THE FOURTEENTH ANNUAL SCIENCE AND MATH EDUCATORS CONFERENCE (SMEC 14)

Science and Mathematics Education Center (SMEC)
Faculty of Arts and Sciences
American University of Beirut, Lebanon

SMEC 14 – CONFERENCE PROCEEDINGS

(ENGLISH AND FRENCH SECTION)

PART TWO: DEVELOPMENTAL WORKSHOP SESSIONS

THE FOURTEENTH ANNUAL SCIENCE AND MATH EDUCATORS CONFERENCE (SMEC 14)

Science and Mathematics Education Center (SMEC)
Faculty of Arts and Sciences, American University of Beirut, Lebanon
March 31st, 2012

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We do apologize for any significant omissions.

SMEC 14 MISSION STATEMENT

The SMEC Conference is an annual event designed to promote the continued development of a professional community of mathematics and science educators across Lebanon and throughout the region. Specifically, the conference aims to:

- Provide an intellectual and professional forum for teachers to exchange theoretical and practical ideas regarding the teaching and learning of mathematics and science at the elementary, intermediate, and secondary levels

- Provide a forum for teacher educators and researchers to share their findings with science and mathematics teachers with a special emphasis on the practical classroom implications of their findings

- Provide an opportunity for science and mathematics teachers to interact with high-caliber science and mathematics education professionals from abroad

- Contribute to the ongoing development of a professional culture of science and mathematics teaching at the school level in Lebanon and in the region

- Raise awareness of science and mathematics teachers about the array of curriculum and supplemental classroom materials available to them through publishers and local distributors

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Part Two
Interactive Sessions: Developmental Workshops

Interactive Sessions: Developmental Workshops

MATHEMATICS

Teach Math to Students the Way They Want to Learn

Dounia Sawan

Introduction

If students don't learn the way we teach them, then we must teach them the way they learn! Teaching Mathematics to 21st century learners requires the use of innovative strategies to engage students in interactive learning experiences that foster their higher order thinking skills. Through discussion and interactive activities, participants experienced some math teaching strategies that make students recall the content taught to them by engaging them in active learning experiences. Learning increases when Math is taught to students using strategies such as brainstorming, PBL, cooperative learning and mnemonic devices. This session emphasized several interactive activities that showcased some of the most efficient strategies in teaching Math objectives. The goal was for the participants to be able to apply these strategies in their classrooms. By the end of the session, participants found out the what, why, and how for each strategy.

Description of the session

The session was divided into three parts separated by two breaks and was planned as follows:

(a) *Introduction*

- Warm Up Activity "Fold your arms": to engage participants and introduce the workshop objectives. **(10 mins)**
- What do you know about the ways students learn?
- Brainstorming Activity: to build background, participants were given a question to which there may be multiple answers. They participated in a brainstorming session, in which they generated multiple ideas while adhering to the following DOVE guidelines: ***D***efer judgment when others are responding, only ***O***ne idea at a time is given, a ***V***ariety of ideas are encouraged, and everyone was expected to direct his/her ***E***nergy to the task. **(15 mins)**

(b) *Discussion* of the definition of brainstorming (why, how) followed by a brief list of examples that can be used in classrooms (carousel brainstorming, KWHL, think–pair-share…etc) **(10 mins)**

(c) *Activity 1:* For this activity, students worked in groups of four of five in which they were involved in a sample project that required them to collect and analyze data from a survey. Participants first selected a topic of interest to them and then determined how they will collect the data, what the sample size should be, who should be sampled, and what type of

graph (circle, line, bar, etc…) would be best for depicting the data. This activity was followed by a brief presentation from each group. Then participants defined the name of this strategy: Project–Based and Problem–Based Instruction and gave examples. **(30 mins)**

(d) *Break 1: "Make Learning Math Fun":* To motivate participants and help them to implement the same activity in their classes in order to make the session more fun. Participants defined the name of this strategy: Humour. **(10 mins)**

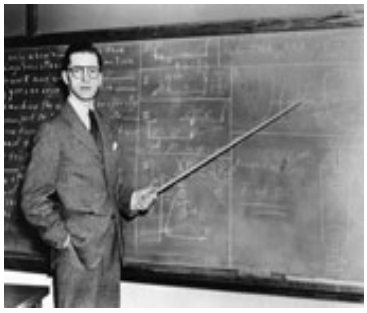
(e) *Activity 2*: Participants were placed in cooperative groups and were asked to solve a set of problems. They were individually accountable for their work, and the work of the group as a whole was also assessed. Cooperative groups require working face -to -face and learning to work as a team. A brief presentation of the set of problems for each group will follow. Participants defined the name of this strategy: cooperative learning while keeping in mind that there are plenty of models for cooperative and collaborative teaching strategies: Think, Pair, Share technique; Jigsaw…..etc At the end, participants watched a video of my students engaged in cooperative learning activity. **(25 mins)**

(f) *Break 2: "Making Math Easy":* Participants created mnemonics, which are slogans or phrases used to help students understand and remember information that may be difficult to recall, such as PEMDAS, MEST, SOH CAH TOA…Then, participants defined the name of this strategy: mnemonic devices. **(10 mins)**

(g) *End of the session:* Participants were invited to answer the following question: Which of the strategies we've covered would you like to try in your own classes? The answers were posted on the wall for discussion. **(15 mins)**

