INTRODUCTION

As a middle school science teacher, I am challenged daily to make science fun, interactive and to allow for a wide variety of learning levels and learning styles. Since abandoning our old textbooks 4 years ago, I have tried to provide as many hands-on activities as possible. For content, I have used hand-outs of encyclopedia excerpts, re-writes of high-school and college science books as well as articles from magazines and newspapers (which need updating every other year)! In addition, our science MEAP scores have been below the state average. Our eighth grade teachers expressed concern that our students don't know how to organize an experiment or to even have a clear understanding of what they are suppose to find out! Therefore, I have designed a unit that will set the stage for the rest of the school year. Through it, I will create a template for learning that will not only meet the social, intellectual needs of my students but also challenge them to learn at each student's individual learning level of mastery while addressing the concerns brought about by MEAP results and teacher input.

PURPOSE

My purpose in creating this unit, "Paints, Polymers and Play Things: or What Mrs. LaLonde did over Summer Vacation." is multi-faceted. First, it will start the school year out by establishing an investigation-based attitude for my students. Secondly, it will give me an opportunity to get to know my students by having them share what they did during summer vacation. Thirdly, it will be evidence that life-long learning is valuable, not just for kids but for teachers also. Lastly, it will improve students' confidence about using the scientific method and see its practical use, not only in the world of scientific research, but also in their own world. Besides being experimentation based, I will integrate many different writing opportunities in the form of Science Journals (Experimentation Notes). I believe that by writing their thoughts and predictions, students will gain a better understanding of what they have learned or what they want to learn.

Part of our "needs improvement" as teachers of science is to let kids know what we expect of their learning. Therefore, before presenting any material, I will inform students of the objectives (what I expect them to be able to do after 4 weeks) and the vocabulary that they should be able to use in verbal and written form. Students should also be made aware of how they will be graded. In some cases, I would like students to decide how they should be graded especially if they are being graded on their group interactions. This will relieve the stress that academic achievers feel at the beginning of a unit as well as for those students that see learning as an impenetrable wall of mystery and failure.

BENCHMARKS

The benchmarks that this unit specifically addresses are found in the Constructing Science Knowledge and are as follows;

- Generate scientific question about the world based on observation.
- Design and conduct scientific investigations.
- Use tools and equipment appropriate to scientific investigations.
- Use metric measurement devices to provide consistency in an investigation.

ACTIVITIES AND PROCEDURES

Week ONE

To set the stage for the unit "What I did over summer vacation" I will begin with brainstorming a list of most common activities that students may have participated in over the summer. This might range from "travel" to "TV", "swimming" or "reading". After establishing a list, each student will choose the one activity that is closest to describing how they spent their summer and will write that word on a 3 X 5 card. Using these cards, we will build a graph on the wall to discover which activity was participated in the most. "Going to school" would also be an option and I would include my card under this list. The class results (data) will be interpreted and compared to other classes'. Students might also be asked what other way these cards could be used. For instance how would a graph look if it was titled, "activities that I NEVER did over vacation"? While doing this activity, I would be sure to identify the x and y axis to our graph as well as labeling and titling our graph. We will also discuss how this data-collecting could be useful or not useful. I will be sure that we expose the idea that accuracy is important as well as a graph being a "picture of the data".

I will use the first activity as a model for future experimentation. After a brief assessment of prior knowledge, regarding paints, stains or dyes, I will introduce the ingredients for ink. (hot water, tea bags and iron pills). While working in groups, students will follow a procedure to create their own ink. After the activity, questions can be raised about how this ink could be used. I will give them the plastic straws and scissors, and demonstrate how an old fashioned pen can be made. There is an abundance of topics that can be discussed at this point. I might ask students to describe some of the problems that this method for writing might create and what qualities might a person want for a writing tool. Another inquiry might be about the history of writing utensils or what the future might be for writing tools. In order for students to become comfortable with writing in science, I will ask them to write to me about what they think would improve the quality of the tea ink and what they might change or add to make the ink more intense. A brief 1 - 3 sentence paragraph is a start for the reluctant writer.

