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WRNC 2017 - Fresno, CA

From Cookbook to Inquiry in STEM Classroom

“I hear... I forget; I see... I remember; I do... I understand.”
- Chinese proverbs.

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As presented by *teach*HOUSTON at the University of Houston

5-E Lesson Plan aka a Hero's Journey (Ramsey Musallam)

Engage	Introduces the lesson and captures student's attention
Explore	New concepts are discovered through inquiry-based activities
Explain	Building new concepts through discussion
Elaborate	New learned concepts will be applied to new situations
Evaluate	Assesses students' new knowledge

Engage: Cookbook Lesson Example

- What are some teaching strategies you observed in this lesson?
- What are the advantages?
- What are the disadvantages?
- From a student's perspective, what do you think of this lesson's setup?
- From a teacher's perspective, what are your thoughts on this lesson?

Explore: Getting Wired for Circuits

- In a **group at your table**, explore the Getting Wired for Circuits activity.
- You will have **15 minutes** for this activity.
- While you participate in the explore activity; **observe the differences between the cookbook video and inquiry explore activity.**
- **Write your observations on the two sheets provided!**

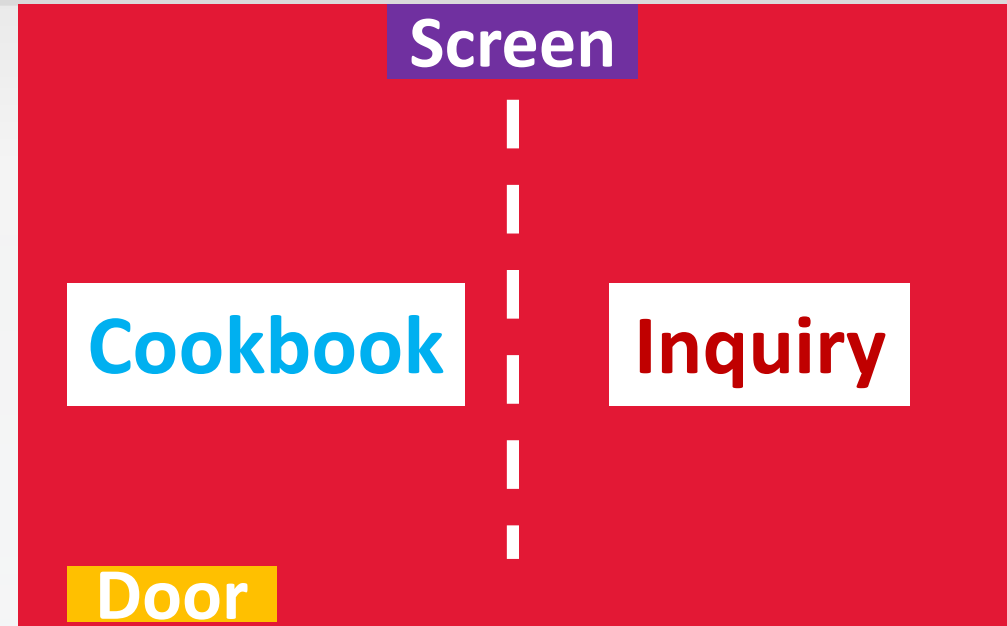


Explain: Cookbook vs. Inquiry

- We gave you a mystery card and the card's content should have either the characteristics of a cookbook lesson or an inquiry lesson.
- Our room will be divided in half.
- The **left side** of room will be **cookbook**, and the **right side** of the room will be **inquiry**.
- Your **task is to determine which side of the room you belong to**.
- **It's time for Family Feud**



FF



Explain: Cookbook vs. Inquiry

Cookbook	Inquiry
Driven with step-by-step instructions requiring minimal intellectual engagement.	Driving by questions requiring ongoing intellectual engagement using higher-order thinking skills.
Verifying information previously communicated in class. (Abstract to Concrete)	Collecting and interpreting data to discover new concepts, principles, or laws. (Concrete to Abstract)
Students execute imposed experimental designs that tell students which variables to hold constant, which to vary, which are independent, and which are dependent.	Students create their own experimental designs; independently identify, distinguish, and control pertinent independent and dependent variables.
Rarely allow students to confront and deal with error, uncertainty, and misconceptions.	Allow for students to learn from their mistakes and missteps; provide opportunity recover from mistakes.
Show the work of math and science to be unrealistic linear process.	Show the work of math and science to be recursive and self-correcting.

