<u>Lesson Plan Final Report</u> – Sam Ansaldi

The Engineering Performance Expectation that I taught (4-PS3-4. Energy) focused on the application of scientific and engineering ideas to design, test, and refine a device that converts energy from one form to another. The activity that I designed for the students began with an initial problem, "how can we convert stored energy into heat energy?" The students then had to come up with a solution to this problem by designing and constructing a device that would transfer that stored heat into usable energy. Once the two dimensional design process was complete the students built working models of their designs and tested out their effectiveness. Observing their results the students were then asked to reflect on their models and explain any revisions that they would conduct in order to make their design more efficient. The execution of these designs from blueprint to model went very successfully. All of the student groups were intrigued by the freedom of design and the ability to create a working model using their hands. They used many aspects of the eight science and engineering practices identified by the Framework including defining problems, developing and using models, planning and carrying out investigations, analyzing and interpreting data, designing solutions, and obtaining, evaluating and communicating information. Using the information that we provided them the students were able to use their imagination and creativity to design and build a 3D working model in order to devise a solution to a problem. This process exemplifies the core ideas of engineering design: defining and delimiting engineering problems, designing solutions to engineering problems, and optimizing design solutions. Out of the five groups that we put together only one was able to successfully generate fire, but the majority provided well thought out ideas that upon student reflection had valid modification strategies.

Aspects of this project that the students were very successful in were designing solutions and developing and using models. These particular elements of the scientific and engineering practices were embraced by the students and came very naturally once the activity began. Throughout this lesson the students produced very inventive blueprints for solving the problem of energy transfer; however some of the specific processes regarding the successful transfer from stored energy to heat may have escaped some of the students between the design and building process. This lack of understanding seemed to translate into some of the final products that the groups produced resulting in one out of five models that successfully generated heat in its initial trial. However that being said, once the students analyzed and interpreted the data that came from their trial observations most were able to jointly refine their designs and communicate the adjustments that could be made during a second trial run. One girl actually used the word "aha" during a design revelation after primary testing. My goal for the students during this assignment was to expose them to the application of scientific ideas through the process of designing, testing, and refining a device in hopes that they would gain insight and confidence with these elements so that they may apply them successfully in their future endeavors. Although the students were excited to participate and eager to create and build, I don't think they were able to get as much out of this activity in a conservation area setting as they would if this material had been initially taught to them in a traditional classroom. The educational environment that we teach in at the conservation area is set predominately outside in a naturalistic setting. There is less classroom structure and more opportunity for inquiry and exploration. For many students this is a wonderful way to learn. It is immersive; it allows you to focus on one topic without the distractions of next period looming ahead at the sound of a bell toll. But for some this freedom is a too overwhelming. When some students visit they leave behind the academic structure of the classroom and automatically switch into field trip mode, which generally means a one track mind for play and less of an opportunity for material retention. Ideally, with the nature of this experiment, a combination of the two atmospheres would be ideal. If the students were afforded a class or two to delve into the background of energy transfer they might come to our location with a little more comfort and understanding of how their designs should operate and thus create a better opportunity for overall success. Schools and individual classes pay a relatively large fee in order to have their students taught by our educators at the conservation area. In order to accomplish this they also must travel to our facility, some from relatively great distances, which can put certain constraints on the time we have allotted with the students. By the time a school arrives and is scheduled to leave a full school day turns into a mere 3-4 hours, but then again that is why we try to condense pertinent information into hands-on memorable opportunities for the students so that they leave our institution with a firm knowledge of the information provided to them and a once in a lifetime opportunity to transform that knowledge into a tangible memory that they will not soon forget.