At this point, I would direct the students to thinking about paints, which would be similar to inks. I would give them a few basic paragraphs about ingredients that are necessary for paints. Their homework will be to bring in a substance that they think could be used for a painting pigment. They will also need to bring their own creation of a "painting utensil". I am avoiding the chemical pigments, due to cost, accessibility and safety. (Some middle school students carry experimentation too far and as this is the beginning of the year I do not know who to watch more carefully for those behaviors). The following day will involve a lab using their materials. I will provide the eggs and paper. They may self-choose groups so that I may make notes about those choices. Later, I will do a "Co-worker Inventory", (Who do you
Work well with, who have you never worked with and who would you rather not work with) in order to pre-design the groups.

Past experience tells me that these students will jump in and "play" instead of "experimenting". We will discuss the similarities and differences between these two. I will require experiment notes to be taken regarding what the thoughts and plans of the group are in the beginning of the activity, what their results were and what will be the next course of action. One report paper will be required per group. However, this format will change as groups and individuals gain understanding of what I expect as well as the ability to put their scientific thinking into words at each step. (NOT in hindsight but in foresight!) Day Two will be Mini-Report Day when groups describe what they used and their results. Students in the audience will be required to take notes in order to emphasize the sharing of scientific knowledge.

Day Three will involve the same groups ideating the idea for their improved experiment, or groups may choose to borrow ideas from the other ideas that were presented on Day Two. The last day will be an Assessment Day in which groups will present their second round of findings. I will have a brief checklist of requirements to assess whether the students have fulfilled the requirements such as forming an idea, planning, recording and evaluating their experiment.

WEEK TWO

The second week will utilize polymers for experimentation. The Anticipatory Set will be a brief demonstration of the "melting" of different kinds of plastics in acetone. Questions for discussion will be, "What properties do plastics have that cause it to act like this?" I want to lead them to be curious about the structure of polymers and to associate that with why polymers act the way that they do. Prior knowledge will be discussed and new facts will be presented where students have ever seen this type of plastic. I will really match what is being observed. In order to keep all students involved, these ideas can be discussed in desk rows and then condensed into one list to be presented by a spokesperson. Other methods of sharing might be writing the ideas on the board (they love to write on the board!) or on the overhead. Pair & Share is another method for keeping all students on task.

To begin the experimenting, research groups will be given the ingredients (Elmer's Glue and Borax) with small measurement tools. At this point, I will outline the group's ideas, effort and cooperation with a writing prompt such as, "Today in science class we...". After the first experimentation, I will present a brief explanation of what a polymer is and how its molecules work. After the final day of experimentation students will be asked what substance they think was the "monomer" and which was the "connector". Students will then be asked to reflect back to the demonstration presented on Day One. The question will be, "What role does the acetone play in the chemical change of the plastics?" This question deals with more with content so it would be followed up by a question regarding the procedure used for creating the required substance. One such question might be, "How is the problem solving strategy of trial and error like scientific method?" How is it NOT like scientific method?"

WEEK THREE

The third week will be the introduction of "play things" or toys. By this time, the concept of "play" and "research" should be firmly entrenched so that playing with the toys will be less of a problem. Middle school students thrive on consistency so I will follow the same class outline as in previous weeks. I will do a brief demonstration of different toy cars. There are basically 3 propulsion systems: push, wind-up and pull-back. I will ask students to predict what is happening inside the latter two in order to guarantee that everyone understands the method of motion. This would also be an excellent time to review kinetic and potential energy. Research groups will be given the task of determining which of the free-wheeling, push cars will go the farthest after rolling down an inclined plane. A prize will be awarded to the group that can make their car go the farthest. The cars will be as dissimilar as possible. I will purposely not discuss variables such as the mass of the individual cars and the degree of angle for the inclined plane. After experimenting, groups will be "tested" to see which car goes the farthest. I anticipate a comment such as "that's not fair" as an introduction to controlling variables. Day Two's research question will involve the pull-back cars. Which group can get their car to jump the greatest distance across two inclined planes. Water moats can be added on the actual performance testing. Emphasis for this experiment will be to recognize, measure and record all variables that determine the jump distance. A brief demonstration includes the push cars, wind-up, or pull-back will be provided.

