need guidance, but most of the thinking and ideas for the test should be coming from the
students. By the end of the first class period the groups should all have the first four elements
of the experiment recorded so that they can begin right away on day two.

Day 2

At the start of the second day all of the groups should have their plans set in terms of what they
need to collect for materials, how they are going to test the research question, and what data
they plan on collecting. At the beginning of class give each group a few minutes to review the
plan and what needs to be achieved at each part of the day. The class will start by going
outside in order to gather branch samples for their test. Remind them of the elements included
on the top of the second page that each group should try to consider. The collection of branch
samples should only take a few minutes. Once all the groups have gathered their samples, then
return back to the classroom so that they can begin their tests. It is likely that putting branches
in ice or a freezer will be part of their test, so having a cooler with ice or a freezer unit close-by
should be considered by the teacher. The remainder of the class will be for the students to
work on their experiments and complete the lab write-ups. With respect to the write-up, the students should have a completed data collection (including charts or tables), data analysis, and conclusion section at the end of the period to accompany the parts completed on the first day. Again, students are going to have to check in with the teacher after completing each of the three remaining components. As the students are working, the teacher should circle from group making sure that the students are on task and sticking to the procedures that they have created.

After a group has finished with their experiment they should clean up their work areas. Any branches used in the experiment can be collected and disposed of outdoors later. All other materials used by the group should be neatly placed in their original location and the workspace cleaned properly. After cleaning the work area, each group should answer the follow-up questions for the lab. At the end of the class remind the students that the typed lab reports and answers to the post-lab questions are due at the beginning of the next class period.
Sticky Situation: Oil Spill Simulation

In today’s activity we are going to investigate oil spills; a human-initiated natural disaster that can be extremely lethal and hazardous to the environment. After getting some background information on the issue, you will form small group to carry out a simulated oil spill and examine the ways in which we try to prevent the spread of these harmful materials into the ecosystems and organisms that inhabit them.

Part 1: Background Information

In order to prepare yourself for the activity that you will be carrying out, you first are going to read a brief article discussing oil spills and the efforts used to contain them. Be sure to pay special attention to the methods used to contain and eliminate the escaped crude material.

Part 2: Examining the vocabulary/equipment

Once you have read the article and gained a better understanding of the methods used during an oil spill, you are now going to prepare for the simulation that you will be carrying out. Follow the following steps for this part of the activity:

1. Get into a group of 3-6 students and move to one of the assigned stations.

2. At your station are copies of “Before Dispersant” and “After Dispersant” worksheets. Pass these out to each of your group members, making sure everyone gets a copy of each.

3. As evenly as possible, assign roles to every member of the group. The roles are as follow:
   - Observer: Make observations during the simulation, record these on your worksheets for the rest of your group to write in
   - Data Collector: List the characteristics of the materials being used in the simulation. Lead discussion as to what each material represents
   - Oil Remover: Uses the materials to run the simulation

** These roles should be swapped between each material being used during the simulation**

4. With your roles assigned for the simulation you may now open the materials that have been sat in the kit for this activity. In the chart below fill in the materials that have been provided, what you and your group think each material will represent, and why? This is a group discussion so all members should take an active role in talking and identifying what parts are what.
<table>
<thead>
<tr>
<th>Type of Material</th>
<th>What It Represents</th>
<th>Reasoning Why</th>
</tr>
</thead>
<tbody>
<tr>
<td>Popsicle Stick</td>
<td>Oil Tanker/Ship</td>
<td>The stick will float like a ship and can represent a longer vessel sitting in the water where the oil is leaking from.</td>
</tr>
</tbody>
</table>
Part 3: Running the First Simulation

Now that you have identified with the materials in your kit, you are now ready to run your first simulation. Follow the following steps in order to run the simulation.

1. Fill your large bucket almost all the way to the top with water. This is going to represent the ocean in which the spill will occur (only about an inch or two of space from the bottom will work so that you can see the simulation better).

2. In your small bowl, measure out 4 tablespoons of vegetable oil. In the same bowl add 4 drops of food coloring. Use a fork or other stirring material to which the components together (Note: two materials will NOT completely mix together)

What do you think that the oil and food coloring represent? Answer this question in the space below.

4. Carefully pour the dyed oil mixture into the center of the water.

5. Place the large craft stick in the middle of the water to represent the ship from which the oil came from.

6. Have the first oil remover grab one of the material to try and remove the oil closest to them before it reaches the side of the bucket. As the oil remover attempts to remove the material, the observer should be talking out what is happening and then recording along with the rest of the group on their first worksheet what is required.

7. Continue to repeat steps 5 and 6 until all of the materials have been used and the charts of all the groups members have been filled in for the before dispersant worksheet.

Part 4: Running the Dispersant Simulation

Once you are certain that all of the charts and data has been collected for the first simulation, empty out the simulation into the identified disposal place and refill you bucket with water. Once again place a popsicle stick in the water and make up your “oil” solution to place in the water. This time however have a member of your group add a few drops of dish detergent into the simulation. Before testing any of the materials again, be sure to wait a minute and observe the simulation, then answer the following questions:
a. What happened to the oil? Why
b. What happened to the food coloring? Why?
c. What color is the water? Why?
d. For each of the materials that you tested in the previous simulation, how effective do you think they will be in this test? Briefly discuss your hypothesis for each below.

Once all of the questions have been answered you and your group may then re-test all of the materials from the first simulation. Be sure to fill in all parts of the second worksheet and the observations that you make for each material.

Part 5: Wrapping Up the Experience

With the simulation complete you may now dump the contents of the bucket down the sink and clean up your work area. Make sure that all of the materials are gathered and neatly placed back into the appropriate areas. Upon cleaning up your work area you may return with your group to your seats and answer the following questions about the experience.

1. Did any method completely remove the oil?
2. What happened to the chemicals (dye)?
3. Do you think all toxins or chemicals behave the same way? Why or why not?
4. Based on your observations, how effective do you think the Gulf oil spill efforts (equipment types) have been?
5. Did any of your observations change the way you view the cleanup strategies being used in the Gulf?
6. Did any of your observations change the way you view the effects cleanup strategies may have on the water quality and wildlife of the Gulf?

Part 6: Follow-Up Home Investigation

Now that you have examined first hand the efforts and general methods used to fight oil spills, look up the use of Corexit 9500 during oil spills. This is a dispersant used during oil spills to help in a very similar way as the detergent did in our activity. Using sources from text or online, write brief response (couple of paragraphs) answering the following questions:
- What is the chemical make-up of this material? What is its purpose during an oil spill (try to be specific)
- How does Corexit work? Why is it useful during oil spills?
- What are some of the ingredients found within Corexit? Are any of these ingredients interesting in any way? Why?
- Are there any negative effects of Corexit on aquatic animal? Humans?
- Do you believe that Corexit should be used in the event of an oil spill? Why or why not? BE able to justify your answer in relation to the potential effects and drawbacks to the environment and organisms in it.
Oil Spills in Marine Environments

Read the background information below independently or in small groups.

Oil enters freshwater and marine ecosystems around the globe daily because of natural leaks and accidental oil spills. Oil leaks from oil transport pipes, boats, and oil wells. Some of the biggest and most publicized spills include the 1989 Exxon Valdez oil spill, the 1979 Ixtoc I spill, the 1991 Arabian Gulf spill, and the 2010 Deepwater Horizon spill. In 1989, the Exxon Valdez tanker ran aground and released 10.8 million gallons of crude oil into Prince William Sound, Alaska. The two-mile-deep well, Ixtoc I, blew out in June 1979 in the Bay of Campeche in Mexico. By the time the well was controlled in March 1980, an estimated 140 million gallons of oil had spilled into the bay. The most oil ever spilled in water occurred in 1991 during the Gulf War. Tankers and oil terminals in Kuwait were destroyed, releasing about 336 million gallons of oil into the Persian Gulf.

On April 20, 2010, an oil-drilling rig called the Deepwater Horizon exploded in the Gulf of Mexico, killing 11 people and causing a well deep below the surface to leak for 88 days—the world’s largest accidental release of oil into the ocean. The federal task force estimates that 4.9 million barrels of oil were released from the time of the accident until the leak was contained in mid-July 2010. British Petroleum (BP), the company responsible for the spill, used many different methods for oil cleanup, including booms, skimmers, absorbers, and dispersants. For this particular oil spill, BP used a dispersant called Corexit 9500. BP maintains that the dispersant is harmless; however, little is known about how it will affect the environment over time.

As of October 2010, government scientists estimated that BP had removed a quarter of the oil. They believed another quarter had evaporated or dissolved into scattered molecules. The third quarter was dissolved into smaller molecules by dispersants, and the last quarter remained in slicks or invaded the shorelines and estuaries of Louisiana, Mississippi, Alabama, and Florida.

Oil Spill Cleanup Vocabulary

<table>
<thead>
<tr>
<th>Words</th>
<th>Parts of Speech</th>
<th>Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>absorber</td>
<td>noun</td>
<td>material used to make up booms that help absorb oil while it is being contained</td>
</tr>
<tr>
<td>boom</td>
<td>noun</td>
<td>an oil-containment device that floats on the surface of the water and is used as a barrier to keep oil in or out of a specific location</td>
</tr>
<tr>
<td>dispersant</td>
<td>noun</td>
<td>chemicals sprayed on oil to cause it to break up and sink</td>
</tr>
<tr>
<td>skimmer</td>
<td>noun</td>
<td>a floating boom system that sweeps oil across the water surface, concentrating the oil</td>
</tr>
</tbody>
</table>
Observations Before the Use of Dispersant

Use the chart below to record your observations of the effectiveness of materials before the use of a dispersant. In column 1, list the type of material used. In column 2, identify its role in the simulation. In column 3, rate how well the material worked. In column 4, record the group's observations.

<table>
<thead>
<tr>
<th>Type of Material</th>
<th>Material's Role (boom/skimmer/absorber/dispersant)</th>
<th>Effectiveness Rating 1-5 (5 being most effective; all oil and chemicals removed)</th>
<th>Observations</th>
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</table>
Observations After the Use of Dispersant

Use the chart below to record your observations of the effectiveness of materials after the use of a dispersant. In column 1, list the type of material used. In column 2, identify its role in the simulation. In column 3, rate how well the material worked. In column 4, record the group’s observations.

<table>
<thead>
<tr>
<th>Type of Material</th>
<th>Material's Role (boom/skimmer/absorber/dispersant)</th>
<th>Effectiveness Rating 1-5 (5 being most effective; all oil and chemicals removed)</th>
<th>Observations</th>
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</table>
Oil Spill Simulation

Teacher Instructions

Pre-Activity Preparation

For this activity each group of students is going to need the following materials:

- Duct tape or other strong tape
- Paper towels
- Bendable straws
- Cardboard
- Cotton balls
- Craft (popsicle) sticks
- Dense foam wedge makeup sponges
- Pencils
- Large-mouth gallon buckets
- Name-brand dishwashing soap
- Red food coloring
- Tablespoons
- Vegetable oil
- Water
- Writing paper

These materials should be grouped together in different work areas ahead of time for ease of the students and clean-up after the activity is over.

Introduction

At the beginning of the class hand out all of the components of the student activity packet including the directions, reading, simulation data sheets, and post-activity questions to all of the students. Then read the introductory paragraph on the first page with the kids. Explain that they are going to investigate the principles behind oil spills, why they are dangerous, the different ways that they are cleaned or gathered, and how they can affect the natural environment.

Main Activity

The first component of the activity has the students independently read a brief article about oils spills and what efforts and strategies are used in order to maintain them from spreading when they do occur. Each student should read the article, making sure to pay close attentions to the terminology and methods that are used in these types of situations.
The second part of the activity is when the students will get into their groups (roughly 3-6 students depending on the class size and amount of materials and space available). Once in groups, the students should go to a particular station and gather all of the paperwork necessary for the simulation. After making sure all of the members have the correct papers, each group will go over the various roles and assign them for the first simulation. Be sure that the groups understand that they will all be switching roles throughout the various parts of the simulation so everyone will need to have a chance to perform each job. After assigning the roles, each group will open the kit of materials for their group and fill out the chart on the next page. For this chart the students will have to fill in each of the pieces within the kit, what they think it represents in terms of an oil spill simulation, and reasoning as to why they think that. As the students are working in their groups and answering these questions the teacher should go around the room assisting any groups who have questions and referring them back to the reading for answers when possible.

The third part of the activity is where each group will run the first simulation. This first test is created to represent an oil spill trying to be contained without the help of other chemicals. The directions are outlined in the student instructions and are self explanatory. Remind the kids that they should answer any questions that are asked within the directions, fill in their observations and results within the “Oil Spill before Dispersant” sheet, and having each member conduct their specific role for the simulation. The fourth part of the activity will have the students run in essence the same simulation; however they will add detergent to the oil mixture to represent a dispersant. The directions outline the modifications necessary for this second simulation. For this part of the activity the teacher should reinforce that the students switch roles within their groups, empty out the previous simulation contents within a disposal container, and make sure they answer the questions in the directions before they use any of the materials to simulate containment of the oil spill. After the students have collected all of the information and recorded it within the second chart, they should again dump all of the materials within the bucket and then neatly gather all of the materials from the activity and place them in the appropriate location.

Wrap-Up/Conclusion

Once a group as finished the simulation and cleaned up their work area, they can return to their seats to work on the questions within part 5. They may work in their groups to answer these questions based off of their knowledge and experience from the simulations. Before the class is over, talk about the sixth part of the activity with the class which will be assigned to them to complete at home. For this part, the students will research a particular dispersant that is used in many oil spills and answer some questions about the material.
Energy is a very broad and encompassing topic. Depending on whom you ask and in what context energy can mean a lot of different things. If you were to ask a physicist you would probably get a different definition than a chemist. Ask a biologist and you would probably get something different than an electrician. Depending on the perspective, energy can mean one of many different things. All of the answer they provide would be correct, it just dependent on your definition and context.

With so many definitions and applications for energy it is sometimes helpful to catalog and build an understanding of how a term is seen and used in different fields. In the chart below are some different fields in which the term energy is often applied. With a partner, think of a working definition of your own in which energy could be applied.

<table>
<thead>
<tr>
<th>FIELD</th>
<th>DEFINITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biology</td>
<td></td>
</tr>
<tr>
<td>Chemistry</td>
<td></td>
</tr>
<tr>
<td>Physics</td>
<td></td>
</tr>
<tr>
<td>Athletics</td>
<td></td>
</tr>
<tr>
<td>Electricity</td>
<td></td>
</tr>
<tr>
<td>Health/Medicine</td>
<td></td>
</tr>
</tbody>
</table>

After you have created your definitions for the various fields, get with another group to discuss what you came up with. In the space below provide any additional definitions or thoughts that the other group had which you did not include or had not thought of when you were creating your definitions.
We could talk for hours on end about all of the different types of energies and how they are similar and different, but for the sake of this project as a whole, we are going to examine energy sources used primarily in the electrical realms. This means the use of various materials to create power that will help light and heat our houses, move us in vehicles from one place to another, and perform other tasks that we do in our everyday lives.

Like many things in life, there is a branching out effect in terms of how something is created and then spread out to other parts of a system. Just as a tree starts with the trunk at its base, all of the materials it absorbs are passed up the tree then out to the branches, which then break off into smaller branches, then into the stems of flowers or leaves that are produced at the very end. Electricity that we make works in a very similar fashion if you think about it. Energy isn’t just created; it has to be converted from other sources into a useable form that then can be transported and used elsewhere. This grid, whether naturally or artificially created, is essential to the spread and use of energy in our lives and in living things.

Starting from the beginning, the sources from which we make the energy we use on a daily basis can be broken down into two main categories: renewable and non-renewable sources. In the space below with your partner, fill in the chart with both a definition for each energy source, as well as at least 3 examples of each.

<table>
<thead>
<tr>
<th>ENERGY SOURCE</th>
<th>DEFINITION</th>
<th>EXAMPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renewable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-renewable</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

After completing your definitions and examples with your partner, meet with another group to discuss your findings and thoughts. Write in the space below and information that the other group had that you did not include.
Once these energy sources have been converted into an energy form that can be used within other things, it is then spread out to other parts, just like in the tree example. This often creates some form of grid with multiple layers and destinations that will receive the final product in the end. Below is an example of a grid that I have created to show the transfer of resources within the tree system.

Below is an example of a grid that I have created to show the transfer of resources within the tree system.

The energy transfer and grid that we use in our lives can be much more complex than this and could include multiple different levels. In order to see this grid and spread of energy for ourselves, you and your partner will each be creating and energy grid similar to the one that I have created above to show the spread of energy and how it is developed and transferred. One of your group members will use a renewable resource (wind, water, solar) as the starting point of your grid, whereas the other person will use a non-renewable source (coal, oil, natural gas) as their starting point. From this base you will create a web that will showcase all of the various stops along the way as it is created or gathered in the very beginning, to your use in some conventional way (driving a car, charging a phone, etc.) Remember that just like a tree, branches can split and go in multiple different directions from one point, so try to include as many points and points in which energy is transferred or converted along the way. An example of branch that would likely have multiple other branches off of it is described below:

**Coal is extracted from the ground, shipped to a plant where it is packaged using the energy from the coal to heat the place, then transported by train which also uses the coal to move, to distributors who transfer it to stores where it is then used at homes for various things including cooking on the grill**

**This would be just one potential branch to go with. Your grid will contain many more sub-sections and branches in general**

Once you and your partner have both created your energy grids, you will critique each others work. Try to think of additional points or connections that could be included to enhance both of your grids. As you think of these modifications, make the changes and include more detail to enhance the energy grid. After you and your partner have both enhanced your grids, meet up with another group to show and explain your energy grids. Again, try to provide more sites and connections to the other groups’ grids as they explain and show of their work.
Pre-Activity Preparation

For the final part of this activity the students will be creating written grids of how energy travels throughout our daily lives. For these grids the students will need pieces of constructions paper or poster board to ensure that the diagrams they make don’t get bunched together and confusing.

Introduction

At the start of the class hand out the student activity packet and introduce the theme of the unit which is alternative energies. Briefly discuss the topics that will be discovered with the end goal of understanding and appreciating the different types of energies that can be harnessed. Have the students read through the introductory paragraphs on the first page and then fill in the chart that follows with their personal definitions of energy for each of the contexts identified. Students can work on this first part with a partner and once they have filled in all of their personal definitions they can combine with another group to share their thoughts and record any additional information that might have been revealed to them.

After going over the different definitions of energy in multiple contexts have the students read onto the next page where renewable and non-renewable energy sources are introduced. These paragraphs also introduce the theme of seeing energy movement in terms of grids. After reading the paragraphs the students can then fill in the next chart where they will provide a definition of both renewable and non-renewable energy and examples of each. Again, once a group has completed their own definitions and examples they can meet with another group, preferably different people than they met with the first time, in order to share their thoughts and ideas about each energy source. After this portion the teacher should discuss with the entire class what definitions that groups came up with. As this is a major theme throughout all of the activities in the unit it is important that this basic understanding is solidified and the terminology is precise.

Main Activity

After going over the definitions and examples of renewable and non-renewable energies continue to read the directions on the last page that reveal the main activity. For this part of the lesson the students will be making “energy grids” to track how the energy we use is moved throughout various parts of our daily lives. A very simple grid of the energy transfer in trees is provided and can be explained to the students as a primer for what they will create. As you
continue to read the directions along with the class a written example of a single branch that might be seen for a coal energy grid is provided in bold letters. It may be helpful to draw up on the board an example of what this branch would like, as well as additional points where more information could be included to give a better visual representation of the expectations for the grids that the students will be making. The students should plan out the different ways that the energy travels in their system before creating the actual grid representation to ensure that they have everything down and don’t make any mistakes when it comes time to actually draw out the grid. Also, be sure to emphasize that the students will have to make a visual grid for this project, not just a written description of the various ways in which energy is moved and transferred in the real world. After going through all of the directions ask the class if they have any questions and clarify any confusing elements. When everyone is all set they may begin creating their energy grids. As the students are working independently the teacher should go around the room and assist students who need help.

