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Facilitation Strategies

What facilitation and questioning strategies will you use to promote inquiry and engagement among your students?

Facilitation Strategies:
The entry event will be strategy to promote inquiry, questioning, and engagement among students. By posing a hypothetical situation (us running out of oil) to students they will want to know how likely this is and what can be done about it. They may even recognize the bias in the video and engage in discussion because they want to be contrarian.

While the debriefing sessions will certainly address specific issues from the previous days, the teacher can also use this time to pose question to guide the investigations for the day. For example, on Thursday of the first week, students will be asked to reflect and discuss the question "What ways can I improve as a team member and problem solver?" By guiding this discussion before students get to work for the day, students will be reminded of what is expected during inquiry and group work.

Socratic Dialogue if done correctly forces students to think critically. These can be open-ended questions with no specific answers over a section of an article that the students have read. This could be done before, during (for homework- flipped classroom idea) or after the unit.

> Using the article: Carbon-Negative Biofuels from Low-Input High-Diversity Grassland Biomass from AAAS. http://www.sciencemag.org/content/314/5805/1598.short
> (Permission to reprint this article for classroom use is easy to obtain and costs $0.)
> Using the following questions I would have students read this after the PBL or at the end of the unit.
> 1. After reading the first paragraph we will discuss the question: Does current biomass production compete for food production acreage?
> 2. After reading the data collected in the experiments we will discuss the following questions: Why do you think mixed grasses provides more bioenergy than some of the food-fuel sources? Is planting these mixed grasses beneficial both economically and using good stewardship principles for the use of the soils.
> 3. How does the information from this article tie into what we learned in the Biomass to Biofuels unit.
> 4.Is this information important in your everyday life and if so, how? if not, why not?

Questioning Strategies:

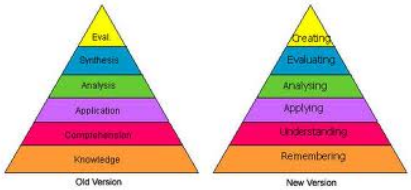
Questioning is a crucial component to teaching and to PBL. In order to be an effective questioner in the classroom, one must plan out the questions that you want to ask and also use tools so that you are asking higher level questions as well as the basic questions. One tool that we will use throughout our unit is that of Blooms' Taxonomy. Below are some of the tools that will be used to help us develop our essential questions throughout our unit.

The first visual shown displays Bloom's Taxonomy and the old and new versions of his pyramid. From this visual you can see that there are many types of questions one needs to ask and it is best

to ask questions from all different levels of the pyramid. We will use this pyramid not only to develop questions for our unit but also to display for the classroom as a whole so that students also are engaged in asking good questions.

Bloom's Taxonomy Pyramid

coe.uga.edu



Another tool that can be used to facilitate questions within the PBL Classroom is a Verb chart to help both students' and teachers' ask strong questions. This verb chart will be inside of the students' binders and also posted in the classroom so that it is visible. As a teacher, it will be handy to have this verb chart accessible to use at all times while facilitating instruction throughout the PBL as well as to help pose questions when students are conducting laboratories and working on their final projects.

Bloom's Taxonomy Verb Chart	
Knowledge (Recalling learned material)	recall, underline, list. name, record, label, cluster, match, memorize, define, arrange
Comprehension (Understanding the material)	understand, show, summarize, explain, describe, demonstrate, review, cite, restate, locate
Application (Using the material)	apply, select, model, organize, illustrate, utilize, choose, imitate, demonstrate, use
Analysis (Breaking material down to increase understanding)	analyze, compare, contrast, classify, map, characterize, divide, break down, choose, examine
Synthesis (Reshaping material into a new form)	construct, speculate, design, compose, create, develop, invent, blend, propose, formulate
Evaluation (Judging the worth of material)	evaluate, convince, argue, judge, criticize, rate, measure, persuade, assess, recommend

http://www.teaching-tips-machine.com/blooms_taxonomy.htm
http://www.in2edu.com/resources/thinking_resources/blooms_taxonomy_chart.pdf

With these tools we were able to come up with our essential questions for our PBL unit.

First we have our driving question which is our overarching question for the unit.
Driving Question:

- How can biological methods be effectively used to convert biomass to biofuel to meet our energy needs?