Adapted from “Experimental inquiry in introductory physics courses”
Carl J. Wenning Ed.D. (2005)

Explain: Cookbook to Inquiry Process

	Traditional Hands-on	Structured Inquiry	Guided Inquiry	Student Directed Inquiry	Student Research Inquiry
Topic	Teacher	Teacher	Teacher	Teacher	Teacher/Student
Question	Teacher	Teacher	Teacher	Teacher/Student	Student
Materials	Teacher	Teacher	Teacher	Student	Student
Procedures/ Design	Teacher	Teacher	Teacher/Student	Student	Student
Results/ Analysis	Teacher	Teacher/Student	Student	Student	Student
Conclusions	Teacher	Student	Student	Student	Student

“Inquiry: Learning from the past with an eye on the future” Ronald J. Bonnstetter (1998)

Explain: Cookbook to Inquiry Process

- **Questioning**
 - **Avoid answering directly**
 - **Student's Question:** "What is the Voltage in a circuit?",
 - **Teacher's Answer:** "What do we need to determine the Voltage of a circuit?"
- **Taking data/Experimenting/Analyzing data**
 - **Allowing students to come up with alternative solutions or methods to get the same results.**
- **Encouraging active participation**
 - **Set clear rules such as:**
 - **Must participate for credit, individual participation grades, structure for presenting results, time limits for individual participation within a group.**

Elaborate: Cookbook to Inquiry

- Each group will have a cookbook sample lesson in either Math, Chemistry, or Biology.
- Your task is to **convert** the **cookbook lesson** **into** an **inquiry lesson**.
- You will have **10 minute** for this activity
- Be prepare to share with your peers.

Elaborate: Biology Cookbook to Inquiry

Darwin's Natural Selection Worksheet

Name _____

Read the following situations below and identify the 5 points of Darwin's natural selection.

- 1) There are 2 types of worms: worms that eat at night (nocturnal) and worms that eat during the day (diurnal). The birds eat during the day and seem to be eating ONLY the diurnal worms. The nocturnal worms are in their burrows during this time. Each spring when the worms reproduce, they have about 500 babies but only 100 of these 500 ever become old enough to reproduce.



- a. What worm has natural selection selected AGAINST? _____

FOR? _____

- b. Darwin's 5 points: Identify the 5 points in the scenario above.

Population has variations.

Some variations are favorable.

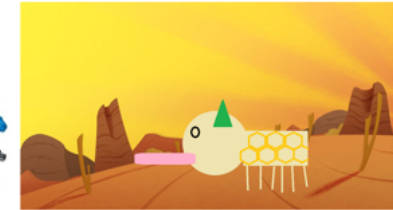
More offspring are produced than survive. _____

Those that survive have favorable traits.

A population will change over time.

Build Your Own Beast

In your groups, use the materials in the boxes provided to build an organism that best suits the environment given. Get ready to defend your choices!



Now that you have created an organism that suits your environment, share with the class the characteristics of your environment and why the traits you chose best suit that area.

What do you think would happen if we put Group A's organism in Group B's environment?



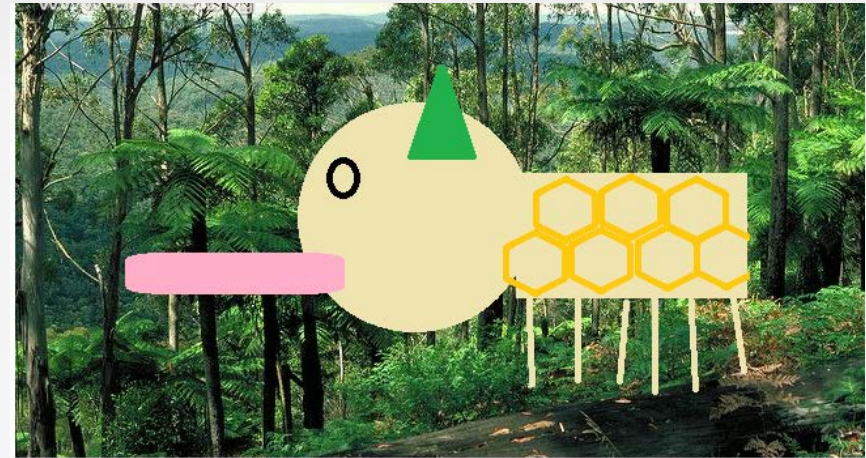
A cookbook lesson where the students are expected to read scenarios and answer the same questions repeatedly

In an inquiry lesson, students are hands on and build on previous knowledge through an interactive activity

Elaborate: Biology Cookbook to Inquiry

Addressing Common Misconceptions

- Cookbook lessons do not address the misconceptions with evolution and natural selection
- Natural selection DOES NOT lead to perfection- it's best suited in that environment!
- This is portrayed when they talk about moving the organisms to different environments