Conclusion

After each person in the partner set has finished their energy grids the two people should get back together to share their work. During this meeting the students will share his/her energy grid with the other explaining how the energy was created, transferred, used, and stored by various things. After the group member explains the grid, the other partner should make any suggestions or ideas that they have in which the energy source may have also been used in the grid. If there is space left on the paper the individual should make these modifications to enhance the grid. If no space is available, the student can write down these new branches of the grid on a separate sheet of paper to be handed in with the final product. The same process would then happen for the other group member so that he/she can also receive feedback on the grid that they made. At the end of the class the grids should be turned in to be looked over by the teacher.
**The Renewable Bean Game**

So far we have talked about energy sources and whether they are renewable or not. We defined two different types of energy sources, renewable and non-renewable. There are specific types of sources that belong to each category and potential drawback and benefits from the use of each. In order to get our minds in the energy use mood, answer the following questions below to the best of your ability.

1. What do you think we use more of in terms of sources of energy: renewable or non-renewable energy sources? Will this change over time? Why or why not?

2. Do we use the same amount of energy throughout the year? Throughout the day? Explain and justify your response.

3. Do we use more energy today than we did in the past? This may seem like an easy answer but consider all of the advances in science and technology to help conserve energy as well? Justify your response.

In order to get a better sense of how much energy we use today and throughout the year we are going to play a game called “Renew-A-Bean.” In essence, the beans are going to represent the amount of resources we have to make energy with and you are going to track their availability and use over time.

**PROCEDURE:**

1. Divide the class into groups of five. Each group will receive a bag with two different colors of beans in it. One will represent renewable sources of energy, while the other will represent non-renewable means of energy. In the games, students in each group will take turns drawing a given number of beans from the bag. When they pick a “nonrenewable” bean, they should set it aside—it is “used up.” When they pick a “renewable” bean, they should return it to the bag. Each drawing per round represents one decade.

2. In the first game, have students in each group take turns drawing 10 beans per decade out of the bag. Have them record the number of renewable and nonrenewable beans they drew on their student data sheet. Continue doing this and recording data until all the nonrenewable beans are “used up.”

3. Once your group has run out of non-renewable beans, answer the following questions:

   1. How long did it take you to “run out” of nonrenewable energy?
   2. When the nonrenewable energy ran out, was there enough energy to meet the next decade’s energy needs (10 beans)?
3. How could they make the energy supply last longer.

After answering the questions, graph energy use over time on the supplied graph paper.

In the next game, you will be given a different variation to simulate. These variations could include using more resources each decade, having more renewable resources at your disposal, or some other scenario. Once again follow the steps for the game and record and graph the data and results that you obtain. Be sure to answer the questions from step 3 as well.

6. At the end of the second game, come up to the front of the room and record your result (both the table and graph) so that they can be compared as a group against the other scenarios that were in place for the games.

After all of the groups have put their data up on the board and the class has finished the discussion about the various simulations, answer the following questions:

1. When did each group run out of energy?
2. How did this relate to how quickly they used energy?
3. Which groups ran out of energy first?
4. Looking at the graphs of the resource usage, during which decade did each group start using more renewables than non-renewables? How is this represented on the graph?
5. Which kind of energy will people probably use more of in the future?
6. Do you think energy use can keep increasing indefinitely. Why or why not?
7. What do you think the ratio of renewable to nonrenewable energy use in the United States is in the current year? How do you think the rate at which we use energy changes each year?
8. Is our current use of energy sustainable? What do we need to do to make it sustainable?
Renew-A-Bean

Take turns drawing beans from your group's bag at the rate assigned by your teacher. Each drawing represents one decade of energy use. If you draw a "nonrenewable" bean, set it aside (but do not throw it out). If you draw a "renewable" bean, return it to the bag after you have completed your drawing for the decade. Record how many renewable and nonrenewable beans you draw each decade on the chart below, then graph your results.

<table>
<thead>
<tr>
<th>DECADE</th>
<th>NUMBER OF BEANS DRAWN</th>
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<tbody>
<tr>
<td></td>
<td><strong>Round 1</strong></td>
</tr>
<tr>
<td></td>
<td>renewable</td>
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<td></td>
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<td>2</td>
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The Renewable Bean Game

Teacher Instructions

Pre-Activity Preparation

For this activity each group of five students is going to need the following materials:

- a paper bag containing 100 beans (or poker chips, or different colored pieces of paper): 94 of one color, six of another color
- extra beans of both colors: 10 of first color, 40 of second color
- five copies of the student handout
- extra graph paper

Introduction

To start the class, have the students think back to the previous activity in which they created the energy grids. Hand out the student activity packets and have them read through the first paragraph and answer the first three questions independently. After giving the students a few minutes to answer the questions go over them with the class, allowing multiple students to share their thoughts on what was asked. After going through the answers to the questions introduce the purpose of the day’s activity. Inform the class they will be performing a simulation with beans representing energy types to view what the future energy situation in the United States is like and how it could be changed.

Main Activity

Break the students in the class up into groups of five people. Have the groups sit next to one another so that they will be close while running the simulation. Go through the directions as a class. For the first simulation, students in a group will take turns picking ten beans out of the bag. For every non-renewable bean that they draw (color there is 94 of in the bag) they will leave the bean out. If they draw a renewable bean, then that bean can be replaced into the bag after that round. For each round the students will record on their worksheet the number of each bean type that they grabbed. This process will be done 22 times, or until all of the non-renewable beans have been taken out, for the first simulation before the students answer the questions in there packet and then graph their results for the first simulation. The graph should show the relationship of how many energy sources remained versus the increasing number decades that had passed.

After the students have made their graphs and answered the questions they will be getting a second scenario to conduct for the game. As the student groups come up assign them one of the following scenarios to complete for the second simulation:
Variation 1: Energy consumption increases by four percent per decade. Compute number of beans to draw each decade (round to the nearest whole number).

Variation 2: Energy consumption decreases by two percent per decade. Compute number of beans to draw each decade (round to the nearest whole number).

Variation 3: Energy consumption decreases by four percent per decade. Compute number of beans to draw (round to the nearest whole number).

Variation 4: Renewables increase by six percent per decade; energy use remains constant. Compute the number of renewables to add per decade (round to nearest whole number).

Variation 5: Renewables increase by 10 percent per decade; energy use remains constant. Compute the number of renewables to add per decade.

For each of the scenarios that you assign the students will have to calculate the number of beans that they will grab for each round. Like the first simulation they will record the number of each bean type that they grabbed in each round on their data chart until completing 22 rounds or running out of non-renewable beans. They will then graph their second simulation in the same way that they did for the first simulation. While the students are working on this second simulation the teacher should construct two different charts at the front of the room. The first chart will gather all of the data from every group for the first simulation. The chart should have two columns: the first column labeled number of round completed in the simulation, and the second column labeled number of energy beans remaining at the end. The second chart at the front of the room will be for the various simulations that each group ran for their second simulations. For this chart you will need three columns: the first column will be a description of what was changed for you simulation, the second column labeled the number of rounds that their simulation lasted, and the final column labeled number of energy beans remaining at the end. After a group has finished logging and graphing their second simulation they may come up to the front of the room in order to record their data for both of the simulations.

**Conclusion**

Once all of the groups have finished their simulations and recorded their findings on the charts at the front of the room, the teacher should lead a discussion about the results. The teacher should refer back to the groups to talk about the second simulations they ran and their thoughts about what they might simulate in the real world. After all of the scenarios have been examined the students may then finish the final questions and record their answers on the worksheet. Before the end of the class the students can then turn in their activity packet, data log sheets, and graphs to be examined and graded by the teacher.
True “Natural Gas”: Making Flammable Fumes from Plants

In this experiment you will create a gas that is a combustible fuel from a biomass source. While for this experiment we are going to use wood chips, any other organic material could also be used. This gas is produced by pyrolysis, or the heating of biomass in the absence of oxygen.

Before beginning the demonstration answer the following questions:

a. Do you think that different types of biomass would be more or less effective than others or are they all the same? If not all the same, what would be some characteristic of the wood from a biology perspective that would enhance the amount of energy provided?

b. What is a benefit of using pyrolysis to obtain the energy versus other heating methods? What does the lack of oxygen use in this method do in terms of creating the gas?

Now that you have answered these questions you are ready to prepare for the lab activity. For this demonstration you will need the following materials:

- Wood Chips (enough to fill a test tube per person)
- Medium to large test tube with stopper (and glass tubing spout)
- Balance
- Bunsen Burner
- Sparker
- Safety Glasses
- Splint

Once you have gathered all of the materials above, read through the directions before beginning the activity. Be sure that you record all of your measurements in the space at the end of the page and show all of your work for the calculations that you make.

Procedure

1. Determine the mass of your test tube (including stopper and glass tubing) using a balance. Record the number that you get for future calculations.
2. Stuff the test tube full of wood chips or whichever biomass source you are using. Leave just enough space at the top so that (a) you can put the rubber stopper on and (b) you can insert the glass tubing so that its end doesn’t touch the biomass.

3. Determine the mass of the filled tube using a balance. The mass of the wood will equal this number minus the mass of the test tube (with stopper and tubing). Write this number down.

4. Ask your teacher to check your setup so far. Then the teacher will show you how to light the Bunsen burner. Put on your safety glasses. Once the burner is lighted, clamp the tube with the test tube holder and put it over the flame. Be careful not to burn yourself.

5. After a while, invisible gas will be released from the end of the glass tubing. Light a splint and hold it about 2 cm away from the glass tubing end. Record how long this gas is released, as well as how long it burns (it may be difficult to keep the flame lit).

6. After no more gas is produced, turn off the burner and let the wood and tubing cool down. Then determine the mass of the remaining material in the test tube (mass of remaining wood = mass of partially filled test tube – mass of empty test tube).

**Measurements and Calculations**

After you have completed all of the demonstration and cleaned up your work area, head back to your desk and answer the following follow-up questions:

a. What conclusions can you draw from the demonstration that you just conducted?

b. How much wood was lost in the test tube during process? Where did this extra mass go?

c. How much gas was produced from your demonstration? Could you determine the amount in another way? If so, how?

d. What type of organic material do you think would be the best to use for this energy method? What would be some of the physical characteristics that the organic material would have?

e. Do you see this method as a reliable alternative energy source? Why or why not?
**True “Natural Gas”: Making Flammable Fuel from Plants**

**Teacher Instructions**

**Pre-Activity Preparation**

For the following activity each student is going to need the following materials:

- Wood Chips (enough to fill a test tube per person)
- Medium to large test tube with stopper (and glass tubing spout)
- Balance
- Bunsen Burner
- Sparker
- Safety Glasses
- Splint

Before beginning the lab it is important to have a safety discussion with your students regarding the proper handling and maintenance of fire in the lab. Going over the use of the Bunsen burner and general lab safety principles should be covered to ensure the safety of the students during the activity.

**Introduction**

At the beginning of the class ask the students to recall the principles needed for a fire to be created and maintained. Students should remember that the elements of oxygen, an ignition source, and some sort of fuel are necessary. After reviewing those basic principles, shift the focus of the conversation towards the fuel aspect of the equation. Write the three states of matter (solid, liquid, and gas) at the front of the room and have students talk with the person sitting next to them regarding different types of fuels that would fall under each category.

After students have talk and recorded their examples of the different fuel types in their group, call on different people in the classroom in order to gather examples of each type. Examples for each type of fuel in different states could include the following:

- **Solid-** Wood, Plant Material, Fabrics
- **Liquids-** Gasoline, Oil
- **Gases:** Natural Gas, Propane, Aerosols

After the students have revealed their examples, and the teacher has included some if necessary, once again narrow the conversation to focus on the gaseous forms of fuel for fires. Ask the class about the non-renewable gas sources (propane, natural gas) and whether these sources can be replenished once they are used. Students should recognize that these non-renewable resources can’t be restored; therefore other sources of fuel would have to be used at some point. At this point introduce the term pyrolysis to the students and briefly explain the
general principles behind it. Explain that the wood material in its solid form is capable of converting its flammable components into the gaseous form and that this gas can then be used as an energy source instead of completely eliminating the plant material.

Main Activity

Hand out the student activity sheets to the class and read through the introduction paragraph. Have the students answer the two questions that follow before continuing on to the directions of the activity. After answering the questions, review the materials that each student will need to grab and allow them to get the materials and take them to a workstation within the room/lab area. Once all of the students have gathered the necessary materials for the activity they may begin to follow the procedure in order to complete the activity. As the students are working the teacher should go from person to person and make sure that they are staying on task and properly assembling the test tube apparatus. Before the students are allowed to heat the test tubes they have made they must get teacher approval to light their Bunsen Burners. After the students have completed their pyrolysis demonstration they can turn off the gas to the Bunsen burner and clean up their work area. Once the work area is cleaned and all of the materials have been put back to the appropriate location the students may go back to their desks to start working on the measurements and post-activity questions.

Conclusion

If there is time remaining in the class, the teacher can go over the questions with the class. The teacher can have students raise their hands to give their responses and input regarding the various questions they should have answered. Before the students leave the teacher can collect the activity sheets from the kids and check them for a completion/participation grade.
What’s in Your Gas: Ethanol as an Alternative Fuel

There once was a time in which all of our gasoline that we use for our cars and other motorized vehicles game from crude, non-renewable sources. Gasoline was just that and there weren’t any real changes to the formula. That was until we started to run out and the prices began to get higher and higher. The need for more fuel that could work in these machines increased and is still a major concern to this day. However for the time being, gasoline has now received a modification in order to save on the supply, while also decrease the cost at least for a while.

When you go to practically all gas stations nowadays, you will see a sticker on the pump that says that the fuel contains some percentage of ethanol. This compound works fairly efficiently within motors and has several benefits to the consumer, and our reservoir of non-renewable resources available. As ethanol can be produced from plant material, it can be produced somewhat easily, but more importantly is that the energy sources can be replenished. While it is not the perfect substitute, it does a great job and works as a combatable partner with the gasoline that we use daily.

In this experiment you are going to create ethanol using household items. While commercially the use of other plant materials tends to be used, such as corn or other plant material, the basic principles require only that some form of sugar be converted into alcohol by yeast. Through this experiment you will see how relatively easy and somewhat cheap this process is and then be able to ignite your final product to confirm that it could in fact be used for combustion within the engine of a motor.

Necessary Equipment
A single set-up requires the following items.

1. Sugar-A sample of about 10 g works for a single experiment.
2. Water, about 100 mL per experiment.
3. Yeast, about 0.5 g per experiment.
4. A beaker or jar, 250 mL or 500 mL beakers work.
5. Filter papers for a coffee maker.
6. Permanent black marking pens.

Procedure Day 1

1. Measure the sugar samples and dissolve in water. It isn’t wise to put so much sugar in a sample that some rests on the bottom. Other than that, just about any amount of sugar will work for a sample.
2. Add yeast. Usually, 1/10th the mass of yeast is desired, when compared to the amount of sugar.

3. Stir the mixture thoroughly.

4. Leave all the mixtures for at least one night.

At this point our work for the day is done. Our mixture is now going to go through the process in order to make the alcohol from the sugar. The science behind this can be rather complex, but in the most simplistic of conversions, the following is the chemical reaction that is occurring:

\[
C_6H_{12}O_6 \rightarrow C_2H_5OH + CO_2
\]

(sugar) + (yeast) \rightarrow (ethanol) (carbon dioxide gas)

In order to develop a better understanding of the process and its implication however, research the topic of ethanol production and its use in motor vehicles over night. As you are researching, answer the following questions so that you have a greater understanding of the principles behind ethanol production for your next class:

1. What types of plant products are being used to make the ethanol included in gasoline?

2. What are some concerns and considerations when using ethanol containing fuel in motor vehicles? Are any parts or types of materials affected more by it over time?

3. What effects from an economic point of view may the production of fuel may there be on other aspects of life for humans?

**Procedure Day 2**

Now that our sample has been reacting for quite some time, we are now ready to extract our ethanol from the rest of the solution.

5. Note and record any visible changes to the sample mixtures.

**Observations:**

7. Using two pieces of filter paper and some permanent black marker, draw a black line approximately 1” from the bottom of the each piece of paper, without touching the sides of the paper.

8. Pour an aliquot of the ethanol solution into a beaker or other container. This should be enough of the fermented mixture to cover the bottom of the beaker to a depth of 1 – 3 mm.
9. Pour the same amount of water into a different container of equal size. This is the comparison, and thus uses just water.

10. Stand either of the papers with the marker line into the container with your ethanol solution, and the other into the container that holds water. Be absolutely sure that neither black, permanent marker line starts out wet.

11. Observe what occurs as the liquids absorb into the papers and creep upward. The paper immersed in water should have not move or smudge the permanent marker. The paper immersed in the fermented alcohol solution should make the black, permanent marker line move. Make drawings of your results and what you see.

Answer the following question: What does the results of this test mean? Why did the ethanol solution affect the marker line as the liquid went up the paper?

Finally we will attempt to light ignite the paper sample that we have used.

12. Carefully remove the paper sample and place it onto a safe counter-space within the classroom/lab.

13. Using a match, attempt to light one end of the paper. Record your results and time how long the product burn for and what happens.

*Did product catch fire?*_____________________  *How long?*_____________________
After performing these steps, answer the following question:

1. What does the ignition test prove?

2. What are some potential issues with the product that we made and its effectiveness? How could we modify the experiment in order to make a more pure product?

3. Would it be possible to make an “all ethanol” based engine for vehicles? Explain your reasoning.

4. The ethanol solution that you and your group made is likely very weak and full of impurities. If you wanted to make your ethanol sample more potent and pure, how could you do that?
What’s in Your Gas: Ethanol as an Alternative Fuel

Teacher Instructions

Pre-Activity Preparation

For this lab each group of students is going to need the following materials:

1. Sugar-A sample of about 10 g works for a single experiment.
2. Water, about 100 mL per experiment.
3. Yeast, about 0.5 g per experiment.
4. A beaker or jar, 250 mL or 500 mL beakers work.
5. Filter papers for a coffee maker.
6. Permanent black marking pens.

As the students will be making ethanol, a form of alcohol, in this activity it is important that students are careful and following all directions. No students should try to consume the material that they make as it is unhealthy and could have serious health side effects if consumed. Teachers should keep a watchful eye out over all of the groups, especially on the second day when the ethanol will be tested, to ensure that the students are following directions and not misusing the ethanol that they have created. One additional consideration for this lab is a review of fire safety for the second day of the activity. All of the students will test the ethanol solution that they made by igniting the filter sample that they tested. Students should be reminded to follow proper lab safety instructions for this part of the lab to ensure the safety of self and others in the room.

Introduction

At the beginning of the class have everyone brainstorm a list of all their prior knowledge about gasoline. Give the students a few minutes to record their thoughts at which point you can arrange materials for the lab in the room. After a few minutes, have students share their current knowledge of gasoline. As students are giving their responses, the teacher should record information given by the students that has to do with the following categories: non-renewable energies, oil, combustion, or anything having to do with ethanol. After the students have provided their prior knowledge, shift the conversation to ethanol in particular if stated by a student (or introduce that train of thought if the students did not mention that in their prior knowledge recall). For this ethanol discussion the teacher should have students elaborate on their understanding of what ethanol is and how it is made. Students may or may not have a good background understanding of what ethanol is or how it is made, so to introduce some topics regarding ethanol to the whole class show this video after you have had a brief introductory conversation about what ethanol is:
After watching the video you may ask the students questions about what was explained and revealed regarding ethanol in the video. Some questions you could ask are:

- What does it mean if the ethanol is “organic?”
- What are the components necessary for the production of ethanol?
- What is denatured ethanol and why is it denatured?
- How are the principles of ethanol production applied in the food and beverage industry?

After going over the questions as a class the teacher can introduce the activity that they will be doing for the next two class period. Explain that they will be making ethanol using very simple ingredients and then testing the material that they make.

**Main Activity**

Hand out the student packets to the class and read through the first 3 paragraphs together. This section reviews the basic principles and reasons behind ethanol use, as well as introduce the activity that they will be doing. Allow the students to form small groups, 2-3 students per group, and then have them move to a work area within the classroom/lab. Once at their location the students should read through the materials that they will need to gather and read through the first day directions. Once the students have measured out the materials they need and have set up their workstation they may begin the Day 1 component of the lab. This section does not take very long to do as they are simply mixing the ingredients together. As students are working the teacher should walk from group to group ensuring that they are following the directions and staying on task. Once completed, the students should mark their beaker of solution with their group names and class period and set them in a location that will not be tampered with in the classroom. After doing so, if there is any time remaining in the period, the students may start to research the questions that they have to answer before the second day of the activity.