SMEC 14,AUB,2012
Teach Math To Students The Way They Want To Learn

Presented by: *Dounia Sawan*
Math Teacher and Coordinator at H.H.S

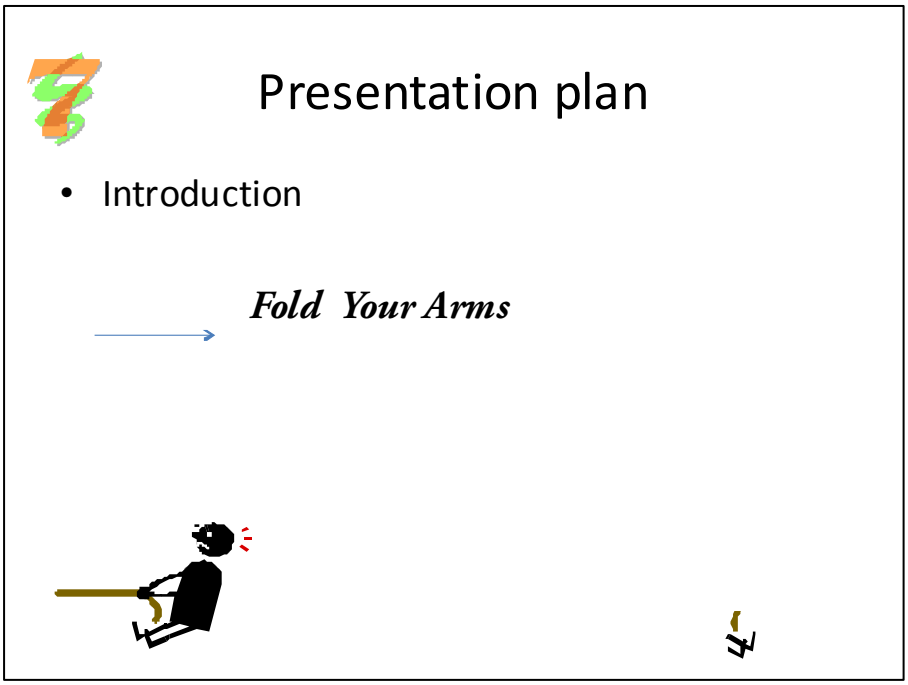


SLIDE 1

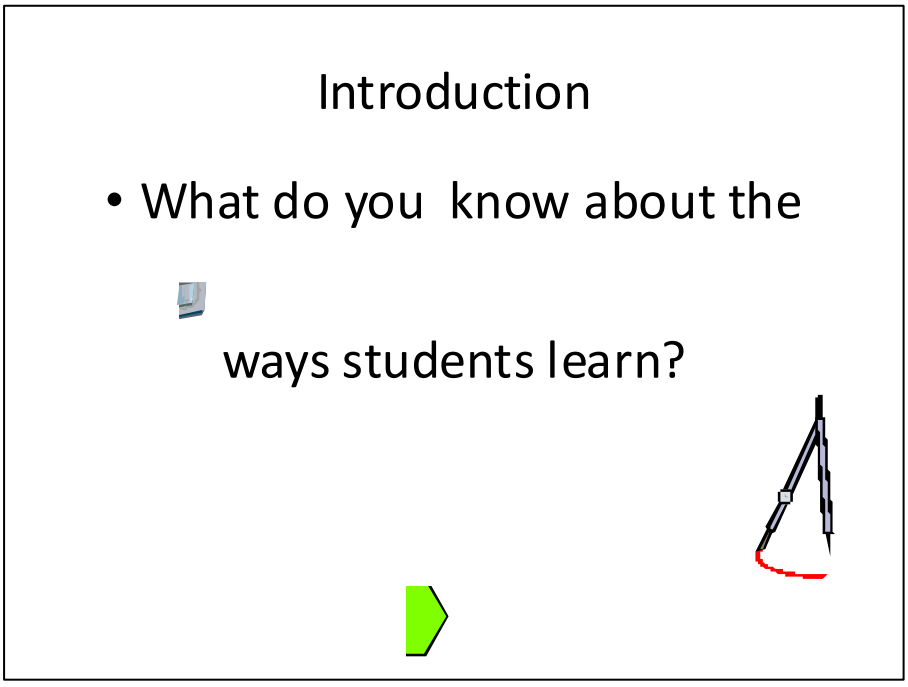
Goals of the workshop:

- Acquire many useful strategies to implement in your classrooms.
- Create a plan of your own as a result of being here today.

SLIDE 2



SLIDE 3



SLIDE 4

Question 1:

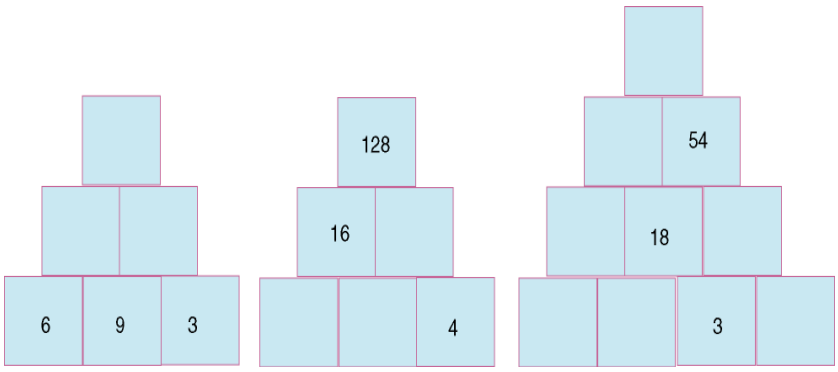
- Which number does not belong ?

6	15
10	12

SLIDE 5

Question 2:

- Use multiplication to solve these arrays:



SLIDE 6

#1 Socialization
Brainstorming and Discussion

- Activity or technique to encourage the creative generation of ideas -- usually a group process, in which group members contribute suggestions in a spontaneous, non-critical manner.

SLIDE 7

Why?

- Humans are social
- Silence is not natural
- Talking leads to breathing
- Brainstorming improves comprehension and leads to higher-order thinking

SLIDE 8

How?

- DOVE Discussions : Defer judgment, One idea at a time, Variety of ideas, and Energy on task
- Pair/Share , quick writes, problem solutions, explain a concept.
- Carousel Brainstorming
- KWHL

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DOVE:

- ***D***efer judgment when others are responding, only ***O***ne idea at a time is given, a ***V***ariety of ideas are encouraged, and everyone is expected to direct his or her ***E***nergy to the task.

SLIDE 10

Think, Pair, Share

- When students are solving math problems, have them use the ***think***, ***pair***, ***share*** technique. Students first individually ***think*** how they would solve the problem , then they ***pair*** with another student , and ***share*** their thought processes and answer to the problem. Both students should reach consensus to the correct answer . If their original answers differ, the discussion involved in convincing their partner that they are correct is invaluable to the learning experience.

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Carousel brainstorming

- While Carousel Brainstorming, students will rotate around the classroom in small groups, stopping at various stations for a designated amount of time. While at each station, students will activate their prior knowledge of different topics or different aspects of a single topic through conversation with peers. Ideas shared will be posted at each station for all groups to read. Through movement and conversation, prior knowledge will be activated, providing scaffolding for new information to be learned in the proceeding lesson activity.

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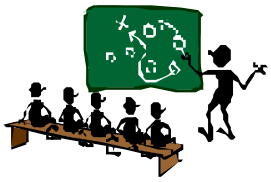
Procedure



- 1. Generate X number of questions for your topic of study and write each question on a separate piece of poster board or chart paper. (Note: The number of questions should reflect the number of groups you intend to use during this activity.) Post questions sheets around your classroom.
- 2. Divide your students into groups of 5 or less. For example, in a classroom of 30 students, you would divide your class into 6 groups of five that will rotate around the room during this activity.

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- 3. Direct each group to stand in front of a home-base question station. Give each group a colored marker for writing their ideas at the question stations. It is advisable to use a different color for tracking each group.
- 4. Inform groups that they will have X number of minutes to brainstorm and write ideas at each question station. Usually 2-3 minutes is sufficient. When time is called, groups will rotate to the next station in clockwise order. Numbering the stations will make this easy for students to track. Group 1 would rotate to question station 2; Group 2 would rotate to question station 3 and so on.