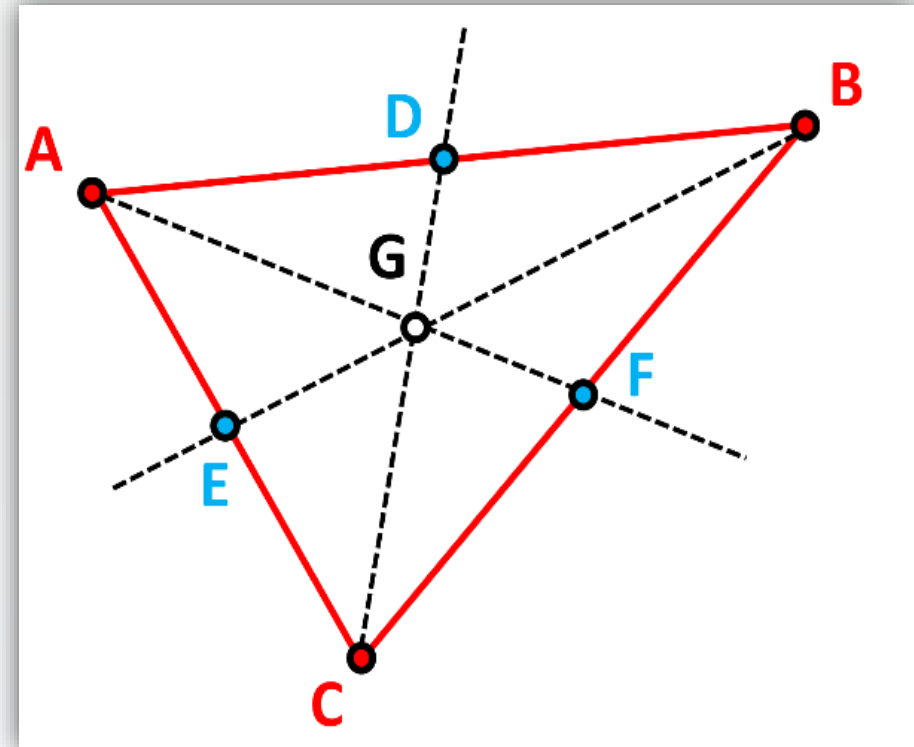


Elaborate: Math Cookbook to Inquiry

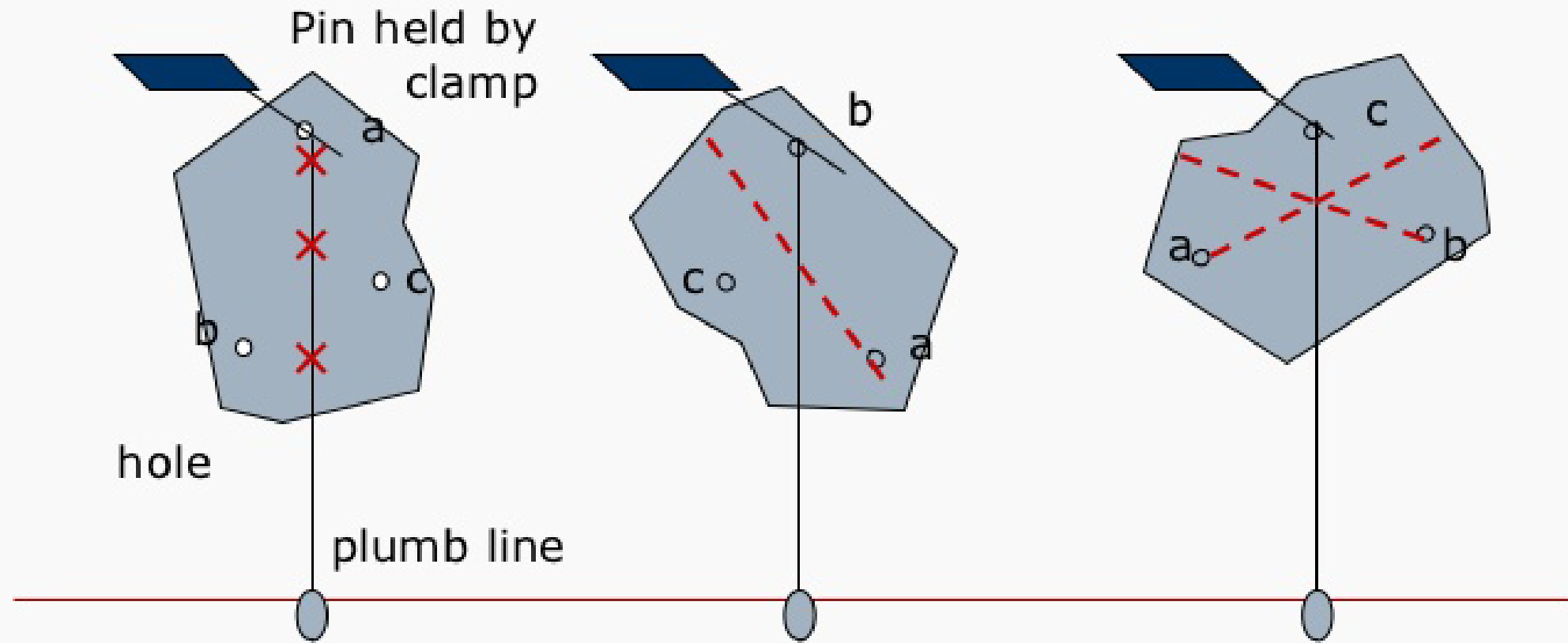
Below is an **example of a cookbook investigation** leads students through a **step-by-step process**.