**Day 2 Directions**

At the start of the second day start the class by reviewing the answers that students gathered from their research of ethanol. Students should include any additional information they may have missed that other students revealed during the discussion. After going over their answers, allow students to get back into their groups and gather their ethanol mixture that they prepared the previous class. Have students read through the directions for the second day before they are allowed to begin. Before starting, be sure to talk about the safety concerns for this activity including the ethanol itself and the ignition of it at the end of the class. After reviewing these safety parameters the students may begin the second day’s procedure.
this part of the activity each group will extract a sample of their ethanol into a small container in order to run a basic chromatography experiment. Students will use filter paper and a marker as the test material they will have both their ethanol solution and water (control) travel up to see how the solution varies to water. After testing the filter paper, the students can then ignite their paper with a flame and record the duration of the fire. As students are working the teacher should travel from group to group to ensure that they are performing the tests correctly, answering and recording their observations as they go, and staying on task. After each group has finished the ignition test, they may clean up their work area before heading back to their seats. The teacher should have a disposal area in place where the students can dump all of the tested and remaining ethanol material so that the teacher may properly dispose of the alcohol.

**Conclusion**

After each group has cleaned their area they may return to their seats to finish the final follow-up questions at the end of the packet. Once completed the students may turn in their completed packets to the teacher to be graded or reviewed. Before leaving the class the teacher should ask all of the students to take out a separate sheet of paper and to respond to the following question:

“Do you think that ethanol is a good alternative to the use of just gasoline? Consider the environmental, economical, and societal implications that the use of this alternative energy has for people around the world.”

The teacher should give the students some time to consider the question and record their thoughts. The teacher can then have students share their thoughts if they would like in order to discuss the multiple perspectives and views of the alternative energies conversation.
Another renewable resource that we are starting to see being used more and more is the use of hydropower, or the use of naturally running water to perform tasks. While today the use of hydropower has been diversified to several different means, back in the day the power of water was used for more specific tasks. Gristmills for example relied on water to move giant stone to help break down corn and other grains into a finer material for various food uses. Hydraulic systems in machinery were invented and still used today to help various parts of automobiles and other machines move. Even dams holding back water have been created to allow water to run through them and create electrical power for everyday use around the country. With a vast majority of our planet being covered by water, there is great opportunity for energy conversion to occur from this highly renewable resource.

One of the simplest and most effective ways that water has been used for energy and other functions however comes from the creation of a hydraulic turbine. In the simplest terms, they take some form of axel, like that of a wheel, and then place various points along the spoke. These places will be bombarded by the water and force the spokes to move in a circular motion around the axel. Below is a picture of a large paddle boat which displays a similar model to the type of mechanism used for the hydro-power machines:

With these boats the paddles are driven by an engine because they are attempting to push the water behind the boat, thereby making it move forward. If the water were to be pushing down
on the blades however, the process in essence could be reversed, allowing energy to be converted towards another source instead of being used.

In order to investigate the mechanics and principles behind these hydro-turbines, you are each going to create and test some simple water turbines of your own. Using the basic design principles of the paddles seen in the paddleboat, you are going to research and answer questions regarding what makes a water wheel more effective. You will be allowed to use any of the materials in the classroom to construct your water wheel and will test it by running the wheel under the faucet in one of the lab sinks. To test the effectiveness of your wheel you will color one of the spokes a different color than the rest and then measure how many rotations that one spoke makes over a period of time. After creating your first water wheel and analyzing how effective it was, you will then make a second one in your group that you have somehow modified based off the previous run and your observations to increase it’s efficiency.

Before going into the actual experiment and test into more detail, answer the following questions within your group. These questions will help center your thinking and guide you towards answering pertinent questions that should be answered from your tests:

1. What is efficiency? How can it be measured in terms of the water wheel?

2. What is more important with regards to these turbines: fast start-up time, consistent movement around by the wheel, or overall rotation speed? Justify your answers.

3. Is the phrase “bigger is better” or “bigger is stronger” appropriate in terms of a turbines ability to generate and maintain power? Explain your reasoning.

For this activity you will be creating your own lab report to go along with the investigation that you are going to run. Your report will include all of the following components:

- Purpose
- Hypothesis
- Procedure
- Wheel Planning
- Data Collection
- Results Analysis
- Conclusion

A description of the expectations and requirements for each of the sections is listed below:
Purpose: In this section you will identify the research question in general. You will discuss the various parts of the water wheel, based on picture from previous page or your own knowledge, and how the contribute to the movement.

Hypothesis: This is where you will make your prediction about what characteristics of the various parts are going to be the most important to the function of the wheel. For each part you will also describe how you plan on shaping and arranging the components. (Feel free to include sketches of your thoughts along with the writing as well).

Procedure: Here you will outline the creation and planning behind the creation of your water wheel. In essence this procedure will be broken down into two parts:

1. Creation of the water turbine: Talk about who will have what responsibilities in the group, how things will be arranged and organized, and the general plan of action for the build.

2. Carrying out the tests: Here you will create a numbered list identifying all the steps that will be taken and all the observations and measurements being recorded for your actual test. This part will include the instructions for both tests.

Wheel Planning: This part of the activity has already been started with your very beginning sketch of what you thought a water wheel should look like and what design would be optimum for performance. However, your planning has to be more detailed than that, just an architect or designer has very specific plans. Before you construct your water turbine you are going to need precise plans for the build. These plans should include the items that will be using to build the wheel, the measurements for these items, and also at least two pictures (side and front views) of what the product will look like when completed.

***THESE STEPS MUST BE COMPLETED AND CHECKED BEFORE BUILDING YOUR WATER TURBINE***

Data Collection: In this section you will discuss what parameters it is that your group plans to observe and collect from the tests. Alongside the description, you will also include some form of table or chart that collects in an organized manner all of the data that you gathered. Your group will also be responsible for including the data from your second test as well.

Results Analysis: In this section you will analyze each of your two tests that you ran. For the first test, discuss the results you obtained, any observation you noticed in terms of the functioning of the wheel, and what modifications you plan to make to the wheel and the purpose for making them. After the second test you will again discuss the results that you obtained and briefly compare them to results gathered from the first test.
**Conclusion:** In this final section you will break down the experiment and what you gathered from it. Discuss your findings from a structural and efficiency point of view. Relate back to your hypothesis and whether you were correct in your initial statement. Discuss how this experiment could be modified to better assess and evaluate the water turbines that you created.

In the end your write-up will be printed, or neatly hand written, and turned in. Each person in the group is responsible for their own copy of the lab and write-up. Any questions can be directed to the teacher who will help when appropriate.
REINVENTING THE “WATER” WHEEL

Teacher Instructions

Pre-Activity Preparation

For this activity the students are going to be creating their own water wheel turbines. While they won’t be generating power, the purpose of this activity is for them to be active in the experimental design in order to try and solve a question: what characteristics of a water wheel will make it move faster? The answers to this question could then be applied to the creation of power through a real-life turbine. In order to make these wheels however the students will need excess to materials for the constructions of their devices. In reality any materials could work and could allow the students to be innovative in their approaches. Some relatively cheap items that would work well include:

- Popsicle Sticks
- Plastic Bottles
- Pencils
- Rulers
- Wooden/Glass Dowels

As this activity will take a couple of days the students could bring in their own materials from home as well in order to build their devices. However, the students shouldn’t be required to go out to buy lots of materials for this experiment.

Introduction

At the beginning of the class ask all of the students to brainstorm anything that they know about hydropower. Give the kids a few minutes to think and brainstorm a list with the person sitting next to them. After allowing time for conversation, collect the input from the student groups and record relevant information on the board. After collecting this information focus on any responses dealing with power and how it is generated. Focus the conversation by asking questions about the wheel or turbine and how it is used for hydropower and what it looks. The teacher can have students draw examples of what they think a water turbine would look like individually, then share their examples with the person sitting next to them; explaining the details and reasoning behind why various parts are as long/wide/etc. as they are. These initial “blueprints” will be the connection between the introduction and the experiment that they will be conducting. At this point the teacher can then introduce the purpose of the activity which is carrying out an experiment to test the effectiveness of a water wheel that they constructed.
**Main Activity**

Hand out the student activity packet and read through the first page together as a class. This information serves as background about the basics of hydropower and the principles behind water wheels in other systems. Continue on to the second page and the directions for the activity begin. Have students break into small groups (3-4 students) and sit in their groups within the room. Read the first two paragraphs on this second page and then allow the students to answer the three questions before continuing with the directions. The first paragraph outlines the whole process for the students where the students will create a first water wheel, test it, and then create a second wheel to test based off of the modifications they felt necessary from the first test. After giving the students a few minutes to think over and answer the three questions within their group, continue to read through the directions. The student sheets goes over all of the directions in detail, including what parts have to be done before the construction of the water wheel itself can begin. The teacher should go through each section in detail with students to ensure that they know the expectations and requirements. It is important to emphasize that all of the sections of the write-up excluding the purpose, hypothesis, and conclusion will have to be written once for each of the tests that the groups run. After going through all the directions and clarifying any questions the groups may begin to work on the first parts of the experiment. As the groups are working the teacher should meet with all of the groups to check their progress and direct them if needed. The first parts of the activity, including the planning and building the wheel, will likely take the rest of the first day and into the second day to complete.

Once a group has finished all of the beginning parts of the experiment they should be checked over by the teacher. If they meet the criteria, the students may start to build their water wheels on the second day. These devices are going to be relatively simple; therefore a lot of time isn’t necessary for the building component. The remainder of the second day should provide each group plenty of time to complete their builds. If the students need additional time, they can complete their wheels for homework before the next class period.

When a group has completed their first model the teacher should inspect it before permitting the group to test it. The teacher should make sure that each model has one spoke that is a different color that will act as the rotation point for measurement. Once approval is granted the students can take their wheel to one of the lab sinks to run the test. The amount of water used to test the wheel should not be strong. A slow continuous stream of water from the faucet will be plenty for the test. While testing one person in the group should record the time, one person should keep track of the number of rotations, and the remaining members will make observations of the wheel for the modifications that they will make. Once the group has finished their testing, they should record their data and write down their initial results before
making the modifications for their second test. The same procedure will occur for the second test using the modified wheel that the group created. Once the group has finished both of their tests they will clean up the work and test area before returning to their desks to work on the final data collection, analysis, and conclusion section.

**Conclusion**

Once a group has completed their testing and clean-up they should proceed to finishing the lab write-up. Each member of the group is responsible for their own write-up; however they may work together on it as a group. The final product should be typed and turned in with the blueprints of the water wheels that they created.
A “BLOWN” OPPORTUNITY: Investigating Wind as Renewable Energy

Even more readily available in some parts of the United States as solar energy is the presence and opportunity to make energy from another natural source: wind. I’m sure you can recall a time in which the wind has been so strong that trees sway violently, or perhaps even stopping your movement. From a physics standpoint that would take a lot of energy to make those massive trees move or to stop the inertia of a running human being. Now if we could harness that power across the country or the globe, imagine all of the free energy that could be produced and stored.

Today there are multiple efforts by energy groups and other individuals to push for more wind energy sources. With non-renewable sources continuing to deplete, the answer for future energy make come from the very skies above our heads. While some efforts have been taken to push more wind energy facilities, we still are seeing only a small amount of them across the country and even fewer in areas where winds tend to travel even faster such as along the coasts and oceans. Sometimes all it takes is the voice of an educated public to ignite the movement for change, so becoming more informed and knowledgeable about these issues can be very beneficial towards future actions.

To mimic not only the search for more information about wind energy, but also expressing those concerns and issues to those with more power to make the change we are going to learn about wind power and then create a letter to a local government official voicing our opinions, the facts about the science, and propose actions to be carried out to enhance the abundance of this free energy source. While the letter you create doesn’t necessarily have to be sent out, should you feel compelled to do so this letter could be sent to a local official, potentially allowing you to be the start of the change.

Part 1: Gathering More Details

The most important part about writing a letter to a government official asking for something to change is background information and facts to go with your point of view. With evidence to support your claim, it is easier to express a point of view and convince others to believe in your cause. In order to do this for this project, I have found a newscast in which the discussion centers on wind power and all of the complexities it contains. The program discusses wind power currently, the structures and science behind it, as well as some future implications and statistics of what we can expect with continued growth. This video provides lots of information that will be beneficial towards writing your letter.
While watching the video you will be required to take notes on all of the issues and topics regarding wind power that are discussed. Remember to focus on the important facts and information that you feel would be most important to share with the government in order to push for more wind energy sources. These notes will be the backbone of your letter so be sure to pay close detail and attention to the figures and details that is discussed.

**Part 2: Writing Your Letter**

With the collection of data and information that you have obtained from the video, you will now be prepared to write a well designed and organized letter to a local official regarding your thoughts and facts about wind power. Your letter should be arranged and composed like a typical letter including a proper heading, introduction, multiple body paragraphs, and then an ending with signature. In terms of the body paragraphs you should include one for each of the following:

- Current state of wind power and energy in our state, and the nation as a whole
- Discussion of wind turbines and the grids that they develop
- Any recent or future plans that have been discussed to enhance the efficiency and storage of the electricity gathered

Remember that when possible to include any statistics or data that you gathered from the video to help support the claims that you have made. In addition, be sure to proofread your letter for punctuation, spelling, and grammatical errors. Although you won’t necessarily be sending this letter out, it is good practice to utilize proper writing mechanics for the future.
A “BLOWN” OPPORTUNITY: EXPRESSING A CONCERN FOR MORE WIND ENERGY

Teacher Instructions

Pre-Activity Preparation

For the first part of this activity the students will be watching a video about wind power and how it is being harnessed with wind turbines and other technologies. The teacher should have a SMARTBoard or some other way of showing this video from the website below:

http://www.youtube.com/watch?v=iTyMImpNWyY

This activity will take two days to complete. The introduction and video will be shown on the first day, while the letter that the students will write can be done on the second day. A modification to the activity could be assigning the letter to be completed as a project instead of done in the classroom.

Introduction

At the beginning of the class ask the students if they have ever seen the wind turbines that are starting to pop up around upstate New York, or anywhere else. Some close examples include the wind turbine on 104 in Ontario or the wind farms seen in the hills of Naples. If any of the students have seen a wind turbine, have them describe them to the class. If not student has, the teacher may have to describe them or even draw a picture to help give the students a visual of just how big they are. After describing these windmills, have the students relate back to the “Water Wheel” lab that they conducted and what the purpose of the activity was. Students should recall that it was to determine what wheel size and formation worked best in order to move the wheel using water. Make the connection of these water wheels to turbines and ask the class if they remember what the turbine does in terms of power. Students should recall that the turbines convert the natural power of the water into electricity that can be used for other things. At this point, drawing models on the board if necessary describe how the wind turbines share a similar shape and function to the water wheel in order to produce power. Once this connection is made, introduce the theme of the lesson and the activity that the students will be carrying out. The class will be watching a video about wind turbines and taking notes in order to gather information that could be presented to a government official in the form of a letter. The teacher can then hand out the student activity sheet.

Main Activity

Once the teacher has handed out the activity sheet go over all of the background information and directions provided. Students should understand that they will be watching an educational video about wind power and turbines. During the video the students will take notes about the current status of wind energy in our state and across the nation, what wind turbines are and
how they work in grids, and any recent and future plans for wind turbine use and energy storage. After watching the video, the students will take their notes and create a letter that could be sent to a local government official informing him/her about the issue. Once the teacher has gone over all of the directions and answered any questions, the teacher can play the video for the class. As the kids are watching the video the teacher should make sure the students are watching and taking notes throughout. At the end of the movie, the teacher should review the expectations for the letter that the students will be writing.

**Conclusion**

To wrap-up the activity the students are required to write a letter that could be sent to a government official expressing the knowledge they have gained and their interest in wind energy. While this will not be sent out by the teacher, if the student wished to on their own they may do so. The science teacher, potentially in collaboration with the English department, may want to present to the students the proper mechanics and formats necessary for writing a letter in order to make a greater cross-content connection. When completed the letters should be collected by the teacher to be reviewed and graded.
Trip to Ginna Nuclear Power Plant

One of the fastest growing power sources around the globe is that of nuclear energy. Capable of producing great quantities of energy, nuclear power requires very little of our natural resources in order to make massive amounts of electricity. There is a downside however, in that should something catastrophic happen to the system creating and harnessing the power, great danger and destruction could be a result. There have been cases of nuclear accidents, such as the 6 Mile Island nuclear reactor malfunction in the United States and the catastrophic Chernobyl incident in which serious harm was either merely avoided, or the effects are still affecting the area to date. Overall however, these systems are highly safe with lots of monitoring and protection to prevent from these rare disasters.

In order to see first hand the science and engineering behind the use of nuclear power, we are going to take a trip to a local nuclear power plant right on Lake Ontario. You will be able to take a tour of the facility, speak with true scientists who work with the science every day, and also take part in a simulation with the full-scale practice control room that they have on sight. After all of the experiences you will then write a reflective journal entry about the experience.

IMPORTANT REMINDERS

This is still a functional facility and is a workplace of the employees for the company. Be sure to be on your best behavior and follow the following directions:

- Do not touch anything unless instructed to by the staff of the facility
- If you have a question, raise your hand and ask in a polite and orderly manner
- Be quiet and orderly when moving from location to location
- Use of photography only when permitted by the staff of the facility
- Any violations of these rules or any other unacceptable behavior will result in being escorted out and the assigning of a research paper on the topic

For your journal entry, your submission must be hand-written in the form of a personal journal entry. Within you entry you will talk about the following:

- Facts about the site itself (how big it is, measurements, importance of location)
- What you learned about the science of nuclear energy (how does it happen, what precautions are taken, how do they monitor everything)
- Write about the simulation experience (what happened, describe the control room.
- Finally, sum up the experience as a whole (did you enjoy it, what did you learn, are there any questions that you still have.
Trip to Ginna Nuclear Power Plant

Teacher Instructions

Pre-Activity Preparation

For this activity you and your students will be traveling to RG&E’s Ginna nuclear power plant on the shores of Lake Ontario. This site is a fully functioning and contains a nuclear reactor that provides lots of energy for the surrounding area. This location does provide tours to groups in order to instruct the population about the facility; however these events must be set up in advance. It is important for the teacher to contact the facility a few months ahead of time in order to get approval for a given date. The teacher should also try to converse with whoever will be giving the tour to inform them of the objectives for the visit and the content that the teacher hopes to cover during the visit. In addition to approval from the site itself, it is important that the teacher also gets approval from the school and parents of the students alike. From the school side it is important that the teacher fill out all the necessary paperwork required including requests for transportation to and from the location. From the parent and students perspective it will be necessary to get permission slips from all of the students to go on the field trip. In addition, this trip will take a few hours to complete, so the students should be prepared with a bag lunch that they can bring with them to the location. It will be important to remind the students ahead of time, including the day before the event, of what the student need to turn in and bring to the trip.

Introduction

On the day of the trip the students should meet in the classroom first. Before the students head to the bus the teacher should go over all of the safety and behavior expectations while on the trip. It is important that the students understand that the place they are going is a fully functioning facility still and it is a privilege to visit. The teacher should emphasize all of the behavior directions as identified on the student worksheet before leaving. In addition, the teacher should briefly mention the journal entry assignment that each student will have to complete upon returning from the trip; therefore the students should be writing down information that they learn and would be helpful for them to finish the assignment. After going over all the criteria, the students should grab their lunch, a notebook, and writing utensil and then head to the buses for the trip to the site.

Main Activity

When the bus arrives to Ginna the students should stay on the bus until the teacher gets instructions as to where to go. Once the students are informed of where to go they should move quietly and in straight lines. While walking around the facility the students should remain
in these straight lines unless instructed otherwise. As the group goes through the facility they should remain quiet and refrain from the use of any electronics (cell phones, cameras, etc.) If any students fail to follow these directions they should be written a disciplinary referral upon returning to the school and required to walk with the teacher quietly for the remainder of the tour. The students can take notes at certain points along the tour when identified by the teacher or the tour guide. After the tour the students will have lunch at the facility. While eating lunch the students should remain in the eating pavilion area. The students can talk with their friends; however they should remained seated during this time. The teacher should bring garbage bags with them on the bus to gather all of the garbage that the students have from their lunches to be brought back to the school to be disposed of. Once the tour is completed the students will get back onto the bus and return back to the school.