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- 5. Using a stopwatch or other timer, begin the group rotation. Continue until each group reaches their last question station.
- 6. Before leaving the final question station, have each group select the top 3 ideas from their station to share with the entire class.

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KWHL

K	W	H	L

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Description

- **K** - Stands for helping students recall what they **KNOW** about the subject.
- **W** - Stands for helping students determine what they **WANT** to learn.
- **L** - Stands for helping students identify what they **LEARN** as they read.
- **H** - Stands for **HOW** we can learn more (other sources where additional information on the topic can be found).

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Activity 1

- Make a survey.

1-Work in groups of 4 or 5 members.

2- Choose a topic (ex: What is your favorite brand and Why? What food should be served in the cafeteria most often?...)

3-Collect and analyze the data , what the sample size should be , who should be sampled , and what type of graph (circle , line , bar,etc...)would be best for illustrating the data.

4- Presentation

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#2 Project-Based and Problem Based Instruction

"Problem-based instruction enables students to learn math content as they solve the same problems that people in the real world (architects, scientists and engineers) have to solve (Ronis,2006).

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PBL

Project -based learning varies from classroom to classroom , but is often characterized by the following attributes:

- Allowing student a degree of choice on topic and/or project presentation/product.
- Resulting in an end product such as presentation written recommendations for solving a large scale real-world problem.
- Involving multiple disciplines.
- Varying in duration from one period to a whole semester.
- Featuring the teacher in the role of facilitator rather than leader.

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Why?

- Develop language skills through discussion.
- Cognitive (basic) and metacognitive (higher-order) thinking skills are stimulated when students interact with other students in a group while solving problems.

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How?

- Create real-world problems
- Involve students in planning
- Use authentic tools as projects, portfolios…..
- Provide students with opportunities to reflect on their thought processes.

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Break 1:
Make Learning Math Fun

- Question 1:Why is simplifying a fraction like powdering your nose?
- Answer: It improves the appearance without changing the value.

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- Riddle : What did the number **0** say to number **8**?
- Answer: Where did you get that belt?

Questions

- **Q1: Ahmad had 8 cows. All died except 5. How many cows are left?**
- **Q2: Which is heavier: a kilo of iron or a kilo of cotton?**
- **Q3: A cord is 1 meter at 1 o'clock. What is its length at 4 o'clock?**
- **Q4: A snake that has no legs is not tied with a cord.**
  A duck that has 2 legs is tied with two cords.
  A turtle that has 4 legs is tied with 4 cords.
  How many legs have a dog that is tied with 6 cords?

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3 Humor

- "A good joke is like a good math problem… the punch line is unexpected, and you have to think to get it."
  Any teacher will tell you that one of the hardest things about being a teacher is keeping students engaged. One of the best methods for keeping students focused on your class is using humor. By keeping a few simple rules in mind, you can use humor in the classroom to help your students learn, even if you're not a natural comedian.

  "As a professor, I'm basically performing three times a week. I like to be funny and to make my students laugh," said professor Edward Burger's , Dr in mathematics at the university of Texas at Austin.

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Why?

- Laughter increases alertness and memory
- Positive experiences improve memory and performance
- Humor and laughter reduce stress

- Group laughter builds community relationships
- The creation of jokes not only reinforces students' conceptual understanding but also encourages students to use their higher –level thinking skills.

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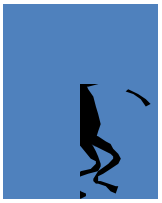
How?

- Incorporate cartoons, riddles, and jokes which reinforce learning
- Students can design cartoons or humorous stories that demonstrate understanding



- Cooperative groups write and solve content related riddles
- Provide feedback with a humorous device (clapper, horn, bubbles)

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Activity 2

- i-Work in groups of 4 or 5 members.
- ii- Cooperative groups : A,B,C,D,E

Tasks

1-Reporter

2-Recorder

3-Material Manager

4-Time Keeper

5-Facilitator

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#4 Reciprocal Teaching, Cooperative Learning, and Peer Coaching

"Share what you know and feel memories grow"

(Sprenger,2006b)

"Children learn best when they have the opportunity to discuss ideas with their peers in ***a nose to nose*** and ***toes to toes*** interaction" (*Gregory and Parry, 2006*).

"People remember 95% of what they are able to teach to someone else" (Glasser,1990).

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Why?

Cooperative learning techniques:

- promote student learning and academic achievement
- increase student retention
- enhance student satisfaction with their learning experience
- help students develop skills in oral communication
- develop students' social skills
- promote student self-esteem
- help to promote positive race relations

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How?

- **1. Positive Interdependence** (sink or swim together)
- **2. Face-to-Face Interaction** (promote each other's success)
- **3. Individual & Group Accountability** (no hitchhiking! no social loafing)
- **4. Interpersonal & Small-Group Skills**
- **5. Group Processing**

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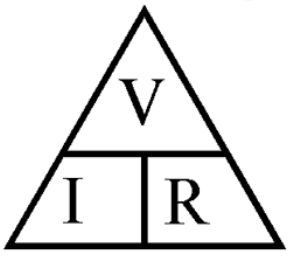
Break 2
"Making Math Easy"

- Find a strategy to memorize Ohm's law.
- V = I × R

Ohm's Triangle



Cover the variable you want to find and perform the resulting calculation *(Multiplication/Division)* as indicated.

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Find a strategy to memorize the following words

- Apple
- House
- tree
- Window
- Mushroom
- Sky
- Cloud
- Rainbow

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#5 Mnemonics

- A set of strategies designed to help students improve their memory of new information.
- Link new information to prior knowledge through the use of visual and/or acoustic cues.

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3 Types of Mnemonics

- Keyword Strategy
- Peg word Strategy
- Letter Strategy

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Why?

- Mnemonics assist students with acquiring information in the least amount of time (Lenz, Ellis & Scanlon, 1996).
- Mnemonics enhance student retention and learning through the systematic use of effective teaching variables.
- Mnemonics provide powerful tools to recall information.
- Create links between new information and information already stored.

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How?

- Give examples and have students create their own slogans or phrases to help them remember information.
- Students create acronyms to help recall content.
- Create rhymes, acronyms, or acrostics to help reinforce and teach important concepts.

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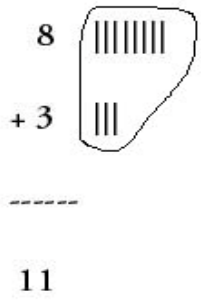
DRAW: Letter Strategy

- **D**iscover the sign
- **R**ead the problem
- **A**nswer or draw a representation of the problem using lines, tallies, or checks
- **W**rite the answer and check



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DRAW

- **D** iscover the variable
- **R** ead the equation, identify operations, and think about the process to solve the equation.
- **A** nswer the equation.
- **W** rite the answer and check the equation.