Sketch and Investigate:

- Construct triangle ABC in the box provided below.
- Construct the midpoint of segment AB . Label it D .
- Construct the midpoint of segment BC . Label it F .
- Construct the midpoint of segment CA . Label it E .
- Construct a line from vertex A to point F . (the median of BC).
- Construct a line from vertex B to point E . (the median of AC).
- Construct a line from vertex C to point D . (the median of AB).
- A centroid of a triangle is the point where the three medians of the triangle meet. (point G)
- The centroid is also called the center of gravity of the triangle.



Elaborate: Math Cookbook to Inquiry

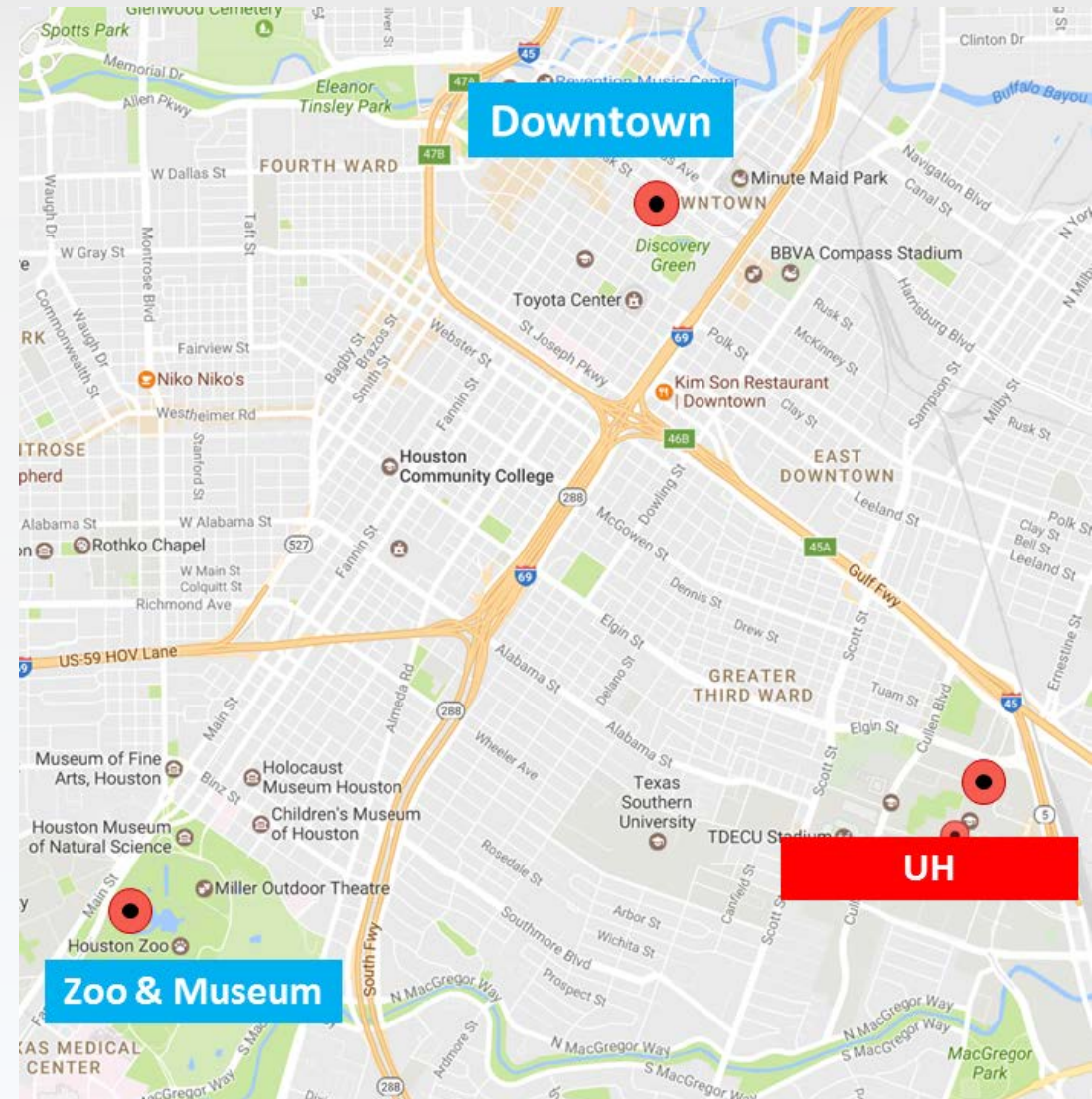


Elaborate: Math Cookbook to Inquiry

Below is the **Inquiry version of finding the centroid**

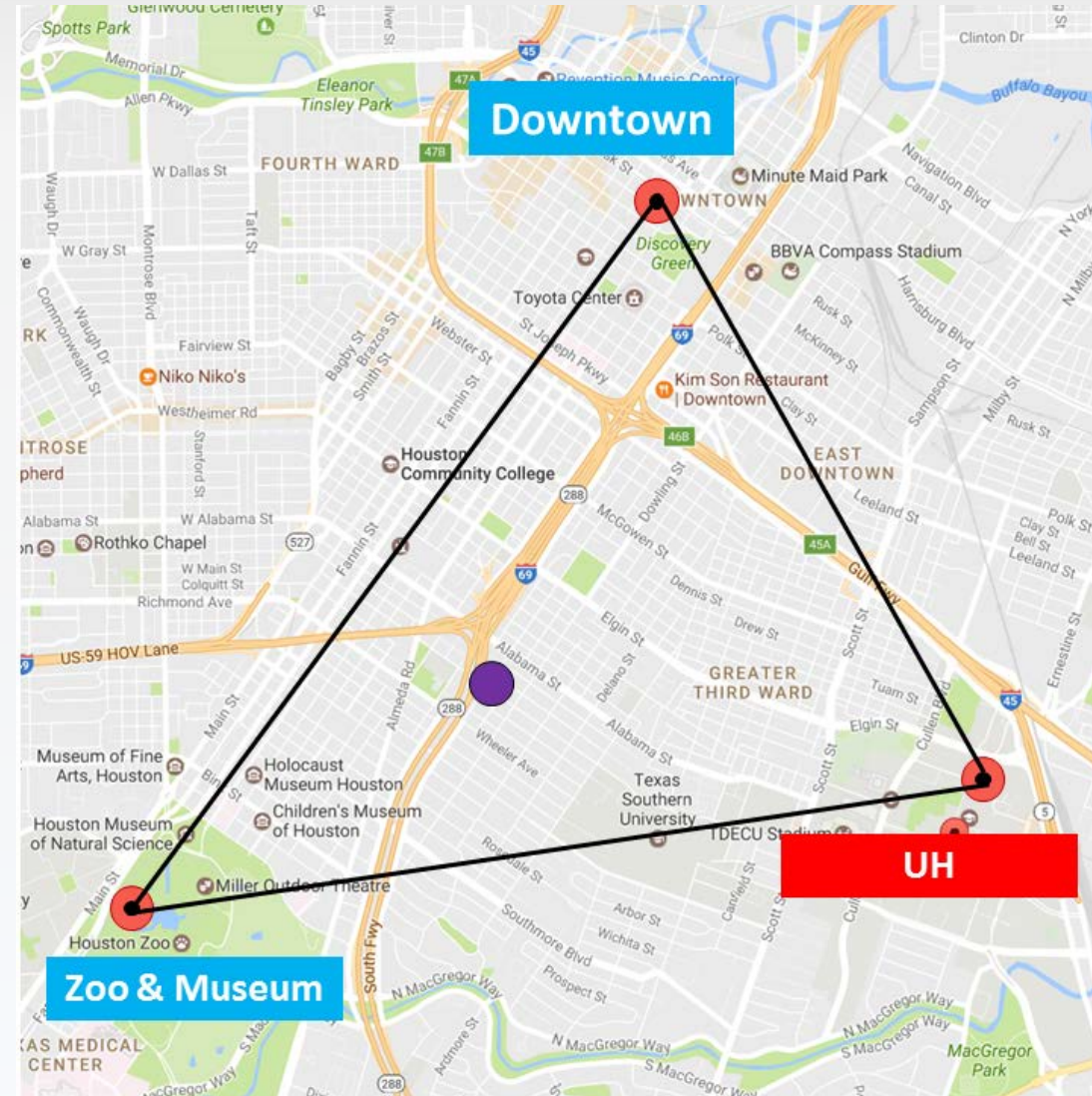
A new life in Houston, TX

Your old friend from college need your help about planning to move to Houston, TX. He is looking for a house equidistant to the University of Houston, downtown, and the zoo and museum district (using the map provided on the right). Locate such a site or sites on the map and let him know how you located where your friend should live. Be prepare to present your solution in class by showing your work using GeoGebra.



Elaborate: Math Cookbook to Inquiry

Student incorrect conjecture that the house lies within the triangle formed by connecting the three schools with the line segments.



Elaborate: Math Cookbook to Inquiry

Student utilized GeoGebra to find the midpoint of each line segment and connect them to each points to determine the centroid.