**Conclusion**

When the students return to the school the class should meet back in the classroom for a debriefing conversation. The teacher can have students break into small groups to talk about what they learned from the trip, what they thought was the most interesting part, and any questions that they may still have about the science or the site itself. This will allow the students to learn from one another and their unique perspectives. After each group member has had a chance to speak, the teacher should bring the class back together and have each group share one of each of the discussion categories that the students were supposed to talk about. If the teacher can answer any of the questions that the students ask then they should be answered in class so that all of the other students can also be informed of the answers. In this conversation the teacher should discuss the journal activity in greater detail and the expectations for the assignment as provided in the student worksheet. The journal entry should be turned in by the students at a date given by the teacher.
The use of the sun in order to cook and treat food has been utilized for thousands of years all across the globe. Utilizing the radiation from the sun is a cheap and efficient way of creating lots of heat in a small area. To harness this energy the creation of a solar cooker is required that will trap the solar radiation in an area and thereby increase the temperature inside the unit. Before beginning the construction of your solar cooker, examine the words below with the person sitting next to you and describe how each is incorporate and important to the function of solar cooking:

STORAGE:

REFLECTION:

INSULATION:

ABSORPTION:

With a better understanding of the scientific principles behind solar cooking, you and a partner will now construct a solar cooker that will be used later to cook a lunch in a later class. Within this packet you will find the directions to build a functioning solar cooker using fairly simple materials. Using the materials provided and the instructions you will make this solar cooker on the first day. After building your solar cookers you will then answer the following questions about the process, science, and other issues related to cooking with solar energy:

1. How do solar cookers work? Be sure to include specific details about what characteristics from the sun are providing the energy, how much energy the sun can provide in comparison to other sources (both long and short term), as well as other uses and applications of solar energy?

2. What are some of the limitations of the solar cooker that you and your group have created? What modifications/materials if they were available could help enhance the effectiveness of your cooker? Explain why.

3. Other than the model that we have created, there are other types of solar cookers that have been created that also work in terms of warming and heating food. In the space below, draw a sketch of a solar cooker that you think might be effective. Think of the properties that allow this model to work and the adaptations that might increase the effectiveness. After you have drawn your diagram include a paragraph that discusses your model and what the function of various parts in terms of the solar cooker and how it would work.
1. Glue foil on the cardboard. Dilute the water-based glue in a bowl so that it will last a long time and you can brush-apply it. Glue foil completely over: (a) the inside and outside of the smaller box (cut off the flaps), (b) the inside of the larger box, (c) the inside and outside of the larger box’s flaps, and (d) one side of the flat cardboard piece.

2. Add bottom supports and insulation. Cut out 4 cm squares from the discarded smaller box flaps. Glue them on top of each other to form eight pillars 2-3 cm high. Glue these pillars inside the bottom of the bigger box to support the inner box. Tear up newspaper sheets in fourths and crumple each piece into a lemon-sized ball. Cover the bottom of the bigger box with these balls.
How to Build a Solar Box Cooker

3. Add inner box and side insulation. Place smaller box inside the larger box. Stuff more newspaper balls between sides of boxes.

4. Cut the flaps of the outer box so that they fit in the inner box. Cut them so that they can be folded over, covering the top space between the boxes as well as the inner wall of the inner box (see diagram). Fold the flaps over and glue them.

5. Put the black tray in the box. Paint it black if it isn’t already. Use nontoxic paint.

6. Make the lid. Take the flat cardboard piece and cut it, foil facing down, on top of the box. Fold down what sticks over the edges of the large box. You need to make four cuts in the cardboard to do this. Then, glue the folded edges of the lid together (not to the box). Make sure the lid fits snugly on the box.

7. Glue the glass to the lid. Cut 3 sides of a rectangle in the lid. This rectangle should be slightly smaller than the glass. Turn the lid over and glue the glass around its edges, to the inside of the lid. Press it flat until the glue dries. If you use plastic wrap, stretch it out around the rectangular opening and tape it around the sides.

8. Make a prop. Bend up the cut-out rectangle in the lid so that it can reflect sunlight into the cooker. Attach a stick with string to the corner of the reflector and the side of the lid. If it is windy, you may want a prop on both sides.

You are now finished with your solar box cooker and are ready to cook!
1. Put your food in covered black pots in the solar box cooker with the lid on.

2. Aim the box so the shiny side of the lid reflector faces where the sun will be in late morning (lunch) or early afternoon (supper). Tie the prop to hold the lid reflector where it shines the most sunlight into the box.

   **Warning:** Temperatures inside the cooker can reach 275 degrees Fahrenheit. Do not leave cooker unattended in a place where it could be disturbed by other students.

3. Food cooks better:
   - on a warm, sunny day in late spring, summer, or early fall
   - if you put it toward the back of the box
   - if you adjust the cooker often so that its shadow lies directly behind it
   - if you divide the food up into small pots

4. You need not stir the food while it is cooking. If you open the box during cooking, be careful of the high temperatures inside.

5. Most importantly, put the food in early, and don’t worry about overcooking—solar cookers seldom overcook. Cooking times for recommended foods are:
   - one to two hours for rice, fruit, above-ground vegetables, pretzels
   - three to four hours for potatoes, root vegetables, some beans (including lentils), most bread
   - five to eight hours for most dried beans
SUNLIGHT: IT’S WHAT’S FOR LUNCH!

Teacher Instructions

Pre-Activity Preparation

This activity will take place over a two day period, with the second day being overlapped with the “Alternative Energies Roundtable Discussion” activity. On the first day the students will construct their solar cookers using the following list of materials for each of the groups:

- two large corrugated cardboard boxes with flaps—one fitting inside the other with about 5 cm between them on all sides and bottom (inner box should be at least 46 x 56 cm)
- a flat piece of cardboard about 20 cm longer and wider than the larger box
- a light piece of glass or Plexiglas about 50 x 60 cm
- a thin metal tray, painted black, about 42 x 52 cm
- dark cooking pots
- aluminum foil
- water-based glue
- lots of newspaper for insulation
- string (one foot long)
- a stick (approximately one foot long)

The second part of the activity will have the students actually cook their lunch using the solar cookers that they made the previous class. The cooking time may vary based on the amount of sunlight available. Generally cooking times will range from 1-8 hours. Therefore based on the weather forecast prior to the class you may want to have your students come in early to arrange their cookers so that the food will be prepared in time. For the lunch that the students make, it should be something that doesn’t require extremely long cooking times to complete. Food items such as hot dogs, hot sandwiches, or other easily heated prepared foods are ideal for the meals that will be made in the solar cooker. The teacher should be wary of any food allergies that students in the class have so that the health concerns of all the students are met. If students are unable to afford materials to cook for their lunches, the teacher should talk to the cafeteria staff ahead of time in order to have food materials to make hot sandwiches available on the day that the cooking will take place.

If the weather on the original day of the second part is not supportive of this activity you could postpone it to a better day. The only consideration for moving the date would be being able to store the food items that the students were originally going to cook. Should the conditions for cooking not be met or the food that started cooking in the solar cookers need more heating to finish, the teacher should make arrangements within the school, either with the cafeteria staff or a room that has ovens, grills, or microwaves to finish cooking using those resources.
Introduction

To start off the class, ask the class how they cook most of the food that they eat. Responses could include multiple methods and are likely to include grills, microwaves, stoves, fryers, or ovens. Record all of the student responses on at the front of the room and then ask them to identify what power and energy sources are responsible for these ways of cooking. Again list the responses that the students provide which will likely include electricity, wood, charcoal, propane, and other non-renewable energy sources. Once you have created both lists start a discussion about the lack of cooking energy and resources in other parts of the world including Africa and other less-developed parts. Discuss the lack of electricity in those parts of the world and also a dwindling supply of trees because of their use for lodging, heating, and cooking.

Have the students look at the first list of food cooking items they came up with and think about which of those types of cooking methods are likely used in these less-developed areas of the world. Students should begin to see that cooking is more difficult in these areas of the world because they do not have the resources that we do in order to cook our food. As a result, ask the class if they know any ways in which other groups of people cook or prepare food without the use of these more conventional heating methods. Students may be able to come up with examples such as drying/dehydrating, pickling, or other methods used to preserve or make foods edible in other ways. Then ask the question of what other natural energy sources might be available that could be harnessed to cook food instead. Solar energy is likely to be revealed by a student at which point you can then introduce the project of creating a solar cooker in order to harness solar energy.

Main Activity Day 1

Hand out the student activity packet to the class and go over the directions as a class. Read the first paragraph and then allow the kids to work with the person sitting next to them to identify how the terms listed after the paragraph are important to solar cooking. After all of the students have written down their responses, go over the principles as a class making sure that all of the students fill in any of the answers that they did not write correctly. Afterwards, continue reading through the directions and the objectives for the activity. Students will be able to work with a partner of their choice in order to make a solar cooker from the materials provided. The directions in the student packet are very self-explanatory and provide visuals that the students can follow throughout the process. Show the students where all of the materials are located and then allow them to start working on the construction of their solar cooker. As the students are working the teacher should go from group checking on their progress and making sure that they are building the solar cooker correctly. Once the unit has been approved by the teacher, they can store the unit somewhere in the room, making sure that they put their names on it so it can be found amongst the other groups. When a group
finished their construction, the teacher should check over the unit they made before allowing them to clean up their area and then answering the questions at the end of the first page of directions. Before the end of the class, be sure to remind students of the date that they will be cooking the food for their lunch. Inform them of what types of materials can be cooked easily in the cookers so that they can go and get materials for their lunch on that day.

**Day 2 Main Activity**

On the day that the students will be making their lunch with their solar cookers, the students should come into the classroom first in order to get the materials that they will need. Once in the room have students get into their groups, go to a work area in the classroom, and get their solar cooker unit out. The students will prepare their food for cooking inside the classroom to prevent contamination from the outside environment. Before taking the students outside, hand out the “Cooking Guidelines” handout and review the safety and instructional protocols for cooking the food. Once all of the groups have their food ready to cook and reviewed the cooking instructions, the class will take their units outside. When the students place their units down, be sure to remind them to face them in a direction that will maximize the amount of sunlight that will enter. At this point the students will then follow the directions for the “Alternative Energies Roundtable” activity until the food is cooked. Once the food is cooked, the students will remove it carefully from the unit in order to eat their lunches as a class.

After the roundtable discussion the students will take their solar cooking units back into the classroom. They are allowed to take them back home if they would like, or they may break them down with any time remaining or after school with any pieces that can be reused kept within the classroom.
Freedom of Speech and Energy: A Group Discussion of Renewable Energies

As our lunch is cooking in the solar cookers you have built (hopefully), now is the perfect time to discuss some issues about the renewable resources we have been discussing. We have identified and can accept that there are many benefits to the use of the multiple forms of renewable source that Earth has available. Sources such as wind, water, solar, bio-mass, and even nuclear energies are great ways of creating energy that don’t deplete our non-renewable resources. Each of the renewable sources has their own unique list of benefits and ways, in which they perform; however like basically all things in life, they are not perfect. Each of the types of energies has potential drawbacks and concerns should also be considered before using them.

For this activity you are going to be broken up into 4 different groups, each with a specific assigned renewable resource. Your initial task will be to collect and record evidence about your energy source that makes it beneficial in comparison to other sources, both renewable and non-renewable. As a group you will all talk and create a list of the benefits of your energy method to present to the other groups for our lunch-time forum.

After you have created your list of benefits for your energy source, you will then look to critique and identify the drawbacks of the other groups’ energy choices. This isn’t a debate or a competition, but merely a way to identify the pros and cons that all of these energy sources provide. Again, you will look to create a list of evidence against the other types of renewable energies so that both sides of the story can be told.

After your groups and the other have identified the benefits of your energy source and the limitations of the other sources, we will group back together in order to have a structured discussion as a class about all of the energy sources. You will be required to take notes and record both the positives and negatives of all of the energy types so that after the conversations you can write a well developed and supported essay that critiques all of the renewable energy sources and ranks them based off the evidence that was provided in the forum, as well as your opinion.
## SOLAR ENERGY

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## WIND ENERGY

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# BIOMASS ENERGY

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Freedom of Speech and Energy: A Group Discussion of Renewable Energies

Teacher Instructions

Pre-Activity Preparation

This class discussion will immediately follow the “Solar Cooker” activity for this unit while the food that the class has prepared cooks. As the students meals are cooking, the students will be split up into groups to evaluate and review many of the alternative energy sources that have been discussed and covered in the unit. It is preferable that this activity would be completed outdoors so that students may be close to their solar cookers and can keep an eye on the progress of the food that they are making. Should the weather not be appropriate to conduct this activity outside, then the discussions can easily be shifted into the classroom.

Introduction

After the students have finished arranging their solar cookers to heat their meals, have the students group together so that you can explain the activity that they are about to complete next. Hand out the student activity sheet and read through all of the directions as a class. Explain that they are going to be assigned to a specific energy group that they will have to defend a specific type of alternative energy source in a roundtable discussion versus other groups. In addition, they will also justify their arguments by being able to identify the limitations or negative aspects of the other energy sources being represented in the discussion. It is important to emphasize that this is not a debate or a competition. This is simply a way for the class to see both sides of the energy debates that are going on across the nation and world today. After going through the directions and answering any questions that may be asked by the students, the teacher should break the students up into equal groups for each of the following energy types:

- Solar Energy
- Wind Energy
- Water Energy
- Biomass Energy

Once the groups have been made and their energy type assigned they may split up into different areas to start recording the information for the roundtable discussion.
Main Activity

Once the groups have settled in a location they should begin working on identifying the benefits of their assigned energy source. As the groups are working the teacher should go from group to group to check in on their progress and make sure that they are working together and staying on task. In addition, while everyone is working the teacher can also have individuals from each group go over to their solar cookers in order to make any changes or adjustments to the food that they are cooking. Once each group has finished with the list of pros for their assigned energy source they may then go to the cons of the other energy sources that are being represented by other groups. This process should take roughly 30-45 minutes and allow enough time for the food in their solar cookers to be properly heated. Should the food need additional heating, the arrangements made with the kitchen staff of the cafeteria or additional heating via microwave or stovetop (included in considerations and preparation for Solar Cooker directions) can be completed before beginning the discussion.

With everyone’s food heated and ready to eat have the students get into a large circle, with group members for each energy type sitting next to each other, and begin the roundtable discussion. Remind the class that the purpose is merely to identify the pros and cons of each energy type and therefore appropriate behavior and language should be used during the discussion. The teacher will choose one group to begin by discussing the pros that their energy source has. As that group is saying the benefits of the energy source, members from the other groups should be filling in the pros sections of the table for the accompanying table. After the group has discussed all of the benefits, students from other groups may then raise their hands to share the potential cons and drawbacks that they determined from their group discussions. As these negative aspects are being revealed the group that presented the positives should fill in the cons side of their chart for that energy source. This process will continue for the remaining energy type groups until all of the students have the pros and cons for each of the energy types that were presented about.

Conclusion

To finish up the activity, conduct a poll among the students to determine which energy source of those that were talked about they feel is the best of the alternative energies based on the roundtable discussion. This should be based on personal opinion so make sure students know they should vote for the energy method they personally feel is the best, not necessarily the one they were assigned to defend. Give the students a couple of minutes to review the evidence that they gathered from the discussion and then conduct a poll by show of hands for what energy source as a whole the class thinks is the best.
HEATING UP: SOLAR HOUSE CHALLENGE

Background:

For years, the use of solar energy as a heating source has been utilized as a cheap, eco-friendly, and effective way to convey heat for multiple purposes. Being that the sun provides natural free energy, the ability to direct and channel the energy it provides can be of great benefit to people. However, being able to understand the science behind this form of energy and creating effective means of trapping and collecting the heat are fundamental considerations.

Regarding the science of how this energy is taken in and gathered, there are three general forms in which the Earth captures or loses the energy from the Sun. These three ways are reflection, absorption, and radiation. In the space provided below provide a definition and an example of how these methods are used and what they mean with respect to capturing and enhancing the energy provide through sunlight.

Reflection:

Absorption:

Radiation:

With the principles of these energy transfers and conversions better understood, people could then apply their understanding of architectural and other factors into their designs to make even more efficient and stronger energy capturing enclosures. Below is a list of some different parameters that are often considered when building any structures, especially those with heat and energy considerations. For each of the classifications below, write down how these parameters are important in maintaining and collecting energy. In addition, include some details for each with respect to what would be best in the creation of a solar house.

Color:

Density:

Design:

Materials:

Now that we have started to investigate the issues and general principles behind solar energy and its collection, the next part of this activity is going to combine it all in a friendly competition to see who can build the best solar house.
Instructions

Your task in this assignment is to build a “house” that will be heated by the sun. Of course, you will not be building a real house, but you will be using many of the same ideas as a solar-heated house. Your house will be roughly the size of a shoebox, but how you create it and design it will be up to you and your partners.

1. The winning house will be the one that, when placed outside on a sunny day between 11:00 AM and 12:30 PM, achieves the highest interior temperature.

2. Each house must be at least 10 cm x 25 cm x 10 cm (exterior dimension).

3. Houses must be attached to a piece of cardboard or wood (50 cm x 50 cm) to prevent being blown away by the wind. You may want to bring the house and base separately to school for ease of transportation.

4. On the base you should draw an arrow. Your house will be placed outside with the arrow pointed toward magnetic north, as determined by a compass.

5. Each house must have at least one window covered with at least 250 sq. cm of glazing material. “Glazing material” is any material that allows light, but not air, to pass through. It might be glass, Plexiglas, plastic wrap, etc.

6. Any materials may be used as long as they do not create a safety hazard. Try to use materials that have been thrown away. Total cost for materials should not exceed five dollars. Present a statement from your “funding agents” (parents) verifying this.

7. Temperature recording: Temperatures will be recorded by placing a standard laboratory thermometer into the house from the side at a height of 8 cm.

Again, what you decide to build and construct your solar house out of will be up to you. Make sure to consider some of the issues that we discussed in the background section of this activity, as well as other implications and factors that might not have been addressed. The questions below may help guide your construction and provide valuable guidelines and considerations for your structure.

QUESTIONS TO CONSIDER:

1. Which direction should the window(s) face?

2. How can you keep heat in the house?

3. Does the color of the interior make a difference?

4. Does the angle of the window make a difference?

5. What allows heat to get in during the winter but not during the summer?
Heating Up: Solar House Challenge

Teacher Instructions

Pre-Activity Preparation

This activity consists of two different parts, likely to be completed on separate days. The first component of the activity will have students relate the scientific principles of solar heating, along with their “solar cooker” experience in order to create a solar heater. For this first part of the activity the students are going to need materials in order to build their heaters with. Simple materials such as cardboard, aluminum foil, plastic wrap, Plexiglas, and other cheap classroom materials should be available to the students. If the students would like to purchase other materials that may not be available that is acceptable but not required. If students decide to bring their own materials they should not spend any more than around $5 on these materials.

The second part of the activity will have the students take their solar heaters outdoors in order to have a competition to see who could make the best solar-heater. The houses will all be placed outside during an hour and a half time period and the unit that achieves the greatest change in temperature will be considered the winner of the contest.

Introduction

At the beginning of the class have the students close their eyes and describe the following scenario to them: (The following text in italics should be spoken to the class)

Imagine that it is the summer here in Upstate New York. It is a very hot day with not a single cloud in the sky. You walk outside of your house and the heat strikes you immediately. You look around you and take in the surroundings. The heat off of the black road can be seen from afar. The reflected light of the sun off of the car mirror is literally killing off the grass that it hits. Opening the car door a rush of even hotter air comes right at you. You go to sit on the leather seat but it burns your skin and you jump up very quickly.

After reading through the story tell the students to open their eyes and take out a sheet of paper. Have the students write down everything they can remember from the story dealing with heat and energy. Allow the students a few minute to record their thoughts and then have kids raise their hands to share the connections they made. As the students share specific examples, ask them to elaborate on what characteristics of the example dealing with the temperature and heat were most influential. Examples of details include the following:

- Inside of house being cooler: Insulation
- Heat of the outside environment: Radiation
- Black pavement: Color
- Light off of mirror: Reflection, Design
- Inside temperature of car: Insulation, Radiation
- Leather seat: Material, Absorption

As you help the students to make these connections, record the different details that are important to solar heat at the front of the room. After going through the examples from the story, then ask the students how these elements would be applied to collect solar heat in the examples of houses and water heaters. Allow students to provide answers to the question to promote their initial thinking towards the creation of the solar heater unit they will construct. After taking some student responses, introduce the competition to the students and hand out the student activity paper.