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DRAW

$4x + 2x = 12$

Represent the variable "x" with circles.

By combining like terms, there are six "x's." $4x + 2x = 6x$

$6x = 12$

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STAR: Letter Strategy

The steps include:

- **S**earch the word problem;
- **T**ranslate the words into an equation in picture form;
- **A**nswer the problem; and
- **R**eview the solution.

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STAR

The temperature changed by an average of -3\ F per hour. The total temperature change was 15\ F. How many hours did it take for the temperature to change?

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STAR:

- **S**earch: read the problem carefully, ask questions, and write down facts.
- **T**ranslate: use manipulatives to express the temperature.
- **A**nswer the problem by using manipulatives.
- **R**eview the solution: reread and check for reasonableness.

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Letter Strategy

ORDER OF OPERATIONS

- **Parentheses,** brackets, and braces;
- **Exponents** next;
- **Multiplication** and **Division**, in order from left to right;
- **Addition** and **Subtraction**, in order from left to right.

Please **E**xcuse **M**y **D**ear **A**unt **S**ally

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Please Excuse My Dear Aunt Sally

$(6 + 7) + 5^2 - 4 \times 3 = ?$
$13 + 5^2 - 4 \times 3 = ?$
$13 + 25 - 4 \times 3 = ?$
$13 + 25 - 12 = ?$
$38 - 12 = ?$
$= 26$

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- ***D****oes* *MacDonald's* ***S****ell* ***B****urgers*? To recall the steps in long division : Divide , Multiply, Subtract , Bring down.
- ***MEST :***to solve a linear systems by elimination.

  M: Multiply by a constant

  E:Eliminate a variable by adding like variables.

  S: Substitute the value …….

  T:Therefore ,the solution to the system is(x;y)
- ***O****nly* ***H****ighlanders* ***A****re* ***H****appy* ***O****n* ***A****dventures* (Sin,Cos,Tan)

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Reflection

- **Which of the strategies we've covered would you like to try in your own classes?**

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Useful Sites

-http://www.orangeusd.k12.ca.us
-http://www.edtech.kennesaw.edu
-http://www.audiblox2000.com/
-http://www.calstatela.edu

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Thank you

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SLIDE 50

Cooperative Learning

The quality of education that teachers provide to students is highly dependent upon what teachers do in the classroom. Thus, in preparing the students of today to become successful individuals of tomorrow, teachers need to ensure that their teaching is effective. Teachers should have the knowledge of how students learn and how best to teach. Changing the way we teach and what we teach is a continuing professional concern.

The role of the students:

- Maintain noise level in group
- Keep group on schedule
- Give encouragement
- Equalize participation of members
- Write down significant information
- Report to the rest of the class
- Help peers master material
- Keep group on task
- Answer group questions

The role of the teacher:

- Facilitator of learning
- Model and teach social skills
- Model and teach group process skills
- Teach cognitive and interpersonal skills

Group A

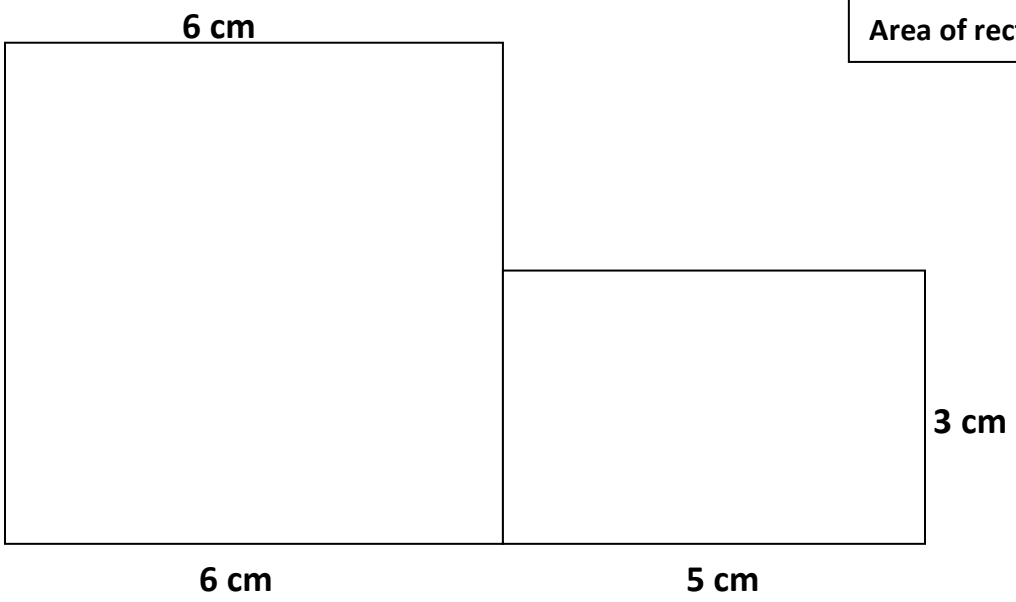
Activity 1:

Rules:

Area of a square = $s \times s$

Area of rectangle = $l \times w$

Calculate the area of the following figure:



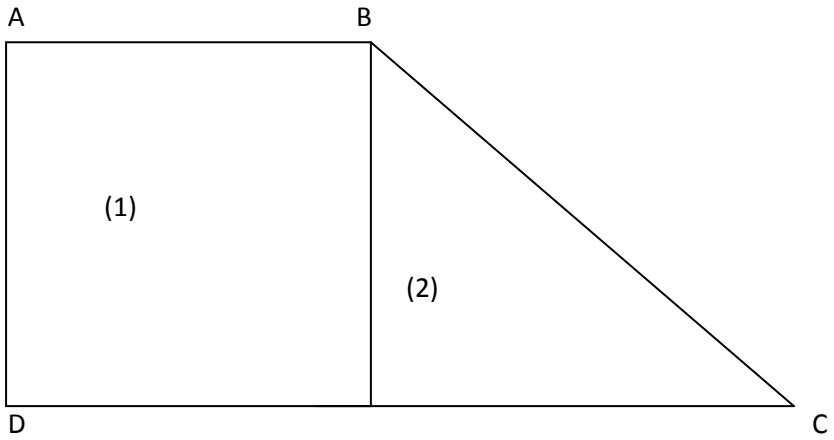
Activity 2:

A field ABCD is formed of 2 plots (1) and (2).

Plot (1) is a square of 320 m perimeter.

The entire field was sold for 520 000 000 L.L. at 50 000 L.L. the m^2.

a) Calculate the total area of the field.
b) Calculate the area of plot (2).