GeoGebra

File Edit View Options Tools Window Help

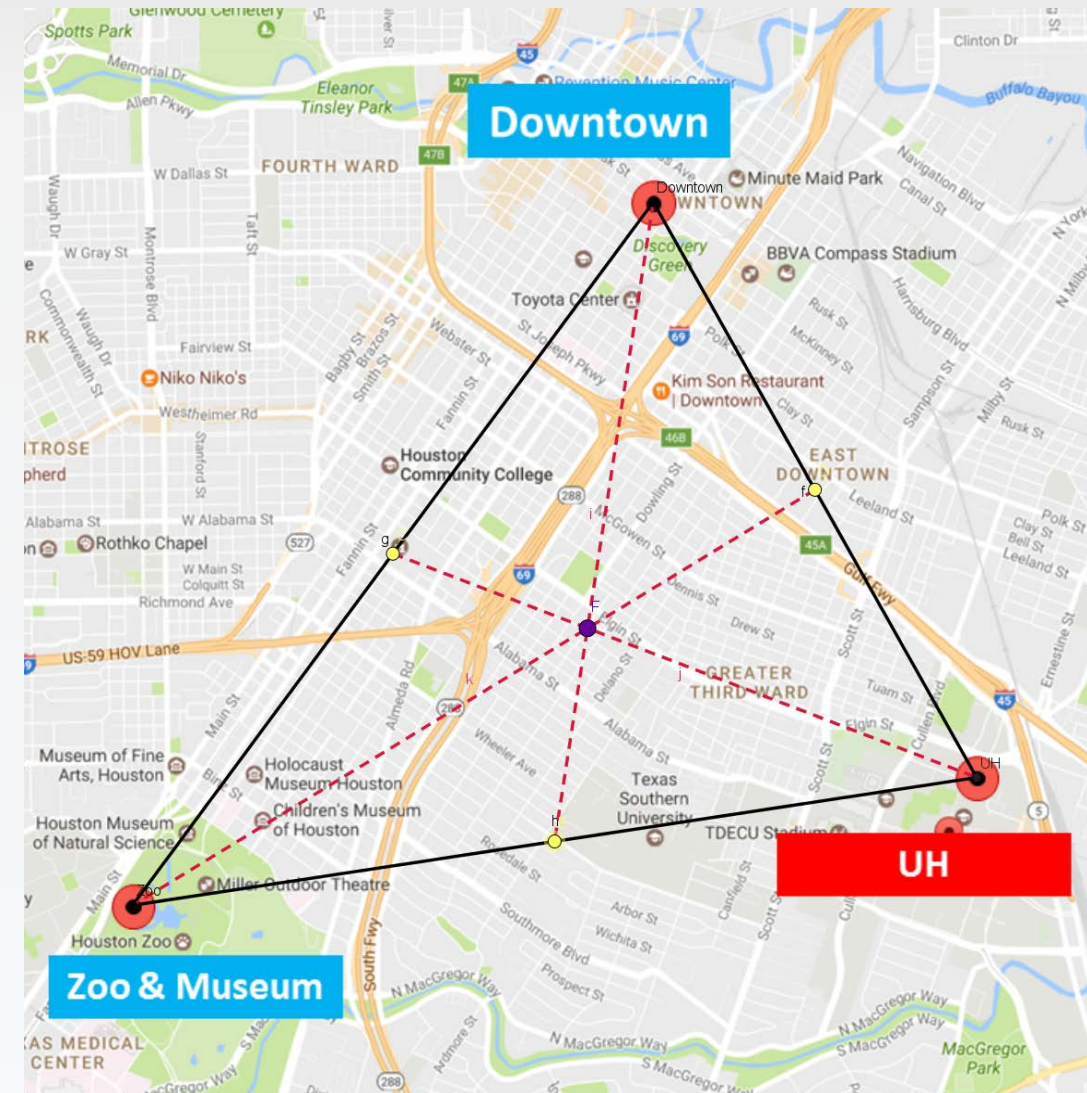
Segment Select two points

Algebra

- Point
 - A = (0, 0)
 - B = (40, 0)
 - C = (16.6, 11.22)
 - D = (25.38, 12.54)
 - Downtown = (22.02, 18.49)
 - E = (19.97, 5.26)