From here we developed our essential questions by looking at our core objectives.
The table below shows the questions that will be asked throughout the unit in conjunction with our core objectives.

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Core Objectives with Bloom Taxonomy

Students will be able to design and implement a controlled biomass to biofuels enzyme catalyzed reaction. (Synthesize/ Creating-Bloom)

- Can you design a controlled experiment where you use enzymes to catalyze a reaction to convert biomass to biofuels?

Students will be able to analyze the data from their experiments and revise based on their results (if needed). (Analyze-Bloom)

- How do your results compare and contrast with other groups?
- Based on your results, what would you do differently next time in order to improve your experiment?

Students will be able to communicate their own experimental designs and results to a group of their peers. (Comprehension/Apply-Bloom)

- Can you share your experiments' with other groups and the larger class?
- What did your experiments teach you about our driving question?
- Apply the knowledge that you learned from hearing the other groups to designing a more effective laboratory.

Students will be able to evaluate the experimental design and results of other groups. (Evaluate-Bloom)

- Can you assess other groups' design?
- What does the evaluation of your own design as well as the other designs teach you about biofuels to biomass?

Students will explain how it takes a reaction (possibly enzyme catalyzed) to convert biomass into a more usable form. (Comprehension-Bloom)

- How does biomass conversion take place? What happens?

Students will describe that biomass is composed of different plant parts that contain energy in their bonds. (Knowledge-Bloom)

- What is biomass?
- Where does the biomass get its' energy from?
- How is energy released from the biomass?

Students will be able to describe the importance of biomass to biofuels to support our energy needs. (Comprehension-Bloom)

- Why is biomass to biofuels important?
- How can biofuels to biomass be a solution to support our energy needs?

Students will be able to differentiate the differences between fossil fuels, alternative fuels and biofuels. (Knowledge/ Analysis- Bloom)

- What are the different types of fuels and what are each composed of?
- How do fossil fuels, alternative fuels, and biofuels compare to one another?

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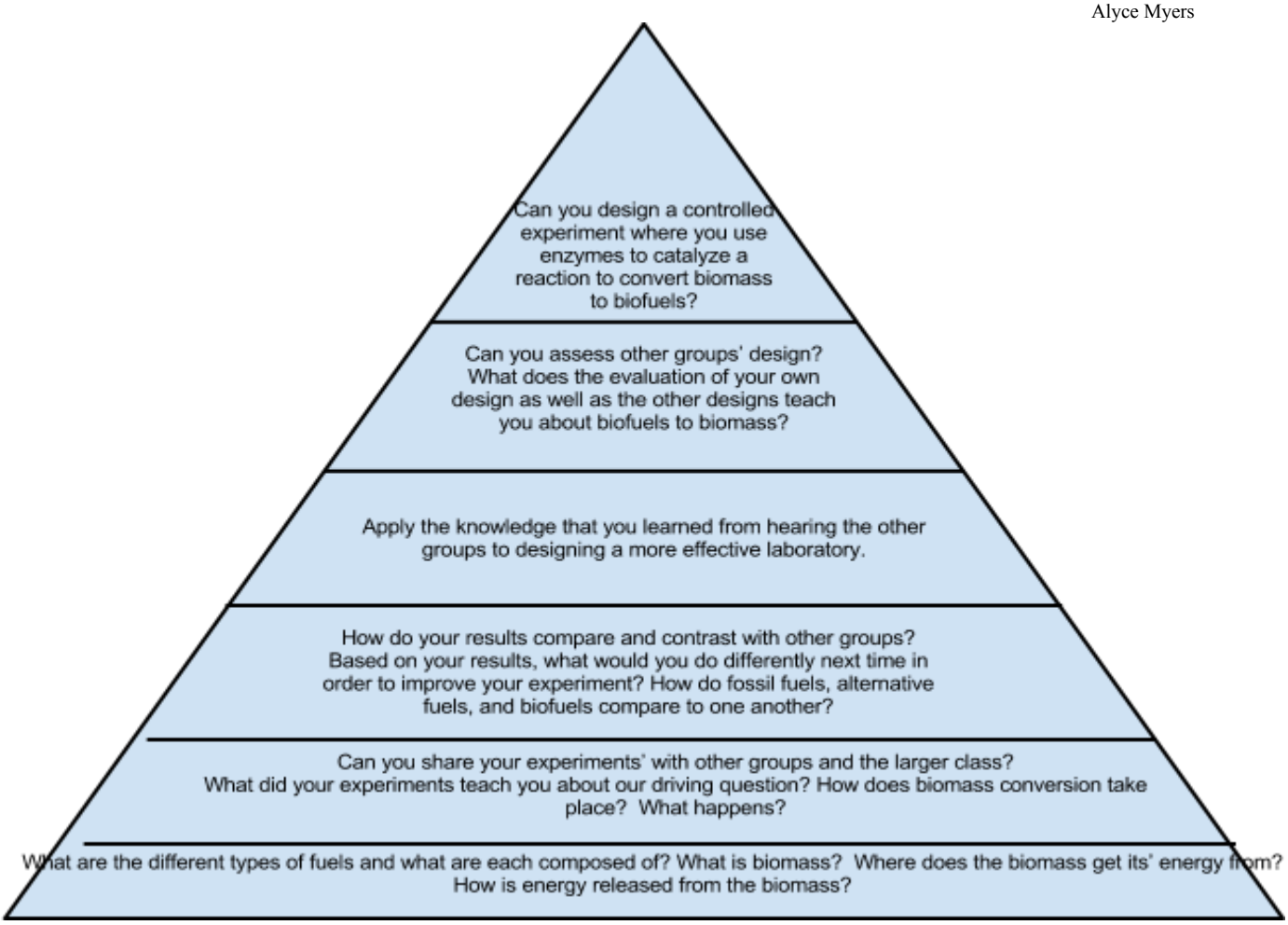