Rule:

Perimeter of a square = $4 \times s$

Perimeter of a rectangle = $l \times 2 + w \times 2$

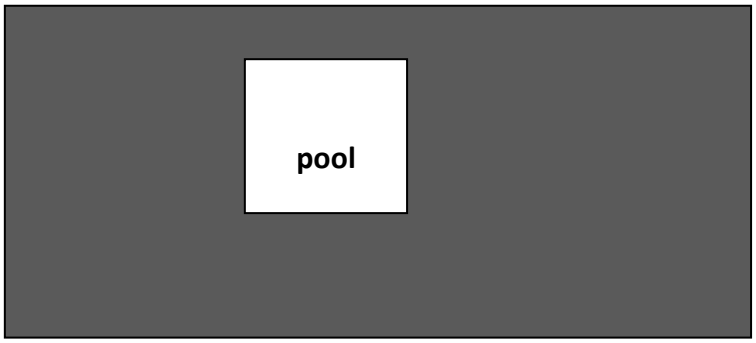
Group B

Activity 3:

In a rectangular garden of area 15 dam^2, there is a squared pool of perimeter 240m.

a) Find the width of the garden knowing that its length is 5 dam.
b) Find the side of the pool.
c) Find the area of the pool.
d) What is the area, in m^2, of the remaining part of the garden?

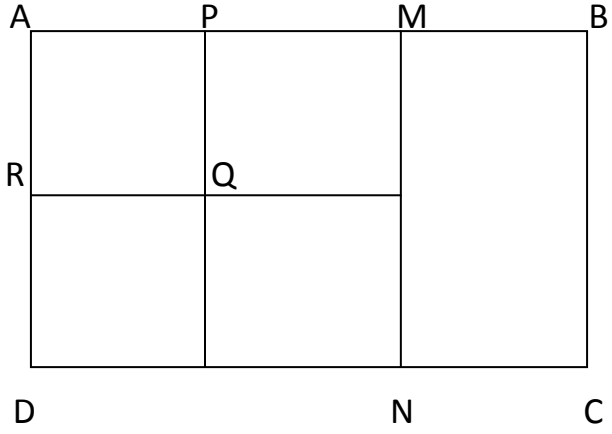
Garden



Activity 4:

Let ABCD be a rectangle of length 6 000 m and width 4 km.

a) Find, in m, the perimeter of the rectangle ABCD.
b) Let M be a point of [AB] such that AM= 4 000 m.
Find, in km, the perimeter of the rectangle MBCN and of the rectangle AMND.
c) Let P be the midpoint of [AM] and R the midpoint of [AD].
Find, in m, the perimeter of the square APQR.

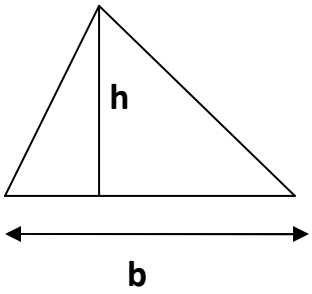


Group C

Triangle:

Area of a triangle: $\boldsymbol{A = \frac{1}{2} h \times b}$

h is called the height of the triangle relative to the base b.

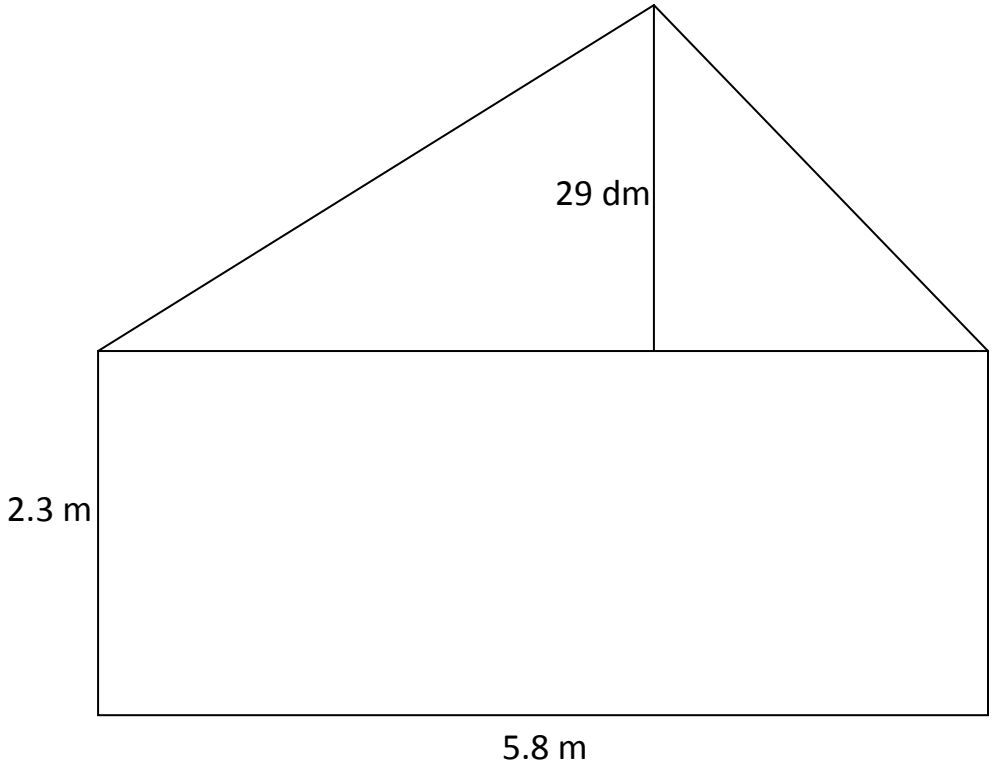


Activity 5:

Calculate the area of a triangle whose base is 7cm and height 4 cm.

Activity 6:

Find, in mm^2, the area of the following surface.



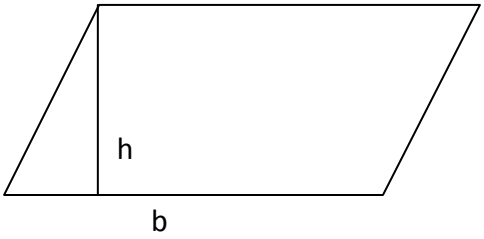
Group D

Parallelogram:

A parallelogram is a quadrilateral having opposite sides parallel.

The area of a parallelogram is $A = b \times h$

where b is the base and h is the height relative to the base.