 - F = (20.65, 9.67)
 - UH = (28.75, 6.58)
 - Zoo = (11.18, 3.94)
- Segment
 - f = 13.68
 - g = 18.14
 - h = 17.77
 - i = 13.39
 - j = 13
 - k = 16.6

Graphics

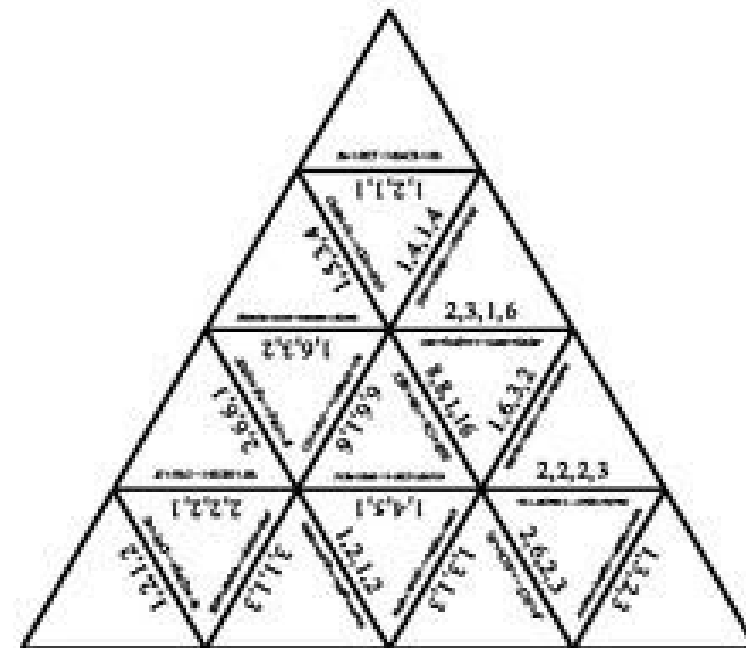
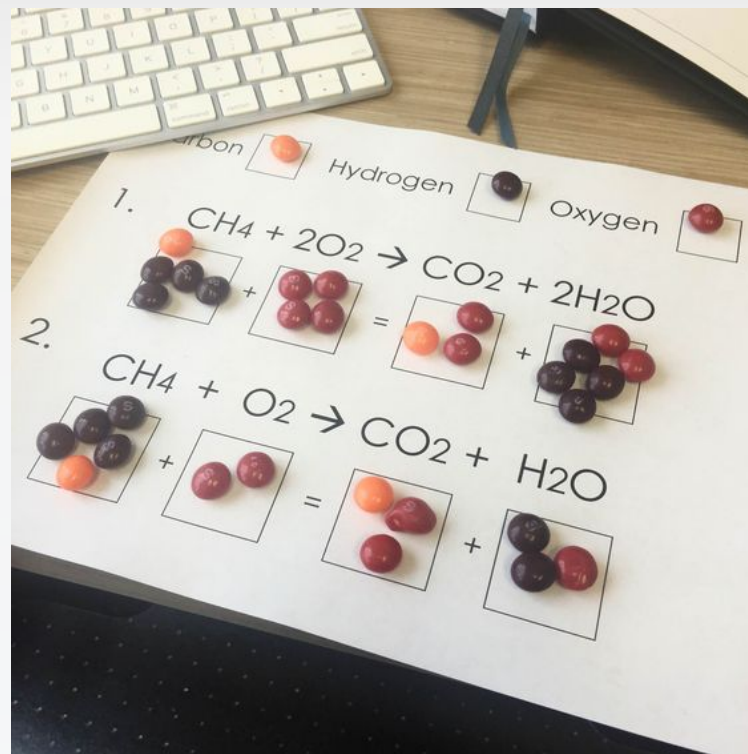
(2.11, 23.1)