Above is another way of looking at the essential questions in this PBL unit as it pertains to Bloom's Taxonomy. As you can see there are a number of questions we need to ask and they are spread out at every level of Bloom.

- ***How will you collaborate with students without giving them answers?***

The teacher will observe students working on their experimental design and ask students questions while they are designing their experiments. These questions will help students revise their procedures. Examples of questions might be..."What variable are you testing?" "What are you measuring in this experiment?" "How will you collect data in this experiment?"
Also, the teacher will collaborate with students in their final product in a similar way. The teacher will observe the students working and the drafts of their product. Upon examining a draft of their project, the teacher can ask questions to the group. For example... "Does this product accomplish the goal?" or the teacher could ask the students within the group, "How could this product be improved?" to spark a conversation that moves the group forward.

- ***How will you facilitate student self-questioning?***

Students will be encouraged to self-questioning through the use of iterations in the design of their enzyme biomass lab. By working in groups and presenting their plans to the whole class, they will question each other to determine a better method of testing enzymes. By students questioning each other they will be better able to self-question.

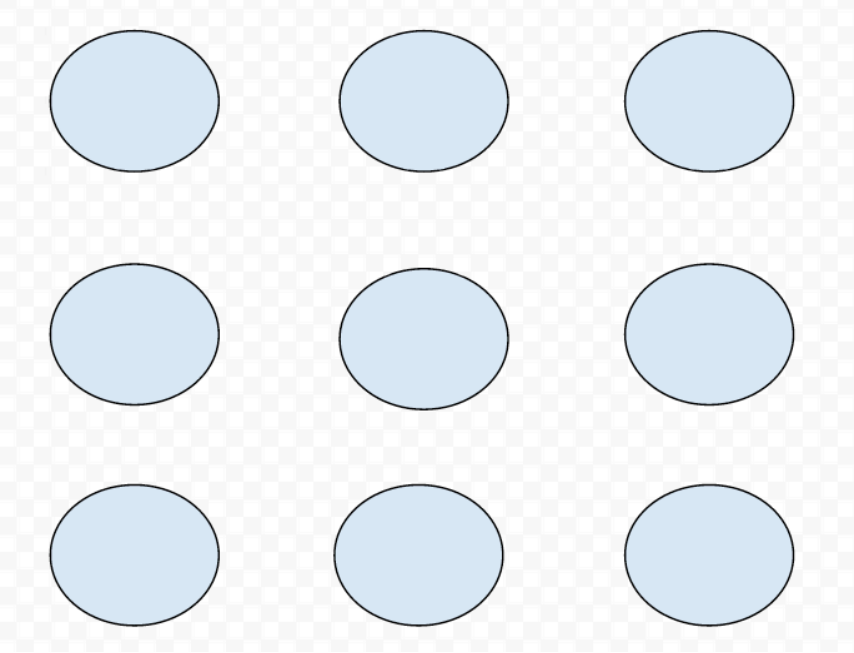
Student self-questioning will be facilitated through reflections at various points in the unit. The student activities timeline outlines on day 1 and day 5 a space for students to reflect on their understanding of biofuels and biomass.
Finally student self questioning will also be facilitated by models of Bloom and the verb chart that is presented at the beginning of this document.