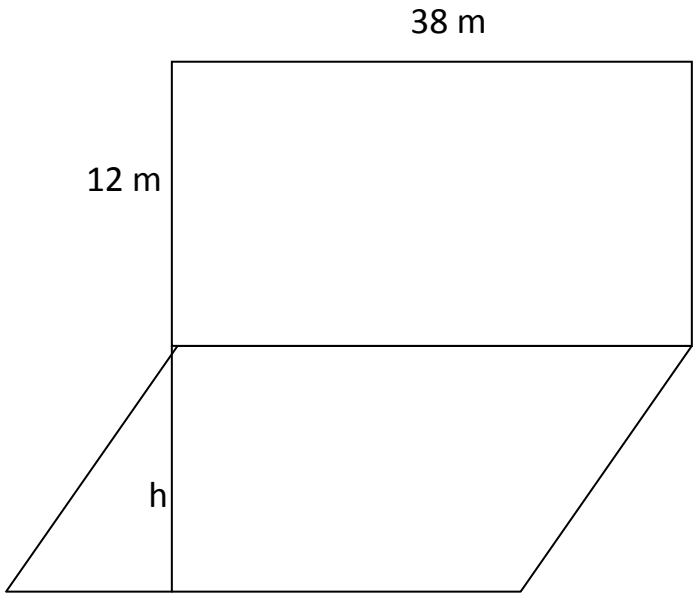


Activity 7:

Calculate the area of a parallelogram whose base is 6 cm and height 4 cm.

Activity 8:

Calculate the height of the following parallelogram knowing that the total area of the figure is 1 122 m^2.

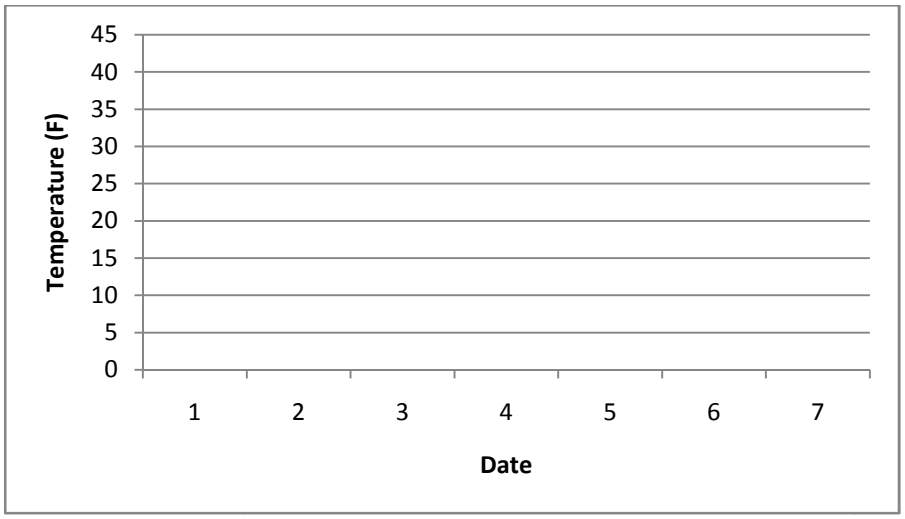


Group E

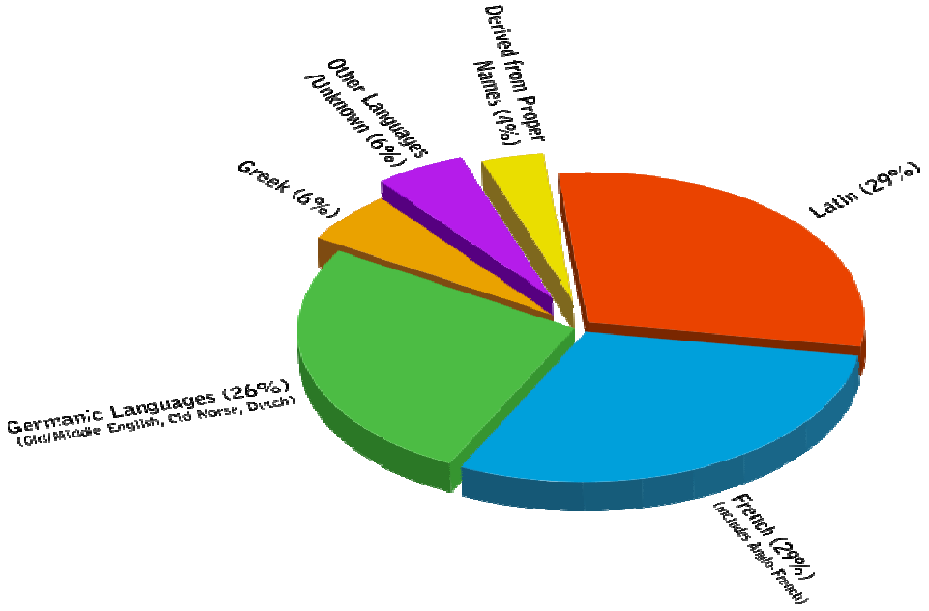
1. Peter bought a pen for 17,000 L.L. and a lighter for 7,500 L.L. less than the pen. He had 135, 500 L.L. left. How much money did he have to begin with?	Hidden question/s: _____ _____ _____ Operations: _____ _____ _____
2. A club buys a ping-pong table for 498,500 L.L., 5 nets for 22,500 L.L., and 8 dozen balls. The sum of 621,500 L.L. is paid for the whole purchases. How much does each ball cost?	Hidden question/s: _____ _____ _____ Operations: _____ _____ _____

3-The table bellow shows the average daily temperature from the 1st to the 7th of January in degrees Fahrenheit. **Construct** the line graph using this information.

Date	Temperature
1	10
2	25
3	30
4	42
5	23
6	25
7	40



4- The English Language is a mixture of different languages. The following pie chart or circular diagram shows the percentages of the various origins of the English Language words.



- Which origin represents the highest percentage of English Language words?

  _____

- Which origin represents the least percentage of English Language words?

  _____

Analytical question:
Why is language a mixture made up of bits and pieces of other different languages?

_____
_____
_____

Challenge: Why does most of the English Language originate from Latin and French? Prepare yourself for a two-minute presentation.

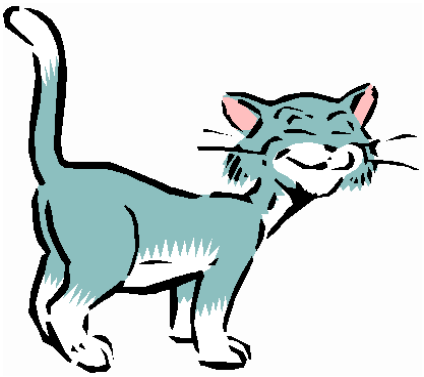
Group F

Activity 1:

Kiara baked 30 oatmeal cookies and 48 chocolate chip cookies to package in plastic containers for her teachers and friends at school. She wants to divide the cookies into identical containers so that each container has the same number of each kind of cookie. If she wants each container to have the greatest number of cookies possible, how many plastic containers does she need?

Activity 2: The Cats

In a village there was a street. In this street there were two houses. In each house, there are two rooms. In each room there are two chairs. On each chair, there are two cats..



How many cats were in this village?

Draw a diagram to find the answer. Think of a mathematical method that allows you to immediately find the same answer.