WEEK FOUR - Assessment

Review of vocabulary

During the previous weeks, each day's class has begun with a 5-10 minute introduction of vocabulary as well as a review from the previous days. By week 4, students have been asked to use these terms both verbally in their presentations as well as in their writing.

Review of writing Observations, Ideas and Results

During the past 3 weeks, I would have been giving students input (verbally as well as on their writing assignments) as to how their thinking could be improved. It is this area that is the most difficult because students come with varying abilities and desires to improve. Keeping a sample of their first writing (and video taping their first reporting) might be one way of goal-setting after this unit. Where-I-Was and Where-I-Arrived can be a valuable tool for improving students' confidence and self-esteem. A more general practice is for students to group edit random anonymous writings. The class identifies particular needs improvement items such as using specific vocabulary, using more words in describing thoughts or actions and being more specific such as including units of measure when writing about an experiment. I am tempted to develop a worksheet that outlines this for students however, I'd rather see if they can internalize the requirements and therefore own the knowledge at a deeper level.

Review of Constructing and Reflecting

For many middle school students, asking themselves what they think about something is very difficult. Self-awareness has not been encouraged or hasn't had an opportunity to be practiced. The use of science journals can be a major tool in accomplishing this goal. Taking time in class for students to think about their scientific thinking into words at each step. Perhaps using a "time capsule" theme could be used. In this case I could collect their first writings and hold them until after the experiment. Then, I would hand them back to the students in order for them to respond to the question "How has my thinking changed since I wrote this?" and "What happened to my thinking?" This practice could become a continuous part of self-assessment for students as well as a way to practice reflective thinking.

Assessment Activity

Students may choose to work individually or to form teams of 2 - 3. The task needs to be fairly simple so that the mechanics don't interfere with the assessment of the process. Therefore, I've chosen a "challenge" that I discovered on the Internet through Southwest Educational Development Laboratory. I've adapted it to serve my needs and have re-titled it, "Boat Drag-Racing". Students are to design a boat that can be no bigger than 8 cm wide by 23 cm long. It can be made out of any material but can not be a pre-formed toy boat. It will be put into a 2m long water trough (a plastic roof gutter, sealed to hold water is recommended). The boat will be connected to a string, attached to a 150 g. weight. As the weight is dropped over the edge of the trough, the boat will be pulled through the water. I will use the trough set up so that the students will be able to plan for a way to connect their boat to the string. I will outline what the students need to include in their Experimental notes, ideas, designs for the boat, and attachment ideas. I will emphasize that the grade is not dependent upon the success of the boat (maybe that will be extra credit to the "winner") but the accurate recording of their thinking and application of prior knowledge. An outgrowth of this will also be how to measure "winning" which will be decided upon by the class. I anticipate that this will be a distance/time relationship and math will be required. This activity will also be useful for the introduction of buoyancy as a force. Surface area and mass is another avenue that could be explored. As I monitor their progress, I will decide whether
there should be "test trials". On the BIG DAY, students will test their boats. The final assignment will be to write the summary to their experimentation, including what happened and what made their boat successful or unsuccessful. With the aid of the students, a rubric will be developed to determine how their finished report will be scored.

**IN CONCLUSION**

In this unit, I have planned for the middle schoolers' need for active learning and their enjoyment of interacting with their peers rather than seatwork. I have emphasized the importance of keeping accurate notes as to thoughts about what ideas might work (constructing new knowledge) as well as looking back to see what didn't work and what did work (reflecting on scientific knowledge). I have provided ample opportunities for practice in writing, as well as consistent application of the scientific method. I look forward to implementing this unit as my own scientific experiment in teaching and learning.

**CONCLUSION - PART II - REALITY CHECK**

I ask your forgiveness in the repeated phrase, "I will" (25 times!). This is terrible writing form but if I tried to search for variations, it would have ruined the presentation of the ideas as well as my sanity. Also, the master teacher in me was in constant war with the creative pie-in-the-sky teacher. The unit is wrought with classroom management problems, such as what to do with off-task students (In MY classroom? Impossible!) as well as materials procurement and signing up for the utility room for the large spaces necessary for the most jumping activity. I question the level of my optimism when I picture doing these activities in FOUR classes per day. I have inner questions as to whether the activities can be done in the time allowed or whether I will have the time to read the writing I'm requiring (That's why I didn't go into Language Arts). I've learned that one of my greatest faults is that I plan twice as much as what is do-able in the time given. When I'm down in the trenches, it's a great temptation to just say, "Uncle", and head back to the safe seatwork, notes from the overhead and quizzes on Friday. Therefore, a real PLUS to taking this class and writing this paper is that it has a high level of commitment to it. Thank you. Are you SURE I won't need to come to MT in November in order to fulfill the requirements of this class? I may need some R & R in the serene surroundings of the REAL world!