Even though they weren't directly addressed during our design building, certain aspects of the Nature of Science were included in our lesson. The students began devising blueprints for the "fire starting device" and during this process they included elements and components that could be powered manually by the students as opposed to the thought that they would just "work". They understood the limitations to their designs and compensated by creating blueprints that operated their models using physical reality based energy generators as opposed to power sources based solely off of their imagination. They didn't assume that a mystical motor would appear out of the ether to drive their apparatus; they knew that in order to make this model work they had to find real world solutions to their design. "So how does this model work", this was one of the most common phrases that I asked the students as they designed their two dimensional models. What amazed me is that they all had an answer; "You grab this piece of wood with your hands and push on it back and forth on this other piece"; "When we wrap a string around this bone and pull it back and forth it will spin just like the one you showed us"; these comments by the students, and many more, were all based on the principles of real limitations. They also understood the social aspects of scientific discovery. Once put into groups the students began bouncing ideas off of one another in order to design the best fire starting apparatus they could conceive. Even though the groups were mandatory the level of participation that the students put forth was up to them. While observing the groups, not only did it appear that every student was contributing ideas to the design of the model but many students were actually bouncing ideas off of one another to improve the overall product; "(girl #1 – group 1) we can use this small piece of wood to rub against the other and it will create smoke. (girl #2 – group 1) But it won't work on this (referring to the flat surface of the large piece of wood); you have to make a track for it." Group 1 then asked me to cut out a path for the small piece of wood to travel in hoping to optimize its performance. These social aspects were once again displayed when the students had finished the initial trials of their models. The students were asked to communicate the findings from their data that they observed and discuss alternatives in which to refine their model for optimal performance. "(Group 1) when we tried to make fire by rubbing these two pieces of wood together we didn't get any smoke but the wood was hot afterwards. Maybe next time we could try different kinds of wood or make something that would push the small piece of wood faster than we did". Not only did the groups come up with working suggestions to refine their design problems, but other groups made suggestions that could be used as well. This communal sharing of scientific problem solving was an excellent example of the social aspects of scientific discovery.

If I were to conduct this type of lesson again there would be a few things that I would change. I teach in a non-traditional educational facility that is based in an outdoor setting. We provide schools with the opportunity to complete certain components of their curriculum at our facility, taught by our instructors. These elements of the curriculum generally have to do with a set of topics that is better understood in an immersive hands-on setting (i.e. Pre-Colonial First Nations culture taught in a 15th century recreated longhouse village). The schools then bring their classes out for the afternoon and we teach a lesson plan that is comprised of environmental learning, physical activities, and student based inquiry. Even though this is an amazing setting to learn in it does have its limitations. As previously stated, some students upon arriving at our facility slip into the "field trip" mentality. The capacity to absorb and retain specific elements of information is replaced by the drive to explore have just have fun. Another setback is that this is the first time we are meeting these students and we have but merely an afternoon to get to know them, discover their learning styles, and teach them the content that they came here to fulfill. I believe a lesson such as this would be better understood if we combined traditional classroom learning with the outdoor freedom of our facility. I would suggest that the core information and initial blueprint designs should be spread out over a few class periods in their schools to ensure proper understanding and retention, while the construction and trials of their models could be conducted at a facility such as ours so as to immerse the students in a setting where fire starting was a necessity and a vital component of survival.

Unfortunately, due to the structure of our facility we only have the opportunity to see each individual class once. This means that I regretfully will not have the chance to follow up with the students regarding their progress related to this lesson plan. Our institution provides schools with a unique opportunity to introduce their students to an inquiry based immersive learning experience conducted in a completely natural setting. We provide academic institutions with the chance to fulfill certain components of their curriculum through the hands-on tutelage of skilled professionals. This service is associated with a fee, and due to its location, not a local commute for all who wish to participate. The school boards and the bus companies dictate when and for how long the student's experiences last once they arrive at our facility so available teaching time varies depending on their schedules. However, upon arrival our teaching staff strives to provide a learning experience like no other; one that the students, within their short time with us, highly benefits from and will remember indefinitely. We hold no formal relationships, outside of client status, with the Ontario school board association, so once the students leave our facility so ends our availability to communicate with them or their primary teachers. We have no influence on the lesson plans that follow the students visit to our location as most teachers are bound to continue with the academic agendas of their individual institutions. While this can be viewed as a drawback to the monitored longevity of our lessons we hope that the information that we provide inspires both the students and the teachers to continue along a learning path of creative knowledge discovery and dynamic lesson engagement.