- ***How will you facilitate student collaboration?***

Collaboration will be facilitated by using scaffolds (for example: Moon Survival Group Challenge or Checks Lab) to establish expectations for group work and collaboration prior to the unit. (These types of activities would happen prior to the unit and throughout the school year to work on to be successful in a group.) At the end class on days where they work in groups, students will be reflecting on the dynamics of their group and ways to improve. Then, we will debrief at the beginning of the next class about problems and successes groups are having with collaborating with one another.

- ***How will students be grouped and seated in the classroom?***

Students will be grouped based on teacher preference. Some teachers might use more random grouping strategies while other might use learning styles inventories. The same teacher might use different strategies for each individual class based on student needs. Our different classroom furniture and lab station structures require seating to be different from classroom to classroom. In ideal situations, students will be grouped in threes and able to spread out throughout the room. The diagram below shows how a PBL classroom should be set up. The circular tables promote collaboration and three individuals can be placed at each table or pod. Unfortunately most science classrooms do not have this flexibility, but teachers should aim to have students set up in their collaborative groups. This could occur at their lab stations or desks could be put together and moved around when needed.



- ***How will you help students decide on group roles?***

Groups can be given a set of tasks that they must complete as a whole. In the enzyme lab, students will need to determine their procedure, collect their materials, record their data, keep track of time, and analyze their data. Different students within the group could fulfill one or multiple roles from the list of tasks that need to be completed. A class discussion may prompt students to examine all of the tasks that need to completed. Groups can discuss who is best at fulfilling each of those roles.
Alternatively, the teacher could assign roles to students within groups if the group needs significant structure.

How will you help students set goals?
First, I will help students set goals by providing a rubric for their experimental design.
Second, I will help students set goals at the beginning of their product creation at the beginning of week three. I will attempt to establish a culture of healthy competition and cooperation as they try to make the most persuading piece of marketing material.

- ***How will you assure effective group work (using class time efficiently, ensuring equal participation among students)?***

If students need the structure, the teacher can assign roles to specific members in the group. Rubrics can be used to provide structure and clear expectation with regard to group work. Examples of roles that we might give include: Team Leader, Recorder, Lab Data Specialist, Technology Director, etc. Students might have more than one role at different times throughout the project dependent on the number in the group as well as what specific roles are available to play.
Also, students will be told they will have less time than I think they will need for group work. Meaning that we will give them extra time, however we will have a goal of 15 minutes and we might give more time as needed. Using checkpoints, a countdown timer, etc. gives students an idea of how much time they have and what they need to get done in the allotted amount of time.
Finally, to ensure equal participation among students multiple strategies will be used. First, individual grades will be earned for many parts of the work completed by the group. Second, students will evaluate their group members as a means of reflection and at the end of the project. Additionally, the teacher will continually attempt to have students tie evidence to their conclusions. Requiring students to support claims and use evidence within their group help ensure effective group work. Finally, the teacher will circulate the classroom and redirect those students who are off task.
Depending on the classroom, some other tools a teacher may use include: checklists, group task list, etc. Below are some examples of how teams can keep themselves on task and ensure equal participation among all students within the group. All of these ideas are found at www.bie.org and are available for free download.