Activity 3: History Units for Measuring Length

In the past, people measured lengths or distances for very long units using parts of the body. Thus, we measure in inches, in finger, foot, palm (width of a hand) in cubit (distance from elbow to fingertips of the hand) in steps, etc. The metric system was invented during the revolution. It is used almost everywhere in the world, especially since hundreds of years.

a) What is the paragraph about?

_____

b) What did people use in the past to measure length and distances?

_____

c) What is the metric system? Do research to find the answer.

_____

_____

d) When was the metric system invented?

_____

e) Do you have some ideas of tools with which we can measure? Give examples.

_____

Activity 4:

Read the word problem thoroughly, underline the key words, and write the operations that solve the problem. Use the calculator to find out the answer.

Problems	Operations
1. Tom bought a raincoat for 114,000 L.L., a pair of trousers for 49,500 L.L. and a pair of shoes for 109,800 L.L. He had 300,000 L.L. in his wallet. How much money did he pay? How much money does he still have?	_____ _____ _____ _____ _____

Creating Mental Math Classrooms

Samia Henaine and Zeina Zaatari

Introduction

Empowering students to perform mental calculations is crucial. First and foremost, it is a mental exercise for the brain. It is also an essential part of coping with society's demands and managing everyday events. Research has shown the vital role of elementary school teachers in helping students acquire strategies to perform mental calculations efficiently. Teachers are supposed to encourage students to use a range of methods and to apply them appropriately in different situations, and understand the students' mental processes that lead to develop their own strategies of calculation. This session was designed to provide the elementary math teachers with the main strategies of mental calculation and the principles for teaching mental math in their classrooms. Participants took on the roles of learners and were involved in activities and typical problems in which they presented and demonstrated their strategies. In addition, participants discussed the effectiveness of these tactics in assessing students' knowledge of numbers.

Description of the Session

The session was planned as follows:

(a) *Introduction*
Participants were given five minutes to discuss a list of misconception statements and decided whether they strongly agreed, agreed, disagreed or strongly disagreed with each statement. We collected the answers and recorded them on a flip chart without criticism, judgment or questions. We intended to refer back to them and discuss them during the session. **(10 mins)**

Later, in groups, participants discussed the following issues:
- "What" is mental calculation?
- "Why" do we use mental calculation?
- "How" do we calculate mentally?

Participants were asked to give two reasons to get good at doing math in your head and two situations where you might need or want to do math in your head, not with a calculator. **(10 mins)**

(b) *Body of the session*
The body of the session was divided in *two* sections of activities separated by a theoretical part. In each section, participants took on the role of the learner and discovered the different strategies to do calculations.

Activities I: Addition and Subtraction Strategies (35 mins)
This section set out the main strategies for adding and subtracting mentally. It described activities to support teaching of these strategies and typical problems. Some of strategies that were covered included:
- Counting forwards and backwards
- Reordering
- Partitioning: counting on or back
- Partitioning: bridging a multiple of 10

Theoretical part:
- Principles of teaching mental calculation (10 mins)
This promotes a broad interpretation of mental calculation and identifies principles that underpin teaching: for example, encouraging children to share their mental methods, to choose efficient strategies, and to use informal jottings to keep track of the information they need when calculating.

- Mental imagery (5 mins)
This mental activity was designed to develop participants' powers of mental imagery. We asked them to close their eyes, follow the oral instructions and describe mentally the obtained figure. Then, we asked for volunteers to describe their shapes.

Activities II: **Multiplication and Division Strategies (35 mins)**
This part set out the main strategies for multiplying and dividing mentally. Again, it described activities to support teaching of these strategies and typical problems. Some of strategies that were covered included:

- Knowing multiplication and division facts to 10 × 10
- Doubling and halving
- Multiplying and dividing by multiples of 10

(c) *Conclusion and reflection* **(15 mins)**
Participants drew a conclusion about the session, discussed how to be effective teachers of mental calculation, and we presented the importance of having teaching programs that deal with mental calculations. Participants wrote their reflections on Exit cards.

Mental Computation Strategies: Addition

It is essential that all students are able to calculate mentally as well as with paper and pencil. Students can make mental calculations quickly and easily with the help of strategies. There are mental computation strategies for each of the four operations: addition, subtraction, multiplication, and division. Strategies for addition are explained here.

Adding the places
Start with one addend, then add the value of the digits of the other addend(s).
See 35 + 23
Think 35 + 20 + 3

Bridging to ten
Start with one addend, count up to the next multiple of 10 (100, 1000 etc.), then add the balance of the second addend.
See 17 + 8
Think 17 + 3 + 5
Synonyms: bridge the decades; bridge to ten; make a ten; make to ten; use ten

Compensating
Round one or both addends before adding. Then adjust the answer to compensate for the rounding.
See 28 + 36
Think (30 + 36) – 2
Synonyms: compensation; round and adjust; round or adjust; use a nearby number

Counting on
Start with one addend, then count on parts (not places) of the other addend.
See 58 + 24
Think 58 + 10 + 10 + 4
Synonym: jump
Sub-strategies: count on 1; count on 2; count on 3; count on 0

Using compatible addends

Choose pairs of addends to make the calculation more manageable. This strategy applies only when there are three or more addends.
See 14 + 23 + 16
Think 14 + 16 + 23
Synonym: use compatible pairs

Using doubles

Use a known nearby double.
See 7 + 8 = ___
Think 7 + 8 = 15 *because* 7 + 7 = 14
Synonym: near doubles
Sub-strategies: double plus 1; double plus 2

Using place value

Expand the addends into places before adding the value of the digits in each place.
See 56 + 17
Think 50 + 10 + 6 + 7 *or* 6 + 7 + 50 + 10
Synonym: split
(For doubling)
Split one of the addends into places, double the value of the digits in each place, then add the doubled values.
See 12 + 12
Think double 10 + double 2

Thinking Strategies for Addition

Counting On: Students start with a number and count on 1, 2, 3. For example, if the question is 5 + 2, students count 5, 6, 7. Note: This strategy is only useful for adding 1, 2, or 3.

Using Doubles: The first fact combinations students often learn are doubles. Examples:

2 + 2 =
3 + 3 =
8 + 8 =

Making Ten: Students make combinations that equal 10. Then they extend to make combinations that are multiples of 10. Examples: 6 + 4 = 10 extends to 76 + 4 = 80. This can then be extended to 10 + 4 = 14 or 50 + 8 = 58.

Thinking Strategies for Subtraction

Counting Back: Students start with a number and count backwards. If the question is 5 – 2, students count 5, 4, 3. Note: This strategy is only useful for subtracting 1, 2, or 3.

Counting Up: Students start with a number being subtracted and count up to the number from which it is being subtracted. For example, for the question 9 – 7, students can count 8, 9.