Main Activity

After handing out the papers to the class read through the first two paragraphs and then allow the students to record their definitions of the three science topics as they relate to capturing and enhancing solar energy. Once the kids have recorded their answers, have students share their definitions and adjust them if needed to fit the purpose of solar energy. Continue to read through the next paragraph and then again have the students write down how each of the 4 variables listed would apply towards the creation of a solar house. Do not have the students share these elements as they will be important and potentially unique attributes that will define the different types of solar heaters that are made. Continue reading the instructions section that outlines all of the parameters that the solar heaters have to meet. Generally speaking, the heaters should be around the size of a shoebox and attached to a piece of wood so that they do not blow over or away if windy during the testing day. The rest of the specifications and creation is up to the students and they are free to use creativity and ingenuity to create the best solar house that they can. The rest of this first day will be spent on the construction of the solar houses from the materials that are available at that time. The teacher should suggest that students make blueprints and plans for their solar houses so that they can plan what materials and how much they will need. As the students work for the rest of the class the teacher should go from student to student to check their progress, heater idea, and offer any minor suggestions to those that may be struggling. At the end of the class students may bring their heaters home to continue working on them, however they will need to bring them back on the assigned date for the testing.

For the second day of the activity, or whenever the teacher assigns them to be back, the students will start the class by sitting with their heater units. Once everyone is ready they will receive a thermometer to be placed inside of their unit. Once placed and checked over by the teacher, the class will go outside and students will place their solar heaters in the location that
they feel is best. Once in the spot they are going to keep it at, the kids will record their initial temperature inside of the box. Once all of the units are placed the class will go back inside and continue on with instruction.

**Conclusion**

After the time period has ended the class will go back outside and the final measurements will be made and the units brought back indoors. Once inside the students will determine the change in temperature and the class will reveal their results. After determining whose box created the highest temperature the teacher should start a discussion amongst the class about what characteristics they think having completed the tests was most significant to raising the internal temperature. The conversation can also include what factor was the least important and a discussion of other variables that might have played a factor in the success of certain peoples’ boxes versus others.
Organic vs. Non-Organic: You Be the Judge

One of the big new trends in the food and farming industry nowadays is the organic food boom. Many farmers and food suppliers are pushing that their food is either “all-natural” or use some other term to convey a product that is more natural and less tampered with. Then again, the science that is available for food production now is greatly enhanced compared to many years ago. The use of specific chemicals and conditions allows up the ability to make fruits and vegetables that are more enhanced in many ways. There are critics on both sides of the food debate and which product is superior is a very controversial subject.

In order to gain a better perspective on the differences and debate that is occurring between these types of food products, you are going to carry out multiple activities that will not only enlighten you about the terminology and meaning or these modified or natural products, but also put them to the test.

**Step #1: Retrieving the Samples**

We couldn’t possibly have a true test and comparison without having some products to analyze. In order to do this we must travel to our local grocery store that carries both organic and regular produce. While there, you and your group will be obtaining specimens for your investigation. You will be picking out 4 samples of produce, 2 vegetables and 2 fruits, to use in your tests. Make sure that the specimens you grab are foods that you and your partners are not allergic to! Our trip to the store will be brief so make sure to get your products and check out as soon as you can. While at the store, if you have any questions about products and their classification be sure to ask myself or one of the produce department workers.

Upon coming back to the classroom you are going to create a table to use for your tests. You will have to determine at least 3 variables that you will be assessing each of your food items against. For these variables think about the qualities that you look for most or enjoy most in the foods that you eat from the produce section.

**Step #2: Planning and Conducting the Research**

Like any effective and informative lab experiment we will need a lab write-up to go along with the actual hands-on testing. This will include all of your typical lab components including:

- Purpose
- Hypothesis
- Procedure
- Data Table
The criteria for each of the sections are listed below and should be arranged in a neat and orderly fashion at the completion of the experiment.

**Purpose:** In your written purpose you will include answers to the following questions

- What is the general intent of performing this lab? What are you examining?
- What variable do you look to examine in your produce and why?
- Provide some slight background (1-2 sentences) about the organic foods recent popularity.

**Hypothesis:** Your prediction about what you think you will determine from the experiment. Try to include as much information about what you think you will find from your testing as possible.

**Procedure:** Starting from the time the class went to obtain our produce, create a numbered list that identifies all of the steps that you have taken already, and are going to take in order to test the produce that you obtained. For this section you will also have to consider how your test will be administered. If you choose to have a sample of individuals score certain characteristics of the produce (taste, smell, etc.) you will have to include additional explanations of how you chose the sampling size and the scaling used for grading. If you choose to have more concrete values as your data (lengths, widths, and numerical measurements) you will not need to consider a testing population.

**Data Table:** The data table that you created after obtaining your specimens will be used as your data table. After filling in all of your findings, copy that table neatly into this section of your lab report.

**Results:** After completing your analysis and recording your opinions about what products were better, it is time to learn more about what these terms “organic” and “all natural” really mean and how they differ from the other produce that you tested. In order to do this, you are going to search online for information. Using at least 3 sources, you will look up information to answer the following questions in order to develop a better understanding about the produce:

- From a definition standpoint, how do these products differ? What the definitions of each of the types are of produce (organic, all-natural)?
- What modifications or changes can be done to the non-organic produce? Answers can very here from chemicals, genetic modification, or other modifications.
- Does the FDA (Food and Drug Administration) have any qualifications for determining what category different produce goes under? If so name a few examples that are relevant to your products that you tested.

The answers to these questions, along with a written collection of your findings from our research will all be included in this section.

**Conclusion:** Wrap up your findings and final thoughts in this section. Include what you think is the best type of produce and why? Include details about your findings from the test and how they affected your opinion on what type of food is the best.
**Organic vs. Non-Organic: You Be the Judge**

**Teacher Instructions**

**Pre-Class Preparation and Considerations**

For this activity the students are going to create their own experiment to test specific variables of foods that are organic versus those that aren’t. One of the first steps in this process is a trip to a local grocery store or produce market that sells both normal and certified organic produce. Like any trip, the permission by the parents and the school are going to have to be approved. The teacher should create permission slips and fill out the appropriate paperwork from the school, including transportation, in order for this field trip to occur.

Another aspect of this lab activity that should be considered is the funding for the purchase of food materials to test with. The teacher can choose to use part of their budget for this, pay for the products out of pocket, or have the students bring in a certain amount of money to help cover the expenses. Some students may come from low-income families that will not be able to afford the money for the resources for the activity. If that is the case you can ask the school for additional funding to help offset the costs or reduce the cost and help to cover the difference with the money from the other students.

Another concern that should be considered for this lab is the fact that student will be dealing with food samples. Before starting this activity you will want to become aware of any food allergies that students in your class have. If there are types of foods that students are allergic to, the teacher should ban these products from being used in the lab for the safety of those students. Another safety concern for this activity is that students will likely be cutting into section of the fruit either to take sample or measurements. Like any lab in which tools with blades are being used it is important for the teacher to have a safety discussion with the class about the handling of tools that could cause physical harm to self or others.

**Introduction**

At the beginning of the class, ask the question “What is the difference between organic and commercial food?” Allow the students to talk to the person sitting next to them for a couple minutes then get the classes’ attention back to front of the room. Ask groups to provide some differences about the two types of products and list the differences in some sort of chart at the front of the room. After creating a list based off of their prior knowledge show the video from the link below up until 3:10. The last part of the video provides a biased interpretation of the processes which should be avoided to not conflict with the purpose of the lesson and experiment that they are going to create and run.
http://www.youtube.com/watch?v=mg4bllcO6Sw

After showing the video to the class ask the same question about what the differences between organic and conventional farming are and allow students to build on the list based off the information that they saw in the video. After filling in the chart of differences, then ask them what they think the difference would be from a physical perspective between foods that are organically grown versus not organically grown. Allow the students to think about the question for minute and then have them talk with the person sitting next to them about what the differences might be.

After the students have talked for a minute or two about the physical differences in the produce itself, hand out the student activity packets and introduce the activity that they are going to be carrying out. Read through all the directions and parts of the activity that the class is going to be carrying out. Breakdown the process into two components: the planning and organizing of the experiment, and actually carrying out the experiment. The two different parts of the activity will be separated by the gathering of materials from a local grocery store or produce market that carries both organic and commercial foods. Explain that the first section of the activity will have students form groups of two. These groups will be responsible for creating the purpose, hypothesis, procedure, and data tables that will be used in support of the experiment. The guidelines and requirements for each section are included in the student handout and will be completed on the first day. Along with these components, the students will also have to consider what products they are going to test in their experiment. The only stipulations for what they can use are that they must include two fruits and two vegetables, and that they may not use any foods that students in the class are allergic to. After going through the directions and expectations for the first part of the experiment and answering any questions that the students have up to this point, allow the groups to meet and start planning the beginning parts of the experiment. As the kids are working the teacher should go from group to group checking their progress and assisting them in any parts of the experiment that may need to be modified.

After the class has made their initials components of the lab report, prepare the class for the trip to gather the food items to test. Before leaving for the store, be sure to go over the expectations for behavior throughout the trip and the time constraints for purchasing their food to test. Once these criteria have been explained, load up the kids on the bus and travel to the store where you the purchase of the produce will occur. While at the location the teacher should be monitoring the students as they collect their food samples. Once a group has collected all of their items have them meet at a certain area so all the students can check out at once. After the students have paid for their items the kids can load back onto the bus and return to the school.
After the students have gathered their materials they should then begin the elements of testing the produce. Depending on what criteria the research is based on, some groups may need subjects to test the products. The students should have considered this element already, however if they have not you can have students in your class volunteer to test the food for their classmates. As the students are running their experiments they should be recording any data and values that they get within the data table that they have created. Once finished with the produce samples, the students can consume them, if uncontaminated from testing, or dispose of the produce into a special garbage bag that you assign (this produce material will be used for a compost activity that the students will be carrying out at a later date).

**Conclusion**

After the students have completed the testing element of their experiment they should continue to finish the results and conclusion section of the lab write-up. Once the group has finished with all of the components the groups will combine all of the elements of the experiment into a formal lab report to be handed in to the instructor for a grade and evaluation.
Landfills versus Composting: Alternatives to Trash

Everyday, people in the United States are throwing things away. Whether it is uneaten food, scrap paper, or even recyclable materials that fail to be reused; Americans have a tendency to just throw things away when they feel the usefulness of the item has been met. For certain things this may be the case, but often times stuff we throw away doesn’t just go away. Take a look at the table below and Put in your guess of how long each item takes to decompose in nature. After the class has put in their guesses we will go over how long these items remain before being completely broken down.

<table>
<thead>
<tr>
<th>Trash Example</th>
<th>Your Guess</th>
<th>Ranking</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum Can</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Banana</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cigarette Butt</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cotton Rag</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glass Bottle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leather Boot</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paper Bag</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plastic 6-pack Rings</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plastic Jug</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rubber Sole of Boot</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Styrofoam Cup</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tin Can</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wool Sock</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

After going through the results as a class, answer the questions below:

1. Why is it important to reduce the amount of wastes sent to landfills?

2. What are some specific ways to reduce the amounts of “trash” we send to these garbage dumps?

Now take a look at the “Micro-Landfill” that I created a week or so ago. It contains many of the components on the list we just went through along with a few other items as well. View the landfill and write down your observations of the items that you see. What other changes can you see now compared to picture of the original landfill? What items don’t appear to have been changed at all? Record your observations in the space below.
Clearly a lot of these items that we may throw out are going to sit underground in landfills for a long time, even after we are long gone from this Earth. That is a driving force behind the recycling movement, or reusing these materials that would otherwise sit in landfills and take a long time to break down. I am sure you can think of multiple ways in which materials such as socks, plastics, and metals could be reused for other purposes.

In the space below, write down a few of the examples of trash items on the chart on the previous page and think of ways to recycle or reuse them? This could include repurposing the item for a different job or reason.

Looking at items such as the bananas however, these items can decompose rather quickly. Not only that, but they also have the characteristic that they were once made out of living things. As a result, these items tend to be composed of materials that would be beneficial to other living organisms and could be reused by other living things. The process of composting has become more popular over the years as a way to recycle these valuable nutrients back into other living organisms. Composting by definition is the process of cultivating decomposers in order to turn organic waste into humus, a soil-like natural fertilizer that provides plants with nutrients. In simpler terms, compost is natural recycled fertilizer.

At this point we know that “organic”, from a biology perspective, means that it is or was living at one point. In terms of compost, organic materials are broken up into two different categories: “Browns” and “Greens.” Greens are high in Nitrogen and are usually wet and juicy. Most food and fresh grass and leaves are considered Greens. Browns on the other hand are high in Carbon and include things like wood, dried-out grass/leaves, and paper.

Below is a list of various items. For each of the items indicate whether it could be composted and if so, identify whether it would be considered a green or brown material.

<table>
<thead>
<tr>
<th>Item</th>
<th>Can It Compost?</th>
<th>Is It Brown or Green?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apple Cores</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Socks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hamburger Patty</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glass Bottles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pencil Shavings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dollar Bills</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bottle Caps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tuna</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Broccoli</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
After going through all of the items turn to the person sitting next to you and go over the answers. If your answers do not match, talk about the item and come to a common answer.

Now that you have examined the components that go into compost, it is time to make some of your own. One way in which compost is made, especially among farmers that make their own compost, is by creating a device called a tumbler. These devices hold all of the “greens” and “browns” materials that a farmer or other person has and allows them to decompose to make the humus fertilizer.

For the next part of this activity you are going to create your own “Mini-Tumbler” to make compost. Using household common items you will be able to make a working replica that you will also be able to look inside of it to see the changes that are occurring to the decomposing material.

For you “Mini-Tumbler” you will need the following materials:

- Plastic 2-Liter Bottle (Preferably clear)
- Tape
- Scissors
- Organic waste

Directions

1. Cut the top of your 2-liter bottle off right where it reaches the maximum width.
2. Poke 10-20 holes along the sides of the bottom part of the bottle.
3. Begin to feed your mini-tumbler about 2/3 to 3/4 full. Be sure to make a record of what you originally put in your tumbler. Try to include as much detail as possible so that you can compare your results later.
   a. One third of the amount should be greens: food, wet leaves/grass. (Some of this material is leftovers from the organic lab that you conducted the other day)
   b. The remaining portion will be browns: shredded paper, pencil shavings, dry leaves/grass, sawdust or wood shavings.
   c. You want the inside of your mini-tumbler to be moist, but not wet. If it starts to dry up, add some wet greens to the mix. If too wet, add some more dry browns.
4. Once filled, reattach the top and duct tape the two parts together. Make sure you have a solid seal to prevent any additional leakage.

Your mini-tumbler bottle should look somewhat like the image below before filling.
Now that you have completed your compost mini-tumbler, it is ready to start making humus. Weigh the tumbler at the start and record this data. At the end you will measure again to see how much the weight has changed (Note: If you add more material throughout the process, be sure to record how much you added so the end calculation is correct). Also record the temperature of the materials inside before placing into the environment. Once you have your initial measurements, place the tumbler in an area that will receive lots of sunlight during the day. This sunlight will help the decomposition process to work more quickly. You will check your tumbler every day and record the internal temperature along with your observations. When you check your tumbler, be sure to rotate the materials around in order expose the material to the air more and spread the moisture throughout all of the material. You will also want to place a pan or some newspaper under your tumbler to catch the moisture that will drip through the holes you made. You will record your observations and temperature changes every day for 2 week using the chart below:

<table>
<thead>
<tr>
<th>Day</th>
<th>Internal Temperature</th>
<th>Observations (notes of any additions to tumbler)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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Measurements of Material:

After you have completed the observations for two weeks, talk with a partner about your tumblers, what they were composed of, your observations, and the measurements that you collected. In the space below write a paragraph about your discussion and what similarities and differences that your tumblers had.

After the discussion, then answer these questions individually or with a partner based on the combined experiences and activities:

1. Describe your finished compost material. What does it look like now compared to the beginning? What does it smell like?

2. What modifications could you have made to your tumbler looking back at the experience that would have potentially increased the decomposition?

3. What is one major difference between landfills and composting?

4. Why is composting more beneficial than landfills?

5. What is one drawback of composting, and how could that drawback be addressed?
**Landfills versus Composting: Alternatives to Trash**

**Teacher Instructions**

**Pre-Activity Preparation**

This activity is in essence broke into two different sections: the short term first part and the long term second part. For the first section of the activity it will be necessary for the teacher to create a “micro-landfill” that the students can examine to view the decomposition of various materials. The teacher should make this landfill roughly 2 months ahead of time to allow the decomposition of some of the materials to begin. Directions for the construction of this item are provided below:

**MATERIALS:**
The mini-landfills need 2-liter bottles, duct tape, various items of waste (for comparison to composting systems, include several examples of organic waste), and soil.
First, remove the top portion of a plastic 2-liter bottle. Next, take some garbage and fill it up about halfway. Be sure to mix the materials that will start to decompose around with those that won’t. Try to have a good mix of materials around the outside edge so that the students will be able to see and identify parts more easily. Then, add a layer of dirt or top soil on top to completely cover the garbage. Close it all up, using some duct tape to put the top back on, and let it sit for a few weeks. Make sure it is kept out of sunlight.

As a modification, you could each of your students create their own micro-landfill and record the decay rate of certain materials.

For the second component of the activity the students will be creating their own mini compost tumblers in order to create and take measurements of the humus material that they make. In order for these tumblers to be made the following materials are needed for each group:
- Plastic 2-Liter Bottle (Preferably clear)
- Tape
- Scissors
- Organic waste

It is likely that the teacher will already have the tape and scissors readily available, however the other materials may be harder to come by. In order to get enough bottles for the whole class the teacher should send out an e-mail to the rest of the faculty, as well as ask the kids to save any clear two liter soda bottles that they can and bring them in for the class to use. As for the organic wastes, the teacher should plan on gathering most of the materials in the days leading up to the activity. The teacher and students could also save any leftover produce from the “Organic vs. Non Organic” activity to use for their composters. Some easy materials that can be gathered and used for the green and brown material in the class could include:
- Banana and orange peels
- Apple cores
- Wet sticks and leaves from outside
- Dried leaves (gathered beforehand and left out to dry if not available at time of activity)
- Pencil Shavings
- Paper from shredder

You may ask students to bring in their organic leftovers from lunch as well and store them in a container at a cool temperature to prevent decomposition. For the testing that the students will be doing on a daily basis, the kids will need thermometers and a scale to weigh their tumblers. After the students have created their mini-tumblers they will be recording and taking measurements of the temperature and weight over a two week period. After the measurements and calculation have been completed the students will be able to answer the final questions and wrap up the activity.

**Introduction**

At the start of the class hand out the activity packet to the students and introduce the theme of the lesson for the day. Read over the first paragraph and then have the students individually fill in the second and third columns of the first chart. This chart will have the students’ estimate how long it takes for certain materials to decompose completely and then rank those items from fastest (1st) to slowest (13th). After all of the students have recorded their guesses, and then reveal the following facts about the decomposition time to the class:

*Aluminum Can: 200-500 years; Banana: 3-4 weeks; cigarette butt: 2-5 years; cotton rag: 5 months; glass bottle: unknown: may never decompose in a landfill; leather boot: 40-50 years; paper bag: 1 month; plastic 6-pack rings: 450 years; plastic jug: 1 million years; rubber sole of boot: 50-80; Styrofoam cup: unknown: may never decompose in a landfill; tin can: 80-100 years; wool sock: 1 year*

After revealing the answers to the class, have the students answer the two questions that follow. Once the students have answered the questions continue to read the next paragraph and hand out the “Micro-Landfill” that you created ahead of time. Allow the students to examine the landfill and then record some observations in the space that follows on their worksheet. After the landfill has made its way around the room have a brief discussion of some of the observations that the students made. Some potential discussion points could be which items they saw that looked completely intact, which items they thought might have been in their in the beginning, if there were any surprises in what they saw, and other similar trains of thought. After the discussion continue reading the next two paragraphs and allow students to write down some examples of ways that items could be repurposed or recycled to not throw them away. After the students have written their responses briefly go over some of the ways the class thought of to recycle and reuse materials.
Continue reading through the introduction to composting and the elements that go into it. After reading the description of “browns” and “greens”, have the students work to fill in the chart and identify whether the items can be used in compost and if so, whether that material would be considered brown or green. After each student has individually gone through and filled in the chart they may turn to the person sitting next to them to review their answers with one another. After doing so read through the final paragraph before introducing the main activity in which the students will be building a mini-tumble to create and test their own compost.