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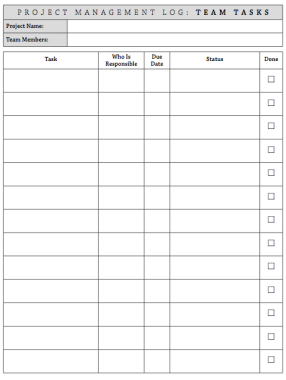
Project Team Contract

We promise to:

Date:

Team Member Signatures:



PROJECT MANAGEMENT LOG: **TEAM TASKS**

Project Name:

Team Members:

Task	Who Is Responsible	Due Date	Status	Done
				☐
				☐
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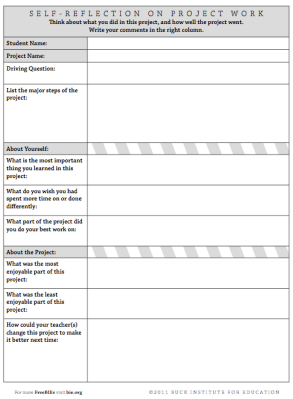

SELF-REFLECTION ON PROJECT WORK

Think about what you did in this project, and how well the project went.
Write your comments in the right column.

Student Name:	
Project Name:	
Driving Question:	
List the major steps of the project:	
About Yourself:	
What is the most important thing you learned in this project:	
What do you wish you had spent more time on or done differently:	
What part of the project did you do your best work on:	
About the Project:	
What was the most enjoyable part of this project:	
What was the least enjoyable part of this project:	
How could your teacher(s) change this project to make it better next time:	

- ***What kinds of non-directive strategies will you use (include specific examples)****?*

Guided Inquiry Lab-The teacher will not dictate the procedures for the lab. Students will devise a procedure, get approval and complete the experiment.
Open Ended Final Product-Students will be given the task of creating a piece of marketing to promote the use of enzymes in biofuels production. While this provides some direction, students will have many different creative outlets they could use.
Reflection-By asking students questions like "What did I learn about myself as a problem solver?" or "What am I thinking about today in regards to biofuels?" students are encouraged to think divergently, in a non-directive manner.

- ***How will you promote inquiry and engagement among your students?***

For the enzyme reaction lab, students will be responsible for selecting the starting materials, enzyme used and method for collecting data. They will also be responsible for devising a method for testing the impacts of one variable on the enzyme catalyzed reaction. This will be engaging for students as they have interact with the lab materials (and not simply complete a cookbook lab). Students will also be engaged in the evaluation of other groups experimental design.
Besides the enzyme experiment, students will inquire through internet research into specific biomass to biofuels reactions.

- ***What tools and techniques will you use to support engagement?***

I will use guided inquiry in the enzyme lab. The lab will require setting up, data collection, data analysis, and presenting. Also, after completing each trial from the lab students will share their results with the rest of the class in the form of a two by three dry erase board. When in groups of three, students are highly engaged during the lab and whiteboard sharing of results. If one student does most of the writing on the whiteboard, they may not be allowed to be the one who explains what is on the whiteboard. Also, while a group is explaining a whiteboard, the teacher may interrupt and have a disengaged student explain the rest of the whiteboard. This allows all three students to participate.
Another tool for engagement is the completion of the finished product. While monitoring the completion of this project, the teacher will check to ensure it is not simply the product of one student. The teacher can suggest and assign roles for the completion of the final product, as necessary.

- ***When will debriefing and reflection activities occur? When will students reflect on their group processes?***

These take place at the end of a class or the students may reflect and the teacher may debrief at the start of the next class. There will be questions that direct student reflections after milestone activities so that we can access and address any problem areas or misconceptions. There will also be a reflection of the final product at the end where students are able to reflect on their learning and their performance in the group.

- **How will students monitor their development as team players and problem-solvers? What strategies will you use to help students debrief and reflect on.**

The teacher will pose questions such as "What am I discovering about myself as a problem solver?" or "What am I learning about myself as a team player?" or "What could I do to improve my problem solving and/or teammate qualities?" The answers to these questions can be used by the teacher to guide a debriefing session on the following day. Each day during the initial debriefing sessions problem solving and team behavior will be addressed as necessary. By having this at the beginning of each class session, the teacher is being proactive in facilitating student development in these areas.

The teams may also use a variety of documents depending on the group and the teachers' needs. Some examples include: Team Management Log, Team Contracts, Reflections. Please refer to the documents above to get examples of the team management log, team contracts, and self reflection forms.