**Research Team Checklist**

**ORAL REPORT**

Did the group;  YES SORT OF NO
(2) (1) (0)
…give at least one idea that was thought of but not tried?

…explain their plan clearly?

…summarize their results?

…tell what they'd do over or differently?

**WRITTEN REPORT**

Did the group;  YES SORT OF NO
(2) (1) (0)

…record at least 1 thought/idea for each member of the group?

…describe a brief plan of how the experiment would be run?

…follow through on the plan?

…record any measurements used during the experiment?

…summarize the results?

…list ideas for a "Plan 2"?

**COMMENTS:**
Pre-Post test

Vocabulary-Matching

a) Hypothesis  b) data table  c) graph  d) test variable  e) responding variable  f) summary  g) procedure  h) question

1.__________  What scientists always begin an experiment paper with.

2.__________  The unknown information that you get when you experiment.

3.__________  The prediction for an experiment (best when expressed in an "if - then" statement).

4.__________  A set of boxes that organize your data in columns and rows.

5.__________  The variable that you are testing to see if it has an affect on the results of your experiment.

6.__________  A list or recipe for your experiment so that someone else could copy your experiment.

7.__________  The part of your experiment report that gives your results without repeating all of the data.

8.__________  A visual picture of your data, that shows whether your responding variable was affected by your testing.

9. Putting the steps in order - Put the following in order from first step to last step. Put a "1" by the first step, 2 for the second step continuing until you have identified all of the steps.

__________  Procedure
__________  Question
__________  Hypothesis
__________  Summary
__________  Experimenting

Lab Terms

a) speed  b) pigment  c) polymer  d) friction  e) buoyancy  f) gravity  g) binder  h) diluent

10.__________ A force that is present with air and any liquid that resists gravity.

11.__________ A ratio of measuring using distance and time.

12.__________ The substance that does the dissolving.

13.__________ The substance that provides the color in a substance.

14.__________ The force that any object has on another object. (like the earth's effect on you!)

15.__________ The substance that holds the pigment.

16.__________ A force that resists the forward motion of an object.

17.__________ A substance that has special properties because of its long chain of carbon and hydrogen atoms.
SAMPLE SITUATION in Paragraph-story. Students must;

Identify the question

Describe how they would design an experiment to solve it

3) Tell what they think would happen if they ran the test they designed

Tell what would need to be measured, how it would be measured and the unit the measurement would use.

(Tools?)

Explain what they would do if the results didn’t come out as they expected. Where might be places in the experiment that might contain errors? What could they change about the experiment that would get better results.

“One day, Jan watched his mother start dinner. She was making spaghetti. As she put the water on to boil, she put some salt into the water. Jan asked her why she added salt to the water when his dad was on a low-salt diet. "Oh, I do that because it makes the water boil hotter", was her reply. Jan wondered if that was true of if it was just a weird thing she’d learned from HER mother!

TOOLS AND EQUIPMENT

On the cart is some of the equipment that is/was useful in this lab. Each piece of equipment is labeled with a letter. By the letter on your test, write the name of the piece of equipment and tell what it is used to measure.

<table>
<thead>
<tr>
<th>Name of Equipment</th>
<th>What’s it used for?</th>
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<td>A</td>
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<td>C</td>
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<td>D</td>
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</tr>
</tbody>
</table>

RESOURCES


Woodward, Linda. Polymers all around you!. Miami University Middletown, Ohio: Terrific Science Press. (No date)

http://www.sedl.org/scimath/compass/v02n03/boat.html

Southwestern Educational Development Laboratory (Design Exploration: Power Boat Design)