Main Activity

Read through all of the directions in their entirety with the class before beginning the construction of the tumblers. At this point, focus on the directions for building the tumbler itself and the materials needed to go inside to create compost. After going through these instructions each student may grab the necessary materials and begin to build their tumbler unit. As the students are working to construct their tumblers the teacher should walk around the room, making sure that the students are on task and following all of the directions. Once all of the students have built and filled their units, go over the directions and requirements for the measurements that they will be taking and making on a daily basis. The students will be required to take a temperature reading of the compost material inside the tumbler daily, as well as record any physical observations about the unit when they are collecting the data. For the sake of consistency, tell the students that they should collect this data around the same time every single day to ensure that the readings aren’t biased in that manner. Be sure to indicate that the students will also weigh their tumblers at the beginning and at the completion of the decomposition period to determine how much weight has been lost from the material inside. After going through all of the instructions and confirming that all of the student questions have been answered, have the students take their first temperature and weight measurements, and then place their tumblers in a place that will receive a lot of sunlight throughout the day. These tumblers will stink, therefore it is beneficial for the students to place them outdoors in a place where they will not be tampered with, and the smell will not affect the building. The teacher may continue with other material during this period of time in which the students will be collecting data once per day for two weeks.

Conclusion

At the end of the data-collection period, the students should bring in their tumblers for a final temperature measurement and weigh-in using the scale. After recording their final observations and stats, the student can then answer the remaining questions in the activity packet. Once completed the students should hand them in to the teacher to be graded or evaluated. If the students would like to keep their tumbler they are welcome to do so, however they should be taken home in sealed bags at the end of the day to eliminate the smell being spread.
Greenhouses: Going Straight to the Source

For most of the world, the growing conditions for plants that produce the food we eat are seasonal. As a result, the availability and prices of certain produce can vary throughout the year. The weather effects along with seasonal conditions in particular can be seen among the products that get produced here in upstate New York especially.

In the space below, answer the following questions:

1. What are the weather trends in upstate New York? Discuss the seasons and the typical weather associated with them. In addition, talk about severe weather issues that can plague the crops in this area as well.

2. What types of produce are commonly grown in the upstate New York area? For each type of produce discuss the growing seasons and conditions for them normally.

Being that weather is unpredictable, farmers look to battle the unknown variable conditions as much as they can. One way that they accomplish this is by creating artificial growing conditions in which plants can grow, regardless of what the weather is like outdoors. One of the main ways this is accomplished is through the use of greenhouses.

In order to develop a better understanding of the science and implications of greenhouses in the agriculture field you will be reviewing an online article that breaks down greenhouses and their ability for growing crops year round. The article is broken into multiple sections divided by different web pages. After reading a given section on one webpage, you will create two questions that one could answer from the reading and record them, along with the correct answer, on a separate sheet of paper. At the end you will then get into a group with another person to quiz one another on the reading and informing your partner on any pieces of important text that you identified that they may have missed. The link to the article is located below:

http://home.howstuffworks.com/lawn-garden/professional-landscaping/alternative-methods/greenhouse.htm

After answering all the questions in your group, the class will be traveling to a local farm which uses greenhouses to help grow crops. You will be able to experience and witness first hand the features and science behind the buildings as well as ask the farmers any questions you may have regarding growth in the simulated conditions.
Greenhouses: Going Straight to the Source

Teacher Instructions

Pre-Activity Preparation

This activity is the first part of a two part greenhouse series. In this first section, the kids will be reading an article about the science and application of greenhouses in order to develop a better understanding of what they are and their importance in agriculture. This article is found online and broken up among different web-pages that are linked to one another. If computers are readily available, the students can read each section of the article, create their questions on a separate sheet of paper, and then proceed to the next part of the article. If computers are not readily available for all of the students, the teacher can copy the different sections of the article and print them out for the students. The link to the article is located below:

http://home.howstuffworks.com/lawn-garden/professional-landscaping/alternative-methods/greenhouse.htm

After reading and quizzing their classmates about the article, the class will then travel to a local farm that uses greenhouses in order to get a first-hand look at the process, as well as have any questions answered by the farmer/s who work there. Therefore, the teacher must set up a trip to a farm ahead of time. Some farmers are not open to these types of school trips so it is important for the teacher to call ahead of time in order to give the farmer plenty of notice and preparation time for the arriving students. It may be beneficial for the teacher to visit the site ahead of time on their own in order to talk with the farmer and talk about the objectives, what types of questions the students may ask, and any accommodations or requests that the farmer may need when giving the tour. Depending on the class size that you will be bringing to the farm, it may be necessary to get chaperones for the trip as well. Seeking teacher or parent volunteers could help with management of all the students on the trip. Be sure to check with your school regarding the necessary forms and paperwork that should be filled out by students, teachers, chaperones, and the farm site alike so that all the requirements are met.

Introduction

At the beginning of the class, hand out the student worksheets. Read the first paragraph together as a class and then have the students individually answer the two questions that follow. Allow the students a couple minutes to write down their responses, and then have the kids turn to the person sitting next to them and share their thoughts and answers. After a couple of minutes of discussion with their partner, re-center the classes’ attention and read the next two paragraphs to the class. These paragraphs will introduce the next part of the activity in which the kids will read a web-based article about the science and application of
greenhouses in agriculture. Students will read each section and before proceeding to the next, will create two questions that could be asked about that section. Students will also have to record the answers to the questions that they create as they will be quizzing a fellow classmate after reading the article. Students will read through the entire article, creating questions and their answers as they go, at which point they will partner up with a fellow student and quiz each other about the reading based on the questions that each created.

After all of the students have quizzed each other with the questions they made, bring the classes’ attention back to the front of the room and read over the final paragraph of the handout. Review the expectations for behavior by the students during the trip and any safety concerns that the students should be aware of. After going through all of the directions, gather the students and head to the transportation that will take the students to the farm.

Main Activity

Upon arriving to the farm, have the students form two straight lines and proceed to where the tour will begin. The teacher and any chaperones should arrange themselves in line in order to watch behavior and ensure that the kids are staying on task. As the tour is going the teacher should remind students to ask any questions that they come up with, or ask questions themselves in order to promote more questioning or relevant conversations towards the other projects that they will be doing in relation to greenhouses and farming. After the tour is completed, once again ask the students if they have any questions. Once all of the questions have been answered have the students load back onto the bus and return back to the school.

Conclusion

Once the class has returned, as a “ticket out the door” activity, have each students share one thing that they learned from the field trip. The students one by one will reveal one piece of information that they learned from the trip to the greenhouses. Students should try to include only information that they gathered from the visit, but if they start to run out of ideas they can expand the activity to include information that they learned from the reading as well. While a student shares what they learned the rest of the class should be quietly listening to what the other students have to say.
One of the most unpredictable and uncontrollable elements in the entire world is that of the weather. We cannot change whether it will rain in a given spot on a certain day, we can’t stop the winds that come along with different jet streams, and the sun is always going to the center of our universe. All of these facts are set in stone and as a result, farmers have to work alongside the natural environment. These conditions can be the source of great conditions and environments for the growing of certain products; however, it also can be the demise of an entire growing season in others. So the question remains of whether weather is really on a farmers side or not?

Sometimes the best way to determine if something is better or worse in comparison is to weigh the pros and cons of each situation. In order to determine if certain factors are better or worse for agriculture, we are going to make our own charts to help track the situations that nature can provide. For each of the environmental weather concerns below, fill in the chart with both pros and cons that each weather factor can have on the growth of crops for farmers. Remember that typically the plants need all of these weather conditions in some range, however when they receive too little or too much of them is when problems can occur. After you have filled out the list for each weather condition, you will then make your verdict and answer whether you think each particular weather component is good or bad for the crops in general. Be sure to provide reasoning and evidence for your claim.

**Factor #1: Rainfall**

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Final Verdict:

Factor #2: Wind

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Final Verdict:

Factor #3: Sunlight/Heat

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Final Verdict:
### Factor #4: Seasons

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Final Verdict:

### Factor #5: Air (Composition and Quality)

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Final Verdict:
Introduction

At the beginning of the class have the students take out a piece of paper and write down all the characteristics that they can about the weather in the past year. This is a very broad request and intentionally designed that way so that the class comes up with a broad range of weather types and implications. The teacher may want to start by saying one example could be that it seemed like this winter was colder than previous years, or something similar to that to provide an example of what you are expecting. Allow the class to write down their interpretations of the weather this year for a few minutes. After the class has recorded their recollection of the weather, have students share what they remembered and write their responses towards the front of the room for all to see. After having the class share their thoughts, then ask students at random to pick an item off the list and what they think and effect of the weather would have been on the growth of crops this past year. Allow the student and others to respond adding their insights as to what the effect would be on the crop yield and why. Continue this for a few of the example on the list allowing new students to contribute to the conversation and add their thoughts. After going through a few of these examples, then ask the students to consider what the effect would be if certain weather patterns were to occur in other parts of the world regarding the growth of plants and crops. Allow the students to talk to the person sitting next to them for a few moments about different scenarios and then gather everyone’s attention back up to the front of the room. At this point hand out the student activity packet to the class and introduce the theme of the day of looking at how weather can affect agriculture in positive and negative ways.

Main Activity

After all of the kids have received the activity packet read through the directions as a class. Explain the objective of trying to include as many examples as possible in which the identified factor can be good or detrimental to the growth of crops in agriculture. Go through the first example of rainfall as a class; asking students to provide examples both in the positive and negative ways in which rainfall effects agriculture. As students provide examples, fill in a chart at the front of the room that looks identical to the ones within the student activity sheet. The class should be filling in their charts alongside you as you fill in the chart at the front of the room. Have the class provide as many examples as possible, assisting if necessary in order to get at least 3 examples for each category, and then have students think about the pros and cons and write down a final verdict statement. The brief response of 2-3 sentences should take a side of whether the factor is more harmful or helpful and provide reasoning as to why they
think that is the case. Have a couple of students share their final verdict statement with the
class and modify their responses if necessary to meet the expectations. After completing the
first example, have the students get into partners to complete the rest of the actors provided in
the packet. As the groups are working to fill in the charts and write their final verdicts the
teacher should circle from group to group making sure they are staying on task and asking them
about the specific factor that they are on.

Conclusion

At the end of the class all of the kids should have their charts and final verdicts for all of the
factors. If there is time left in the class have the kids flip to the back of the second page and
have them respond to the following question: (The following material in italics should be read
to the students)

Now that you have investigated the effects that weather can have, both positive and negative,
on the plants in the agricultural field, would you say that weather combined is more beneficial
or harmful to the plants that we grow? Consider all of the elements combined and the
necessities of plants in general when answering this question. In a paragraph of at least 4
sentences include your verdict and the reasoning that supports your claim.

After answering the question, the students can hand in their activity packets and be finished
with the assignment.
BEEF: Tasty Protein or Silent Killer?

For as long as they have been domesticated, cows have been a vital resource in many ways. From the leather that can be produced from their hides, the milk that is used for countless dairy products, and the very meat that makes up a majority of their bodies, beef have been a staple resource within the United States and around most of the world. As useful and delicious as these animals are, a new threat is being exposed from these animals with the potential of doing more harm then help in the long-run.

Methane is a greenhouse gas that is naturally emitted by many living organisms. Cows in particular produce a much larger quantity of methane than other animals. With the large number of cows in captivity for the resources that they provide, the amount of methane produced from these animals is of major concern to some individuals.

The following article discusses the issue at hand with methane production from cows and why it is a concern. In addition, it discusses how efforts are being taken to utilize this methane in more beneficial ways that would be less harmful to the environment. As you read be sure to highlight important information that is relevant to the issue of over-production of methane by cows and what is being done to counter the issue.

Agriculture is responsible for an estimated 14 percent of the world's greenhouse gases. A significant portion of these emissions come from methane, which, in terms of its contribution to global warming, is 23 times more powerful than carbon dioxide. The U.S. Food and Agriculture Organization says that agricultural methane output could increase by 60 percent by 2030 [Source: Times Online]. The world's 1.5 billion cows and billions of other grazing animals emit dozens of polluting gases, including lots of methane. Two-thirds of all ammonia comes from cows.

Cows emit a massive amount of methane through belching, with a lesser amount through flatulence. Statistics vary regarding how much methane the average dairy cow expels. Some experts say 100 liters to 200 liters a day (or about 26 gallons to about 53 gallons), while others say it's up to 500 liters (about 132 gallons) a day. In any case, that's a lot of methane, an amount comparable to the pollution produced by a car in a day.

To understand why cows produce methane, it's important to know a bit more about how they work. Cows, goats, sheep and several other animals belong to a class of animals called ruminants. Ruminants have four stomachs and digest their food in their stomachs instead of in their intestines, as humans do. Ruminants eat food, regurgitate it as cud and eat it again. The stomachs are filled with bacteria that aid in digestion, but also produce methane.

With millions of ruminants in Britain, including 10 million cows, a strong push is underway to curb methane emissions there. Cows contribute 3 percent of Britain's overall greenhouse gas
emissions and 25 to 30 percent of its methane. In New Zealand, where cattle and sheep farming are major industries, 34 percent of greenhouse gases come from livestock. A three-year study, begun in April 2007 by Welsh scientists, is examining if adding garlic to cow feed can reduce their methane production. The study is ongoing, but early results indicate that garlic cuts cow flatulence in half by attacking methane-producing microbes living in cows' stomachs [Source: BBC News]. The researchers are also looking to see if the addition of garlic affects the quality of the meat or milk produced and even if the animals get bad breath.

Another study at the University of Wales, Aberystwyth, is tracking quantities of methane and nitrogen produced by sheep, which provide a good comparison model for cows because they have similar digestive systems, but are less unruly. The sheep in the study are living in plastic tunnels where their methane production is monitored across a variety of diets.

Many other efforts are underway to reduce ruminant methane production, such as attempting to breed cows that live longer and have better digestive systems. At the University of Hohenheim in Germany, scientists created a pill to trap gas in a cow's rumen -- its first stomach -- and convert the methane into glucose. However, the pill requires a strict diet and structured feeding times, something that may not lend itself well to grazing.

In 2003, the government of New Zealand proposed a flatulence tax, which was not adopted because of public protest.

Other efforts look at the grazing lands being used by livestock farmers, which will be discussed in the next section.

So we know that ruminants are producing enormous quantities of methane, but why? Humans produce gases daily, sometimes to their embarrassment, but nowhere near the extent of these animals.

With the development of large-scale agriculture in the mid-20th century, farming became a big business for some companies. Farms became consolidated into large enterprises with many thousands of animals across large acreages.

Initially, grazing areas were filled with a variety of grasses and flowers that grew naturally, offering a diverse diet for cows and other ruminants. However, in order to improve the efficiency of feeding livestock, many of these pastures became reseeded with perennial ryegrass. With the aid of artificial fertilizers, perennial ryegrass grows quickly and in huge quantities. The downside is that it lacks the nutritious content of other grasses and prevents more nutritious plants from growing. One commentator called it the "fast food" of grasses [Source: Guardian%20Unlimited]--Guardian Unlimited.

This simple diet allows many cows to be fed, but it inhibits digestion. A perennial ryegrass diet also results in a significant number of weak and infertile cows, which have to be killed at a young age. This is where the methane comes in. The difficult-to-digest grass ferments in the cows' stomachs, where it interacts with microbes and produces gas. The exact details of the
process are still being studied, and more information may allow scientists to reduce cows' methane output.

A study at the University of Bristol compared three types of naturally grown pastures to ryegrass pasture grown with chemical fertilizers. Lambs were fed on each type of pasture. The meat from lambs fed on natural pastures had less saturated fat, more omega-3 fatty acids, more vitamin E and higher levels of conjugated linoleic acid (CLA), a "good fat" that is believed to fight cancer. The meat from these lambs was considered very high quality and scored well in flavor tests.

Because of concerns about ruminant diets, many researchers are investigating ways to alter what livestock eat and to mix the best of old cow pastures -- diverse, naturally growing, nutrient rich grasses and plants -- with the best of the new -- fast-growing and resistant to invasive species. One possibility is to increase the ability of beneficial, nutrient-rich plants and flowers to grow alongside the fast-growing grasses commonly used in pastures. Another branch of research focuses on plants that are high in tannins, which are believed to lower methane levels in ruminants and to boost milk production -- although excessively high level of tannins are harmful to a ruminant's growth.

A study by researchers in New Zealand recommends the use of plants like birdsfoot trefoil that are high in alpha-linoleic acid, which boosts CLA levels. Planting legumes and genetically engineered plants to trap airborne nitrogen will also improve nitrogen levels in the soil, which is important for rich soil and healthy plants.

Some dairy farmers use processing systems to harvest methane from cow manure. The energy is used to power the farm while excess is often sold back to the local electrical grid.

Believers in naturally grown, mixed-species pastures say that the use of them will reduce greenhouse gases, improve animal health and meat quality and reduce the use of artificial fertilizers. Efforts like methane-reducing pills or the addition of garlic may just be stopgap measures that fail to address some of the core problems of livestock, namely ground and air
pollution, cutting down of forests, the production of weak animals that later have to be culled and the use of artificial fertilizers and steroids.

Another possibility exists in trapping the methane gas and using it as energy or selling it back to the electrical grid. Some farmers already extract methane from livestock waste, but that does not solve the bigger problem of belched methane. Harnessing that methane would mean trapping it in the air, perhaps by housing cattle indoors or outfitting them with special muzzles that may inhibit eating.

With this information in mind it is time to dig into this issue a little more and create a piece of informational media to spread the word on the issue. For this project you will research more about the issue of methane release into the atmosphere and how cows are contributing to the problem. In the format of your choice you will answer the following questions, making sure to cite reliable sources:

- From a chemical standpoint, what is methane? What about it structurally makes it a dangerous greenhouse gas?
- Discuss the cow’s production of methane in greater detail. What about being a ruminant enhances the amount of methane that they produce.
- What examples are there of the methane produced from cows being harmful in other ways other than as a greenhouse gas? Have any accidents occurred?
- What attempts and efforts are being made by people to counter the methane being produced by cows? What technologies or plans are in action to eliminate or use this gas?

In addition to the specific topics listed above be sure to include a general introduction to the issues and basic science principles that align with it, as well as a conclusion to wrap-up the facts and issues discussed. How you present your knowledge and understanding of the material will be up to you. Whatever method you choose should be informative to the person viewing it. Some styles of presentation that you may choose to use could include the following:

- Informative Essay (Single Person): Write a paper that reveals the facts and information above. Make sure to use in-text citations and include a references page for this style
- PSA Commercial (Single Person or Groups up to 4): Create a Public Service Announcement commercial (either audio or visual) about the issue of methane release by cows. In the commercial you will discuss all of the topics from above. Be sure to refer to any sources of information that you used and referred to within this style of presentation.
- Create a Poster (Single person or groups of 2): Make an informative poster with multiple visuals to help display the issue with cows’ production of methane. Like the paper, make sure to include citations after each piece of information that you gathered and credit them somewhere on the poster.
**BEEF: Tasty Protein or Silent Killer?**

**Teacher Instructions**

**Pre-Activity Preparation**

For this activity the students are going to read an article about methane production by cows, how it affects the environment, and what efforts are being taken to counter the issue. After developing this basic understanding the class will then research the topic more in order to create some form of project that would help inform the public about the issue and what can be done to help. As a result, students will need access to the following materials for either the research portion or creating their final product for this activity:

- Computer lab or library
- Video Camera (with editing if applicable or available)
- Voice Recorder
- Poster board
- Art Utensils (colored pencils, paint, etc.)

**Introduction**

At the start of the class refer back to the previous activities that the students have done regarding greenhouses. In particular, ask the students to define greenhouse gases and what they do. Students should be able to recall from the past activities specific examples and how greenhouse gases affect the heating of the earth, however prompt discussion point sin the direction if necessary. Then ask the students if they know the name of any specific greenhouse gases that are fairly common. Most likely methane will be brought up, however if it isn’t reveal this gas to the class. Then ask the class where methane can be found and produced in nature. Multiple answers may be given by the students including naturally by the earths crust or by living organisms such as humans or cows. Continue off this thread by asking how animals release methane to reveal to the class that passing gas is a common way in which methane is released into the atmosphere. At this point introduce the main issue that the students will be looking into which is the productions of too much methane by cows.