Image #1 – Traditional fire starting materials shown to students – Bow Drill

Image #2 – Flint point used for hunting, protection, and fire starting (creating a spark once struck against another piece of flint)

Image #3 – Fellow colleague showing the students how to go from coal to flame

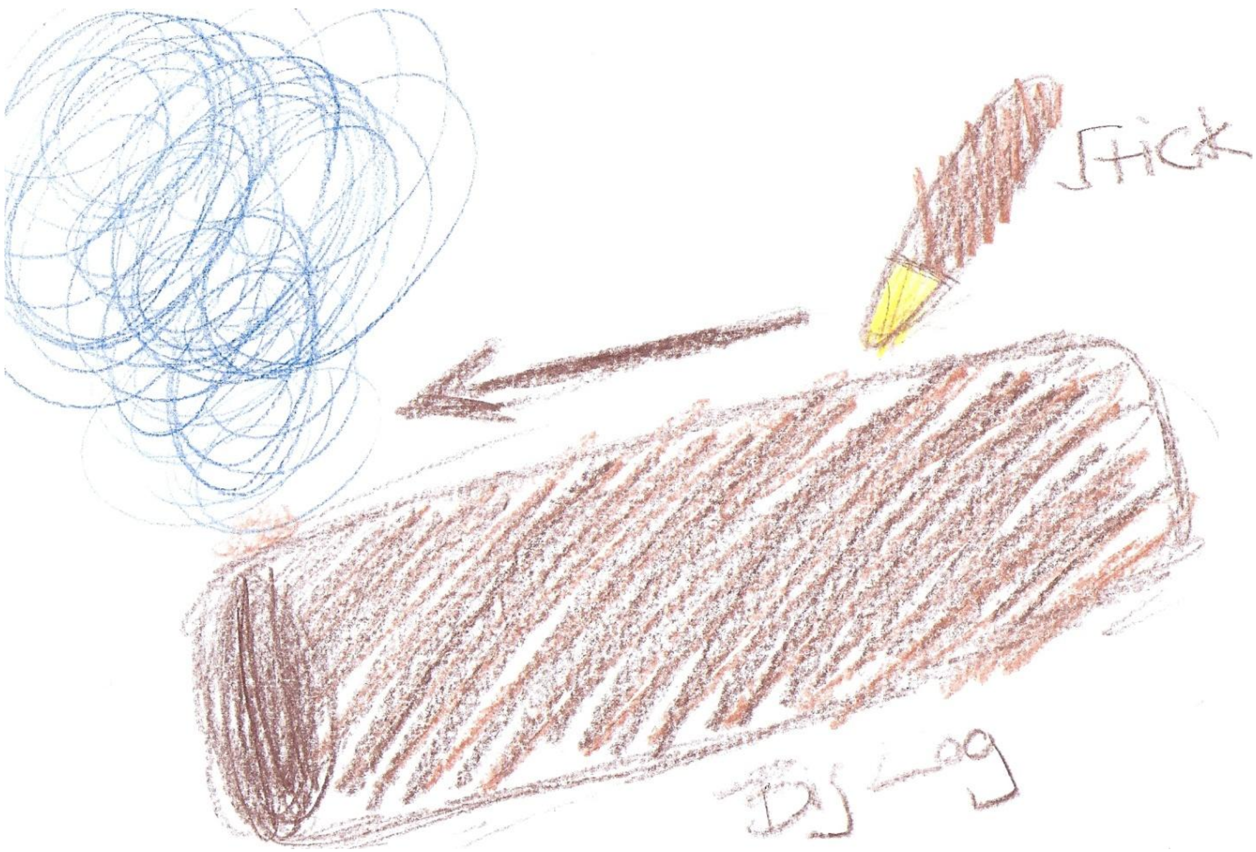

Image #4 – Group 1, initial heat energy design. This design is based off of the “fire plough” method of rubbing a small stick on a larger log to generate a coal. One student from the group mentioned that he had seen his uncle start a fire in this fashion which ultimately led the group to go in that specific design direction