Elaborate: Chemistry Cookbook to Inquiry

Balancing Equations Worksheet

- 1) ___ Na_3PO_4 + ___ KOH \rightarrow ___ NaOH + ___ K_3PO_4
- 2) ___ MgF_2 + ___ Li_2CO_3 \rightarrow ___ MgCO_3 + ___ LiF
- 3) ___ P_4 + ___ O_2 \rightarrow ___ P_2O_3
- 4) ___ RbNO_3 + ___ BeF_2 \rightarrow ___ $\text{Be}(\text{NO}_3)_2$ + ___ RbF
- 5) ___ AgNO_3 + ___ Cu \rightarrow ___ $\text{Cu}(\text{NO}_3)_2$ + ___ Ag
- 6) ___ CF_4 + ___ Br_2 \rightarrow ___ CBr_4 + ___ F_2
- 7) ___ HCN + ___ CuSO_4 \rightarrow ___ H_2SO_4 + ___ $\text{Cu}(\text{CN})_2$
- 8) ___ GaF_3 + ___ Cs \rightarrow ___ CsF + ___ Ga
- 9) ___ BaS + ___ PtF_2 \rightarrow ___ BaF_2 + ___ PtS
- 10) ___ N_2 + ___ H_2 \rightarrow ___ NH_3



Evaluate (Closure): Think-Pair-Share

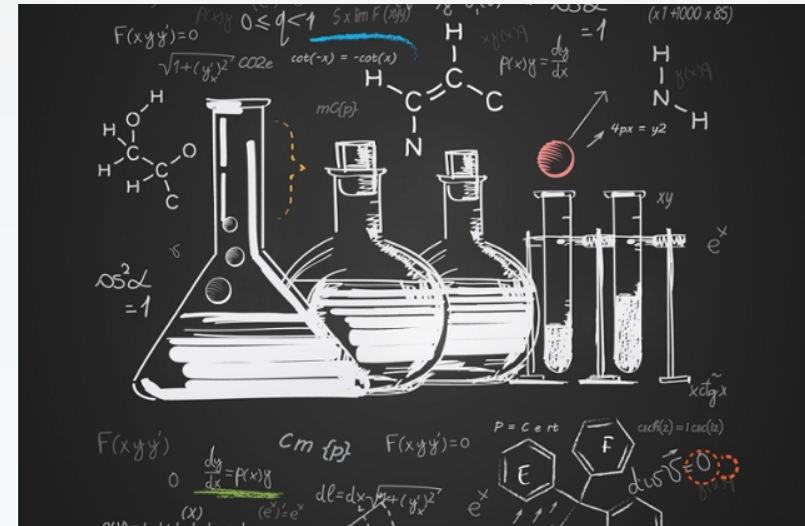
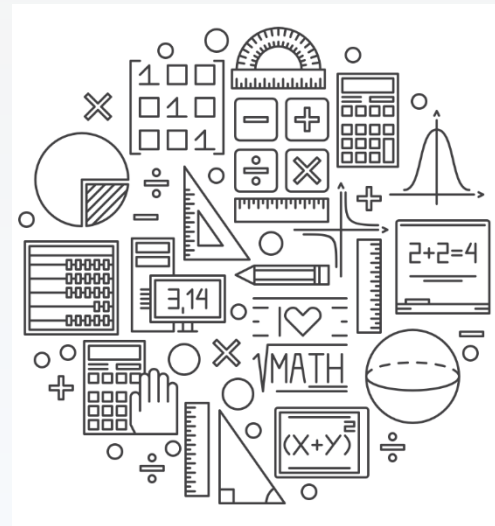
- In your groups talk for **2 minute** about some of the **things you learned today and/or enjoyed** from this presentation.
- You will **share 1 thing as a group**, so get your group's speaker ready as well.



Important Message

“Sometimes it is the people no one imagines anything of who do the things that no one can imagine.”

- Alan Turing



Acknowledgements :



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References:

- **Wenning, C. J. (2011, Summer). Experimental inquiry in introductory physics courses. http://www2.phy.ilstu.edu/pte/publications/exp_inq_intro_courses.pdf**
- **Bonnstetter, Ronald (1998). Inquiry: Learning from the past with an eye on the future.**

Thank you!

- Questions?
- Feedback?
- Noyce 2017 Survey Link: <http://tinyurl.com/wrni17fb>

- Presentation will be available on:
<http://www.uh.edu/nsm/physics/undergraduate/noyce-scholarship/>