**Main Activity**

Hand out the student activity packets and go over the first three paragraphs with the students. These paragraphs will discuss a little more about the issue at hand and provide the direction to read the article in order to develop a better understanding about the topic. Have the students read the article by themselves and highlight important information regarding the causes, effects, and ways in which science and technology are being used to manage the methane
production. After the class has finished the reading, briefly go over some of the main points that the students were able to gather from reading the article. After the discussion, read along with the students as they go through the remainder of the directions which will explain the remainder of the activity and the project that they are going to create. Explain the criteria for the assignment and the different methods in which the students can share what they have learned about cow methane. Make sure to emphasize that the students will have to gather information from additional sources, hence why they will be going to the library/computer lab in order to get more facts. Be sure that the kids gather citations and information about each of the sources that they use as it will be required for all of the project types. Before heading to the library or computer lab give the class a couple of minutes to figure out what type of project they will do and who their group members will be if they choose to work with one. After the kids have figured out their general plans, head to the library/computer lab and allow them to start doing the necessary research for the project. As the students are working the teacher should go from group to group and check to see what the plan is for each student or group. If a group or person gathers all the information that they feel they need for the project, check to see if they have all the information necessary for proper citations, and then they may begin working on their projects. This project will be completed outside of the class as well so be sure to inform the class of a due date for the project.

Conclusion

To wrap up the activity, students will present their projects to the rest of the class. Each presentation should be no more than five minutes and allow time for questions at the end to be asked to each group by the teacher and students. As the students are presenting the rest of the class should be silently listening and thinking of potential questions that could be asked to each person. After each person has finished their presentation the floor can then be opened up for questions. If students don’t have any questions for a particular student, the teacher should have at least one prepared to ask.
Literal Micro-Climates: Global Warming in a Jar

Perhaps you have heard of the greenhouse effect. In a greenhouse, short-wave radiation from sunlight passes freely through the glass and is converted to long-wave radiation inside. But the long-wave radiation cannot pass back out through the glass. The result is a build-up of heat inside the greenhouse from the captured solar energy. Certain gases in the Earth’s atmosphere—especially water vapor and carbon dioxide—act in much the same way as the glass in a greenhouse. We call this situation the greenhouse effect, and we call these gases the greenhouse gases, because of their ability to trap energy from sunlight. Most greenhouse gases occur naturally, but some are being added to the atmosphere because of human actions.

Global warming refers to the rise in temperatures at Earth’s surface and lower atmosphere over the last century. Most scientists believe that greenhouse gases produced by human activity are contributing to global warming. The danger in this warming is that it could disrupt Earth’s climate patterns, causing coastal flooding, and forcing major adjustments in the way people live. The more we are able to learn about the causes and effects of global warming, the better prepared we may be to deal with the possible consequences of a changing environment.

In this set of experiments you will use models of Earth’s atmosphere to see how it is warmed by sunlight. You will also discover how lakes and seas affect this warming by storing and releasing energy from the sun.

Materials:
- Large pickle jars
- smaller jelly jar
- laboratory thermometers
- white cardboard
- sheets of 8½” × 11” white paper
- transparent tape
- clear plastic wrap
- rubber bands
- water
- anti-fog solution
- timer or clock
- activity log sheet
- graph sheet

Start by choosing a partner that you will work with for this activity. After all of the partners have been selected the groups in the class are going to be split into two different sections. Each section will be responsible for creating 2 different jar models to test for their experiment. While very similar, each set will be dealing with different controls and variables in their tests.
Experiment 1: Models A and B
Students will create the models seen in A and B to the right.

Experiment 2: Models B and C.
Students will create the models seen in B and C to the right.

Model A: A laboratory thermometer is placed inside a large pickle jar which is left uncovered. Before placing the thermometer, tape it to a strip of cardboard that is a little bit longer and wider than the thermometer. Stand the thermometer on the bottom of the jar and lean it at a slight angle against the wall of the jar.

Model B: Like Model A, except that the jar opening is sealed with clear plastic wrap and a rubber band. Before sealing the jar, spray or wipe a light film of anti-fog solution on the inside of the pickle jar. This coating will make it possible to read the thermometer in the event that water vapor condenses on the inside of the jar during the experiment.

Model C: Like Model B, except that a jelly jar filled with water is added to the setup. Start by spraying or wiping the anti-fog solution onto the inside surface of the pickle jar. Fill the jelly jar almost to the top with water and place it inside the larger jar. (Important: The water should be brought exactly to room temperature before use.) Add a laboratory thermometer to read air temperature inside the pickle jar. Place a second thermometer inside the water-filled jar. The two thermometers should face the same direction. Each of the models represents a different set of conditions in Earth’s atmosphere.

What do you think each type of model is supposed to represent? Write a description of each model type in the space below.

Based on the section that you and your partner are in, follow the directions provided above to create the models required for your section. Once created, and then follow the procedure below in order to test the models. Be sure to record your measurements in the chart on the following page.

1. Place each model on a sheet of white paper in direct sunlight. Read and record the temperature of each thermometer immediately. Repeat this measurement every 5 minutes for the first 30 minutes. After the first half-hour, readings may be taken and recorded at 15-minute intervals.
2. At the beginning and throughout the experiment, the large jars should be turned so that direct sunlight does not fall on the faces of the air temperature thermometers. The sunlight should fall on the backs of the cardboard strips instead. In this way, accurate readings of air temperature inside the jars will be possible.

3. After completing each round of temperature measurements, observe the jars to see if there are any visible changes taking place inside. Record any changes you see on the log sheet.

4. At some point in the experiment your teacher may draw down the window shades, or the sunlight may turn to shadow. If so, make a note in your activity log as to when this lighting change occurs. Then begin again to read and record temperatures every five minutes.

Once you have completed the collection of your data, construct line graphs on the pages that follow for each of your models that you used.

<table>
<thead>
<tr>
<th>Time (minutes)</th>
<th>Air Temperature in Control Jar (°C)</th>
<th>Air Temperature in Variable Jar (°C)</th>
<th>Water Temperature (°C) (Experiment 2)</th>
<th>Notes</th>
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Global Warming In a Jar

Use this sheet for experiments of shorter duration.

<table>
<thead>
<tr>
<th>Time (Minutes)</th>
<th>Temp. (°C)</th>
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<tbody>
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</table>

Experiment ____  Control Jar: Model ____  Variable Jar: Model ____
Before answering these questions about the experiment that you just completed, check your graphs to be sure they are done correctly. The data points in the graph should match the data in your table. Look at the graphs and refer to any notes that you took during the experiment to help you answer the questions.

QUESTIONS FOR EXPERIMENT 1

1. Although two different models were used – one for the control and one for the experimental variable – most things were kept the same in the experiment. What were they?

2. What is the one thing that was changed (the variable) in this experiment?

3. What happened to the temperature of the air in Model A, the control jar?

4. What happened to the air temperature in Model B, the covered jar?

5. What were the minimum temperature _______ , maximum temperature _______ , and range (difference) in temperatures _______ in the covered jar?

6. What caused the temperatures in the covered jar to change?

7. How was this experiment similar to the warming of Earth?

8. If your experiment was put into shadow after being in full sunlight for a period of time, answer this question: What happened to the air temperature in both jars after the jars went into shadow? If this was not done in your experiment, what do you think would have happened?

9. How was this experiment similar to the use of greenhouses by farmers?

10. What happened to the air temperature in both jars after the jars went into shadow?

QUESTIONS FOR EXPERIMENT 2

1. Although two different models were used – one for the control and one for the experimental variable – most things were kept the same in the experiment. What were they?

2. What was changed (the variable) in this experiment?

3. What happened to the temperature of the air in Model B, the control jar?

4. What happened to the air temperature in Model C, the jar with the water?

5. What were the minimum air temperature _______ , maximum air temperature _______ , and range (difference) in air temperatures _______ in the covered jar?
6. What happened to the water temperature in Model C?

7. What were the minimum water temperature _______ , maximum water temperature _______ , and range (difference) in water temperatures _______ in the covered jar?

8. What caused the air and water temperatures in Model C to change?

9. How was this experiment similar to the warming of Earth?

10. What happened to the air temperature in both jars after the jars went into shadow?
Literal Micro-Climates: Global Warming in a Jar

Teacher Instructions

Pre-Activity Preparation

For this activity each group of students is going to need the following materials. While some of the materials could be shared between all of the groups, such as the tape and plastic wrap, the rest of the materials will be needed individually for all the groups and the models that they are going to create.

Large pickle jars
- smaller jelly jar
- laboratory thermometers
- white cardboard
- sheets of 8½” × 11” white paper
- transparent tape
- clear plastic wrap
- rubber bands
- water
- anti-fog solution
- timer or clock

One consideration for this experiment is that in order for this activity to work best, the jars must be placed where there will be direct sunlight, such as on a windowsill. As the rays given off by the sun are a crucial component of the greenhouse effect, if the jars are not able to get the necessary heat this experiment will not work. If the external weather conditions do not cooperate on the day you plan to do this activity, you could use a heat lamp with a heating bulb to simulate the desired effect.

Introduction

At the beginning of the class refer back to the previous activity in which the students read about greenhouses and then visited a farm in which greenhouses were utilized in the growing of crops. Have the students brainstorm for a couple of minutes everything that they can remember regarding the science behind greenhouses and how they are effective. The teacher can describe the trip and some of the elements in order to jump the thinking process of the students. After a few minutes, have the students share what they remembered with the rest of the class and record the information at the front of the room for all to see. After reviewing their prior knowledge introduce the activity of the day and explain that the class will be modeling different scenarios to see just how greenhouses are used and why.
Main Activity

Hand out the student activity packet and read through the first two paragraphs as a class. These paragraphs help to introduce some of the related terminology and introduce the themes that will be investigated in the lab exercise. After reading these paragraphs, have students form groups of two. Then split these partner sets into two different groups sitting in different sections of the room. Assign each section of groups an experiment number to conduct (either experiment 1 or experiment 2). Continue to go through the directions and explain the models that each group will be preparing for the experiment (Experiment 1 group will make models A and B, Experiment 2 group will construct models B and C). Give each group a minute to read about the models that they will create and then answer the questions that italicized underneath the description. After answering the question with their partner, each group can go gather the necessary materials needed to complete their models. After having their models checked by the teacher, they may then read and carry out the procedure for the testing of the models. Be sure to have the kids read through all of the procedure before they begin so they understand what measurements have to be made at what times. Throughout the experiment the students should be recording at various times the temperature in their control jar, the temperature in their variable jar, the water temperature (Experiment 2 people only) and any notes about changes in the jar and what it looks like. After students have gone about the first 30 minutes of the test, pull the shades down in front of the windows in which the jars sitting to simulate no sunlight exposure. The students will then collect data for at interval of 5 minutes until they have filled up their charts or they are instructed to stop by the teacher. As the students are recording their data, the teacher should go from group to group to ensure that they are writing down their measurements correctly.

After a group has finished all of their data collection they may then proceed to constructing the line graphs for each of their models that they used. Tell the students to make notes on the graph of when the shades were pulled down for both of their graphs. After the groups have looked over their graphs to ensure that they are correct, the students can clean up their models and arrange the materials back into the locations from which they were gathered.

Conclusion

After cleaning up their work station they can then work with their partner to answer the post-lab questions at the end of the packet. There are two different sets of questions based on the experiment section which they were a part of. Make sure that the students know only to answer the questions for the sections that they were a part of. After completing all of the questions the kids can turn in their activity packets to be graded or reviewed by the teacher.
Running Wild: A DEC Perspective on Nuisance Animals

When it comes to farmers who grow crops for a living, being able to maintain and regulate what they are growing is essential. Their livelihood and income are often greatly dependent, if not entirely, on the produce they grow and maintain. This isn’t always the easiest of jobs for multiple reasons. There are many factors that can wreak havoc on their plants and it typically is a year-long battle and process to ensure that they get the best possible yield from their plants.

We previously examined how the weather, an unpredictable variable within farming, can cause lots of damage to the agricultural industry. While there are ways to fight these conditions, many of the reactions by farmers have to be swift and calculated in order to protect their product. Another natural threat lingers for farmers in terms of the living creatures that can destroy and devour the very food they are trying to sell. These unwanted and harmful critters are known as nuisance or invasive species and are another great concern to the farmers around the country.

To build a better understanding and recognitions of the problem at hand with these organisms we are going to have a New York State DEC (Department of Environmental Conservation) officer come in to talk to the class. This professional is an expert on the various issues and species that can cause lots of damage to the property and produce being grown by farmers around New York. The officer has prepared a presentation that will provide valuable insight on these animals, how different types of harmful organisms are classified, and other important information about the issue and how it affects farmers. During the presentation you will answer the following questions below, as well as asking some of the questions if the officer does not directly answer them throughout his presentation. Feel free to ask your own questions as well, as you will be later be creating a presentation using the information from this experience and other sources.

Questions

1. What is the definition of a nuisance animal? What is the definition of an invasive species? How are the two similar and different?

2. What statistics are there regarding the number of different types of invasive and nuisance species?
3. What are some ways in which the nuisance species arrive to New York from other places? What precautions can be done to prevent the spread of these organisms?

4. What are some examples of nuisance plants and animals in the upstate New York region? What are the affects that these organisms have on the agricultural industry?

5. What are some examples of invasive species, both plants and animals, in the upstate New York region? What are the affects that these organisms have on the agricultural industry?

6. What efforts are being done by the DEC to control or eliminate these organisms? Provide specific examples.

Creating the Presentation

Having gained a better understanding of the types of organisms and issues that they cause on the crops being grown by farmers, you are now going to focus on one particular species and create an informational brochure that could be used to inform the public about your specific nuisance or invasive species in upstate New York. This will require that you do additional research on your particular species. You will have a lot of freedom with this project in terms of creativity and how you arrange your information. The only guidelines are as follows:

- Your brochure must contain the following information
  - Name (both general and scientific) of your animal under investigation
  - Description of the organism (defining characteristics, basic measurements, behaviors, etc.)
  - Why plant or animal is considered invasive or a nuisance species? Include details
  - What type of effects they have on the agriculture industry in upstate New York?
  - What actions are being taken by the DEC and farmers to control the problem?
  - Use of at least 3 visuals within the brochure

Following the completion of your brochure, you will give a brief (5 minute) presentation to your classmates about the invasive species that you investigated.
Running Wild: A DEC Perspective on Nuisance Animals

Teacher Instructions

Pre-Activity Preparation

This activity in essence consists of two different components. The first part of the activity is having a New York State Department of Environmental Conservation officer come into the classroom to talk about nuisance species and their effects. In order for this to happen however, the teacher must be proactive in contacting the DEC to have a meeting set up. Often times they are more than willing to have somebody come out to a classroom to talk about different issues, however their jobs do require them to have other priorities. Therefore the teacher should contact the department at least a couple of months in advance in order to set-up this arrangement. Once the meeting time has been set, it would be beneficial to send the person who will be making the presentation information about what the students are currently studying and how you hope that his/her speech will connect with the content. In particular, you will want to explain that your students will be in an agriculture unit and that you wish to get their assistance and expertise regarding nuisance and invasive species. Describe to the individual the project that they are going to end up creating based off of the experience so that the officer can come prepared for the types of information to present and the types of questions he/she is likely to get from the class. A couple of days prior to the speech you will want to confirm with the officer or the department of the meeting date and time.

The second component of this activity will have the students take the knowledge they have gained from the speech as well as research they do online or from text sources in order to create an informational brochure about one particular invasive species within the upstate New York area. For the research component the kids will need access to computers or the library to gather information to include in their piece. For the creation of the physical brochure, the students can either type the brochure with included visuals, or they can create the brochure using paper and drawing materials (colored pencils, markers, etc.) that the teacher should have available to the students.

Introduction

On the day of the guest speaker have the students come into the class and hand out the student activity worksheet. Read through the introductory paragraphs as a class and explain the situation of a DEC officer coming into to talk about nuisance organisms. Review the expectations for behavior during the speech and the punishments that would result from being rude or disruptive while the guest is speaking. Tell the kids to try and refrain from asking questions until the end or when the speaker asks if there are any questions. After going through the expectations preview the project that will follow the speech so that students can
start to think of some questions they may want to ask that would help them with the brochure that they are going to create. Open the floor for any questions about the assignment or the speaker and answer them before introducing the officer to the class.

**Main Activity**

Introduce the officer to the class and thank him/her for coming to speak. As the officer speaks to the class take personal notes so that you can develop some questions to ask in the event that the students don’t ask questions about material that would be vital to the completion of the project. The teacher should also be keeping an eye on the students and making sure that they are behaving and being respectful to the speaker. Should a problem arise the teacher should appropriately handle the situation in a way to not draw attention away from the speaker. After the speaker has finished open the floor for questions. Allow the students to ask all of their questions first and include any additional questions at the end should you need or want to. After answering the questions thank the officer for coming and have the class give a round of applause before leaving.

After the speech, whether it is the same day or the next class period, have the students refer back to the activity worksheet and review the expectations and guidelines for the nuisance species project. After reviewing the assignment take the class to the library or computer lab in order for them to start their research. As the kids are all doing their research the teacher should go from person to person asking what species they are planning on presenting on. Multiple students can present on the same type of animal, however they should be working independently on the project itself. The teacher should check in with all the students as they are working to make sure they are on task and gathering all of the information required for the brochure. After the students have gathered the information necessary for them to complete their brochures, return back to your classroom so that they can begin working on the creation of their physical projects. Some students can be allowed to work on computers in order to create their brochures; however the teacher can use his/her discretion about who will have the opportunity to base on behavior. The students will then continue to work on their brochures until completed, or have them assigned to be completed for the next class period.

**Conclusion**

Upon completion of all of the brochures have each student come to the front of the class and give a brief description of their brochure and the information that it includes. The sharing of their brochure should take no more than a couple of minutes to allow the rest of the class to present. After everyone has presented the teacher can collect the brochures and questions from the speech to be graded.
Cabbage Chemistry

Background
Read the article that follows regarding acid and bases and then answer the questions that.

A solution is a mixture of a soluble chemical dissolved in water. Think about the difference between salt water and tap water. The salt in the salt water has dissolved and the solution looks clear, but the salt is still there and will taste salty if you taste it. Because solutions are made with water, which is made of hydrogen and water, the hydrogen in the water can make a solution into an acid or a base.

You might think about an acid as something that an evil villain uses to trap a super hero, but actually some very common household solutions are acids. Acids are solutions that will donate hydrogen ions in a solution, and usually taste sour. Some common acids are citrus fruit juices and household vinegar. Bases are solutions that accept hydrogen ions in solution, and usually feel slippery. Bases have many practical uses. "Antacids" like TUMS or Rolaids are used to reduce the acidity in your stomach. Other bases make useful household cleaning products. How do you tell if something is an acid or a base? You use a chemical called an indicator, which changes in color depending on whether a solution is acidic or basic. Specifically, an indicator works by responding to the levels of hydrogen ions in a solution. There are many different types of indicators, some are liquids and some are concentrated on little strips of "litmus" paper. Indicators can be extracted from many different sources, including the pigment of many plants.

Red cabbage contains an indicator pigment molecule called flavin, which is one type of molecule called an anthocyanin. This water-soluble pigment is also found in apple skin, red onion skin, plums, poppies, blueberries, cornflowers, and grapes. Very acidic solutions will turn anthocyanin a red color. Neutral solutions result in a purplish color. Basic solutions appear in greenish-yellow. Therefore, it is possible to determine the pH of a solution based on the color it turns the anthocyanin pigments in red cabbage juice. The pH of a solution is a numerical measure of how basic or acidic it is. A solution with a pH between 5 and 7 is neutral, 8 or higher is a base, and 4 or lower is an acid.

Questions

1. What is a solution? What are the two components necessary to make any solution?

2. What is the difference between an acid and a base? How do each of these types of solutions generally taste?
3. What is an indicator? Where do many indicators come from/are derived from?

**Objective**
For this activity you are going to be making your own natural pH indicator from a product that can grow quite well in this area during the summer months: cabbage. Especially here in upstate New York, cabbage is a form of produce which some farmers rely on. Despite being a nutritious food source, cabbage also has some very unique characteristics in the chemical realm. The pigment in cabbage that gives it its color can act as a natural indicator which we can use to determine the pH of certain household items that we have available.

**Materials**
- Cabbage
- Boiling pot of water
- Strainer
- Small white Dixie cups
- Medicine dropper
- A series of household items to test the pH of:
  - Fruit juice: lemon, lime, orange, apple
  - Soda pop (dark sodas might be tricky to see)
  - Vinegar
  - Baking soda solution
  - Cleaning products. **Note:** Always use caution when handling cleaning products.

**Procedure**
1. Grate a small red cabbage and place the pieces into a glass bowl.
2. Pour boiling water into the bowl to just cover the cabbage.
3. Leave the cabbage mixture steeping until the liquid is room temperature. The liquid should be red in color.
4. Place a strainer over a collection bowl and pour the mixture through the strainer to remove the pieces of cabbage.
5. Now you should have a clear liquid that will either be purple or blue in color. The color of the liquid will change depending upon the pH. Use the table below, to figure out the pH of the liquid by observing the color.

<table>
<thead>
<tr>
<th>pH</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Red</td>
</tr>
<tr>
<td>4</td>
<td>Purple</td>
</tr>
<tr>
<td>6</td>
<td>Violet</td>
</tr>
<tr>
<td>8</td>
<td>Blue</td>
</tr>
<tr>
<td>10</td>
<td>Blue-green</td>
</tr>
<tr>
<td>12</td>
<td>Greenish-yellow</td>
</tr>
</tbody>
</table>
6. Set aside your indicator solution. You will use it as your "stock" solution for your experiments.
7. Next you will test various household solutions with your indicator. Use a separate Dixie cup for each solution you want to test because you do not want to mix chemicals that do not go well together or contaminate your results.
8. Fill about half of the Dixie cup with your cabbage indicator solution. You can use less indicator solution for each cup if you do not have a lot of indicator solution.
9. Add drops of a liquid you want to test until you see the solution change in color. Gently swirl the cup as you add the drops, being careful not to spill the solution.
10. Record the pH and a description of the each solution in a data table that you will create on the next page.
11. Analyze your results. Write a brief written summary in the space below of what you were able to determine regarding the materials that you tested with the pigment indicator.

After cleaning up your work area and checking over all of your data, tables, and results answer the questions below:

How does the pH of the different household items you tested compare to each other? Are you surprised by any of your results?

Do you think that this pigment works as well as other chemical indicator that can be used? Why or why not?

Do you think there would be a difference in acidity between traditional green or white cabbage and red cabbage? Why or why not? Which would be more acidic if so?

Cabbage isn’t the only type of food that has pigments that can act as a chemical indicator. Research another type of food that has a natural chemical indicator in it and provide the following information in your response:

- Name of the food
- Color change that would be seen in acid-base tests
- What color represents which range of the acid-base spectrum
Cabbage Chemistry

Teacher Instructions

Pre-Activity Preparation
The following materials will be needed for the students in order for them to conduct the experiment and testing:

- Cabbage
- Boiling pot of water
- Strainer
- Small white Dixie cups
- Medicine dropper
- A series of household items to test the pH of:
  - Fruit juice: lemon, lime, orange, apple
  - Soda pop (dark sodas might be tricky to see)
  - Vinegar
  - Baking soda solution
  - Cleaning products

From a safety perspective, the students should be careful when handling the boiling water to prevent burn injuries from occurring. In addition, the students should also be cautious with the cleaning products that they will be using and the potential harm that they can cause. Students should read the labels of these materials before beginning the tests in order to handle them properly.

Introduction
Before the class arrives you will want to prepare a mini-demonstration at the front of the room. Although you may choose to use any indicator solution, a fairly simple way to showcase indicators in a non-color changing way could be by using baking soda. For this demonstration you would need a small amount of baking soda, a glass beaker of water, and a glass beaker of vinegar. After the class has come into the room, start the activity by asking the class generally what they know about indicators. Based on your student’s prior knowledge you may get multiple responses or none. Regardless, start a list at the front of the room about all the characteristics the students can develop, or that you help them think of by suggestion. Some of the important characteristics that should be revealed through this first discussion are that it is a chemical reaction to either an acid or base that causes some sort of change. Once these basics have been introduced, then ask the students how we might be able to detect these “changes” or reactions using our senses when using an indicator. Seeing the reaction is likely to be the most common response of whether something is acidic or not when using an indicator. At this point you can then model the baking soda reaction to the students. Explain that baking soda will act only as an indicator when in the presence of an acid. Drop some baking soda first into the water beaker and mix it around. Ask the students what they can determine from this test. After revealing that the substance would have to be basic because no reaction occurred, then drop baking soda into the vinegar beaker and allow the fizzing to occur. Afterwards, ask the
students what can be determined from this test. After reviewing the conclusion that the vinegar must be acidic then ask the class what other types of visual cues and indicator could potentially give off. A color change should be a conclusion that is brought up, at which point you can introduce the topic of the day being the use of chemical indicators to identify acids and bases. Before handing out the student activity packets, ask the class where they think scientists found some natural indicators. Teacher may have to hint towards the color change idea and where else we see color changes in nature. The idea of some foods that we eat having natural indicators should be developed.

Main Activity
Hand out the student packets and let them read through the introduction article and answer the questions that follow the reading. While the class is reading, the teacher can clean up the model they used at the beginning of class and also arrange materials for the main activity if not done so already. After all of the class has finished the reading and answered the questions, then go through the directions for the demonstrations that they are going to be completing. Students can work with a partner for the activity; however each student will be responsible for their own completed activity packet including the data tables and questions. Go over the safety procedures for the activity including the handling of the cleaning materials and the boiling water. After going through all of the expectations, allow the students to move to work areas and start the testing. As the kids are working the teacher should go from group to group ensuring that they are on task and assisting when necessary. After a group has finished all of the tests that are required, they should properly clean up their work area. A disposal container (large beaker) should be available for the students to dump all of their samples into. The teacher can then neutralize this collection for proper disposal after class.

Conclusion
After a group has finished all of the tests and cleaned up their work area, they can return to their seats to start working on the analysis of their results and the post-lab questions. The final question of the activity will require them to research another food that has a pigment capable of being used for acid-base testing. Therefore, the completed activity will be due upon their next class period.
Beyond the Machines: Biotechnology in Agriculture

Find a biotechnology article that is of interest to you, cut it out (or copy it) and answer the questions below. The article should be attached to the questions and then handed in by ___________. You may find an article in the newspaper, a magazine, a science journal, Websites, or any other source that highlights biotechnology.

Why did this article interest you?
Read the biotech article you have chosen and complete the following questions:

1. Title ______________________________________________________
   Author ____________________________________________________
   Source ____________________________________ Date ______________

2. Identify the main ideas of the article. (2-3) Write one or two sentences that summarize each main idea.
   A. Main Idea:__________________________________________________
      Summary: ___________________________________________________________________
      ___________________________________________________________________
      ___________________________________________________________________
      ___________________________________________________________________
      ___________________________________________________________________

   B. Main Idea:__________________________________________________
      Summary: ___________________________________________________________________
      ___________________________________________________________________
      ___________________________________________________________________
      ___________________________________________________________________
      ___________________________________________________________________

   C. Main Idea:__________________________________________________
3. Identify and define at least 5 terms that are either new to you or are related to biotechnology, or biology topics.

Term Definition
A. 
B. 
C. 
D. 
E. 
F. 

4. What questions does this article raise? Does the article present differing viewpoints? If so, summarize each point of view.

_______________

5. Describe your reaction to the article. Do you accept the findings? Why or why not?

_______________
6. How does the information in this article relate to what you have learned in class?
_________________________________________________________________________
_________________________________________________________________________
_________________________________________________________________________
_________________________________________________________________________

After you have answered all of the questions above regarding your article, you will then plan to give a brief verbal presentation to the class about the article you read. The speech will only have to be 3-4 minutes long; however it must include the following information:

- Title of the article that you read and the author
- When the article was written
- Identify at least 3 of the main ideas that the article discussed. Be able to talk a little about each of the main ideas.
- Talk about how this science is specifically important to the field of agriculture
- What concerns or problems are there, or could arise from the application of the science in your article.
- State any questions that you might have still having read the article

It may be helpful to create a script or note cards for your presentation so that you have the information and what you are going to say close by. After you have given your presentation the floor will be open to questions from the class. You should be prepared to answer any questions that may be asked to the best of your knowledge and ability.
Beyond the Machines: Biotechnology in Agriculture

Teacher Instructions

Pre-Class Preparation

For this activity the students are going to research an area of developing bio-technology in order to fill out an organizer and then present to their class about what they found. In order to get the most up to date information in the field, the students will need access to current science magazines or the internet. Therefore, the teacher should reserve space and time within a computer lab or the library so that students can find the information that they need. In addition, the introduction part of this activity will require that the teacher find a very recent article regarding some sort of bio-technology within the field of agriculture. The teacher should print copies of this article for all member of the class and also be knowledgeable about what the article is talking about for an in-class discussion.

Introduction

At the start of the class hand out the article that you have found and briefly discuss the concept of bio-technology. In particular, discuss how the field of bio-technology is extremely popular among the agriculture field. Have the students read the article and then have a class discussion about it. You may want to ask some of these questions during the discussion:

- What is the main idea/purpose of the bio-technology they have developed or are using?
- What implications does this science have towards the field of agriculture?
- How might this change affect the daily lives of humans in the US? Around the world?

After discussing the article as a whole, introduce the activity in which the students will be investigating another area of bio-technology and reporting on the issue to the rest of the class. Hand out the activity packet and go over the instructions with the class. Be sure that the students understand all of the requirements that should be met from the article that they pick including that it is on a topic of interest, contains enough information and facts and science vocabulary to cover all of the components of the review sheet that they must fill out, and also relates to agriculture and other questions and concerns that could be raised in that field. Be sure to briefly discuss the verbal presentation that each student will have to give at the end as well.

Main Activity

After going through all of the directions have your class grab a writing utensil and the student activity packet and head to either a computer lab or the library. Students should be working independently to find their article and complete the questions and components of the packet.
Students should have a copy of the article to go along with all of the questions that they had to answer, so articles should either be printed or copied. As the kids are working the teacher should move around the room ensuring that the students are on task. The teacher can assist with problems and definitions of words when necessary, however the students for the most part should be able to determine the answers and meanings of the articles they choose on their own. After a student has finished reading and highlighting their article along with answering all of the parts of the packet, they may then begin to plan out their verbal presentation that they will give. The speech of each student should be roughly 3-4 minutes long and include all of the information outlined in the student packet.

Conclusion

Depending on the length of your class and how much time remains, have your students present their verbal component either at the end of the class or the following period. As the students are presenting the rest of the class should be actively listening and thinking of questions or comments. After each person presents you can open the floor for questions, or require one or more students to ask a question about the article and what was revealed.
An Agricultural Interview

Names of Interviewers

Instructions

1. Schedule an appointment for an interview with a local farmer, farm manager, or an owner or manager of a farm-related business. (You may not interview an immediate family member.)

2. Before your interview, familiarize yourselves with the operation as best you can. Request flyers or Web site addresses that will give you information about the operation. Learn about the commodities that this person/company produces. This will make your interview more meaningful.

3. The interview must take place at the business site. Obtain accurate directions, and secure a responsible method of transportation. Be sure to complete the Pre-Interview Information prior to your arrival at the interview site.

4. One or two days prior to the interview, call and confirm your appointment.

5. This completed form is due on ___________________. Recopy and/or write a summary about your findings, as instructed by your teacher. Proof your work for proper spelling, punctuation, and grammar. Be prepared to discuss your interview with your classmates.

Pre-Interview Information

Name of farmer or person to be interviewed ________________________________

This person’s title _______________________________________________________

Name of farm or agriculture-related business _______________________________

Address of farm or business ______________________________________________

Business phone number(s) ______________________________________________

E-mail address and/or Web site ____________________________________________

Date and time of interview ______________________________________________

Telephone number of farm or firm _________________________________________

Date and time of interview ______________________________________________
An Agricultural Interview (page 2)

Interview Questions

1. Describe the nature of your farm or business:

2. Type of business: □ Sole Proprietorship □ Partnership □ Corporation

3. Years at present business:

4. Number of employees: ______________. □ Salaried □ Hourly
   If paid hourly, how much do the employees earn per hour?

5. Approximate hours you work per week:

6. Do you have seasonal employees? □ Yes □ No. If so, how many?

7. Do you have more full-time or seasonal employees? □ Full-time □ Seasonal

8. What qualities do you look for when hiring employees?

9. Have you found owners of similar businesses to be friendly? Competitive? Explain.

10. Why did you select this particular business to go into?
An Agricultural Interview (page 3)

11. How did you determine the location of your business?

12. What would you do differently if you were to start a new business this year?

13. How do you promote your business or products?

14. Discuss the sale of your commodities. Who do you sell to? How is the price determined?

15. What do you do to make your profit margin the best it can be?

16. In general, how do you feel about subsidies for farmers?
17. Discuss the use of various chemicals in your operation. Why are they used? What precautions are taken? What regulations must be followed?

18. What kind of sustainable agricultural practices do you incorporate into your work?

19. Describe two unique features of your business:

   a. 

   b. 

20. What is most rewarding about your career?

21. What is the biggest challenge in operating your business?
An Agricultural Interview (page 5)

22. What prepared you to be a farmer, owner or employee of an agricultural-related business?

23. What is one political issue you are concerned about?

Two additional questions:

24. Question:

Answer:

25. Question:

Answer:
An Agricultural Interview

After the Interview

In a well-written essay, discuss what you learned from the interview. Proof your essay and make sure there is a logical sequence of thought as well as proper grammar, spelling, and punctuation. Site examples from your interview in your writing. You may choose to include information that answers the following questions:

- What was your first impression of the person you interviewed and the facility at which you performed the interview?
- Does the person you interviewed seem to enjoy his/her occupation?
- Does the person you interviewed have a passion for agriculture?
- Summarize your impression of the strengths and weaknesses of this particular business?
- What are some specific challenges that were addressed?
- How did your first impressions change after interviewing the agriculturist?
- Would you be interested in this type of job or career? Why/Why not?
An Agricultural Interview

Teacher Instructions

Introduction

At the beginning of the class, refer back to the activity in which the class traveled to the farm that used greenhouses in their operations. Have a brief in-class discussion about the activity just to review the topics and material that was covered. After doing so, introduce the next assignment and the purpose of interviewing a farmer. Hand out the student activity packet and go over the instructions as a class. Be sure to mention that although some of the work and planning will be done within the class period; much of this assignment will be done outside of school. Explain all of the objectives, especially the ones that will be conducted in class including familiarizing themselves with the farm that they decide to go to, planning and scheduling an interview with the farmer on site, and preparing for the interview. As this may take some time to complete, inform the students that they will have a total of two weeks to complete all of the components including:

- Scheduling the appointment
- Filling in the Pre-Interview Information
- Creating the additional questions to be asked during the interview
- Conducting the interview
- Writing the post interview essay

Allow the students to ask any questions that they have for the assignment and clarify any confusion that may come up.

Main Activity

After going through all of the directions, expectations, and criteria allow the students to form groups and start working on the beginning parts of the activity. In class students will be able to look up information on different farms in the area, call the farms to try and set up an interview, and then fill out the pre-interview information. To start, the teacher should take the class to the library or computer lab to start looking up information on potential farms that they could go to in order to interview the farmers there. Each group should come up with at least 3 farm locations in the area in case their first or second choice does not agree to the interview. After the students have gathered some information about the farm sights and ranked them in regards to the one they would like to go to first, the partners should discuss what day and time will work for both of them to be at the interview. The students should have a couple of dates that will work for the farmers in case the first doesn’t fit the schedule of the farmers. After having the dates and times arranged, allow each group to use their cell phones (or school
phones if the school will not allow) to call the locations and set up times for in interview within the next week or two. Make sure that each group records the date and time of their interviews so they do not forget the appointment that they make. After getting approval from a farmer, the group can then fill out the pre-interview section of the packet for the farm that they are going to visit, along with the additional questions that they will ask towards the end of the list of questions. At this point the rest of the work will be up to the students to complete. The interviews will be on their own time out of school.

Conclusion

After completing the interview, each person will be responsible for writing their own essay about the experience using the criteria provided in the student worksheet. The essay will be turned in on the date that you assign based on the school and class schedule. The students should refer back to the criteria listed on the last sheet of the activity packet for the essay.
Chapter Four: Summary and Discussion

In a constantly evolving educational system, the need and value of informal learning opportunities for students is at an all-time high. Formal methods of teaching, while still effective, are not able to provide students all of the experiences that they deserve and require. The lack of relevance and memorable experiences within the science curriculum is a major concern that is directly related to the instruction provided today. By implementing more informal and non-formal teaching experiences, students are able to take advantage of many benefits that these types of instruction provide, while also eliminating the issues present with current instructional methods.

With the push for more informal learning opportunities within schools comes the necessity of knowing what this type of learning will require for teachers and students alike. It is essential to embrace that learning is a personal process, it is contextualized, and that it takes time (Stocklmayer et. al., 2010). Learning is a lifelong process, yet many of the reforms and approaches to education today seek out the quick answer that will provide immediate results. Formal instruction today tends to be driven by facts and specific information, yet the relation of how this material will be beneficial and relevant to the lives of the students goes untouched in most cases. Too often the teacher takes ultimate authority in the classroom and does not allow the students to truly take an active role in their learning by controlling what and how they learn. By using more informal teaching methods within the classroom curriculum, students are able to address these concerns better and therefore take part in a far more beneficial learning experience.
When taking a step towards implementing informal educational strategies within the classroom it is important to acknowledge the factors that will make the teaching provided influential and supportive. From an affective point of view, the instruction must be full of choice and opportunity that allows students to enjoy the experience, while also challenging the students intellectually (Stocklmayer et. al., 2010). The learning that occurs should be holistic; containing powerful and relatable knowledge in a way that is explained simply and naturally. By creating opportunities for students to relate to current issues and problems within an open social context, the students will be more involved and active within the community and world that they are a part of. Finally, putting all of these factors into inquiry based activities and projects where the students are the focus is what makes informal instruction truly beneficial.

This project presents a way in which the multiple scientific themes can be represented through environmental themed units. Whereas traditionally content is grouped into logical sections regarding relevant linked material, these units expand the material and information covered while still connecting all of the concepts by an underlying theme. By utilizing this type of a system, both the teachers and students would experience educational benefits. From the teacher’s perspective, utilization of the inquiry driven lessons within each unit allows for the learning to be more student driven. With student questioning and conversation being an essential component to many of the activities, the students are more interactive with the learning environment and are able to share and expand their learning individually, and with the rest of the classroom science community. In addition, there are multiple cross-content connections that are made between the science material and other curriculum areas within the units. Throughout the individual activities in each unit connections to additional curriculums
such as history, mathematics, engineering, technology, and English can be made. Being able to relate and connect material from multiple educational realms is beneficial to the student learning process and establishing a sense of value for the material to students. Finally, by focusing on environmental issues, the ability for the teacher to translate the learning into external environments becomes much easier. Some content areas are more difficult to expand to locations outside the classroom. By focusing the learning around topics that are dependent on the external environment, the teacher is more easily able to integrate informal learning opportunities within the curriculum.

From the students’ perspective, these units connect to many of the educational desires that students have including diversity, relevance, and interactivity. Each of the units contains multiple styles of activities including laboratory exercises, content readings, creation of diagrams and organizers, and expressive writing opportunities. By providing multiple opportunities and modes of expression throughout each unit students are able to express their understanding of content in ways that are comfortable to them, while also strengthening their abilities to display what they have learned or accomplished in other contexts. The utilization of these units also allows the students to make greater personal connections with the material. By taking place in the science itself or being present at a location where real world application of the concepts occurs, the students are able to make more personal connections with the material, and thereby appreciating and valuing the information more highly. Finally, the use of student-driven inquiry activities allows the students to be more active and hands-on in their learning endeavors. Especially among the current generation of students, the demand for interactive learning is extremely high. By creating, testing, and conversing with one another in
the learning environment, the students become more involved with the content and how it applies to the content and future activities that they may be part of in their future lives.

This capstone project is a way for teachers to create non-formal learning experiences for their students by utilizing units that focus and emphasize on learning and science in the outside world. By allowing the class to become more actively involved with the science content in real-world applications, the students are able to connect and develop skills that will benefit them as life-long learners. With the end goal of developing scientifically knowledgeable individuals for the future, the utilization of the lessons in these units will help prepare the students for how science effects their everyday lives and the future decisions that they may have to make that could effect additional generations to come.
References