Using Part, Part, Whole:

Given: Part + Part = Whole
Therefore: Whole – Part = Part
Examples:
a. Thinking Addition:
15 – 8 = ?
Whole – Part = Part (?)
Students think 8 + 7 = 15 (Part + Part = Whole)
Therefore: 15 – 8 = 7

b. Partitioning:
9 – 7 = ?
Numbers include 9, 7, 2.
Students make all possible combinations for Part + Part = Whole
7 + 2 = 9
2 + 7 = 9
so 9 - 2 = 7 or 9 - 7 = 2

c. Missing Part:
8 + ? = 11
Students use part, part, whole to answer such questions.

When students have an easier time adding than subtracting the following strategies can be helpful.

Make Ten and Then Some: Given a subtraction question such as 14 – 8 = ? students start with the part (8), add-on to make 10 (i.e., 8 + 2), then add-on from 10 to make 14 (10 + 4). Then the students add the numbers they added-on to make 14 (4 + 2 = 6).

Using Doubles: For the question 13 – 6 = ?, students think addition using doubles. For example, 6 + 6 = 12, then add-on 1 to make 13, so 6 + 1 = 7.

Thinking in Patterns

Skip Counting: Starting at any number, students skip count by 10s, 2s, 3s, 5s. For example, ask students to skip count by 10s starting at 46.

100 Chart: Make sure a 100 chart is visible in your classroom and that students have access to desk-size charts. Refer to the chart and practice counting skills or the chart regularly.

Arrow Moves: Indicate moves on the 100 chart by using arrows. For example, 23 + 11 = ?, would be indicated with one space across from 23 to 24 and then from 24 ten spaces down to 34. Note the pattern for all additions of +11 on the chart.
Extend to the addition or subtraction of other numbers.

Chaining Operations:
Example: 8 + 2 + 4 + 6 – 3 = ? (Note: choose combinations that end in multiples of 10 to encourage students' visualization of the 10 frame.)

Strategies for Adding and Subtracting Large Numbers

Multiples of Ten:
For addition: 30 + 50 = , 56 + 10 = , 56 + 30 =
For subtraction: 50 – 30 = , 56 – 10 = , 56 – 30 =

Expanding the Second Addend or Subtrahend:
For addition: 28 + 17 = , 28 + 10 + 7 =
For subtraction: 28 – 17 = , 28 – 10 – 7 =

Front-end Adding:
Example: 65 + 26 = ? Ask students to think 60 + 20 = 80 and 5 + 6 = 11, so 80 + 11 = 91.

Compensation for 8 and 9:
Examples: 67 – 19 = 67 – 20 + 1; 43 + 29 = 43 + 30 – 1; 67 – 18 = 67 – 20 + 2; 43 + 28 = 43 + 30 – 2

Compatible Numbers:
Students bring together numbers that add up to 10 or multiples of 10.
Example:
8 + 5 + 12 + 7 + 5 + 3 + 4 = ?
Think 8 + 12 = 20, 5 + 5 = 10, 7 + 3 = 10
Therefore, 20 + 10 + 10 + 4 = 44

Multiples of 25: Students count by 25s and relate to money.

Common Zeros: For addition and subtraction operations, students remove the 0s, complete the operation, and then tack the 0 back on.
Example:
120 – 70 = ?
Think 12 – 7 = 5
Add the common zero, so the answer is 50.

Strategies for Multiplying

Trailing Zeros: For multiplication, students remove the trailing 0s, multiply, and tack on all the removed zeros.
Examples:
a. 5 x 60 = ?
Think 5 x 6 = 30
Tack on the removed 0, so the answer is 300

b. 20 x 30 = ?
Think 2 x 3 = 6
Then tack on all the removed 0s, so the answer is 600

Activities

Activity 1

Solve addition and subtraction problems by counting all of the objects. Learners solve simple addition and subtraction problems by counting all of the objects. Typically, a learner will use fingers, counters or other objects.

For example, a learner may add 8 + 7 by starting from 1, counting 8 objects, then continuing to count 7 more objects to reach 15.

Activity 2

Solve addition and subtraction problems by counting on or counting back, using ones and tens. Learners use "in the head" (mental) strategies. They can count on (for addition) or back (for subtraction) from the first number given. They do not rely on fingers or other objects, and they can count in ones and in tens and in combinations of ones and tens.

- **Counting in ones:** A learner may solve 8 + 5 by starting at 8, then mentally counting 5 more, by ones, to reach 13.
- **Counting in tens and ones:** A learner may solve 46 – 23 by starting at 46, then mentally counting 20 back, by tens, to reach 26 and then counting 3 back, by ones, to reach 23.

Activity 3

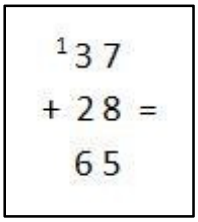
Solve two-digit by one-digit addition and subtraction problems mentally, using partitioning strategies. Learners use mental strategies that require them to partition numbers (that is, to split numbers into parts). Partitioning strategies include the following:

- **Deriving from known facts:** Learners derive unknown information from a known fact. A learner may solve 26 + 6 by using what they know (6 + 6 = 12), then adding 20 + 12 to reach 32.
- **Making tens:** Learners partition numbers in order to be able to work from the nearest ten. A learner may solve 16 + 7 by splitting the 7 into 4 and 3, adding 16 + 4 to reach 20, then adding the 3 to reach 23.
- **Using tidy numbers with compensation:** Learners round a number to the nearest ten or hundred, then compensate for what has been added or subtracted. Learners know that, in the addition process, if they add something to a number, they must take it away again at the end (26 + 9 can be solved as 26 + 10 – 1 = 35) and that, in subtraction, if they take something away from a number, they must add it back on at the end (53 – 9 can be solved as 53 – 10 + 1 = 44).

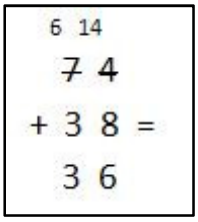
Activity 4

Solve multi-digit addition and subtraction problems, using partitioning strategies *OR* justify the reasonableness of answers to problems solved, using a calculator or algorithm. Learners use partitioning strategies to solve more complex addition or subtraction problems. Partitioning strategies include the following:

- **Deriving from known facts:** Learners derive unknown information from a known fact, for example, solving 25 + 26 by first adding 25 + 25 to get 50, then adding 1 more to get 51.
- **Making tens:** Learners partition numbers in order to be able to work from the nearest ten. For example, a learner can solve 45 + 37 by splitting the 37 into 5 and 32, then adding 45 + 5 to get 50 and then adding 50 + 32 to get 82. Or the learner can solve 64 – 37 by splitting the 37 into 4 and 33, subtracting 64 – 4 to get 60 and then subtracting 33 from 60 to get 27.
- **Place value partitioning:** The learner breaks the numbers into ones, tens and hundreds, adds numbers of the same place value together and then combines these numbers. For example:
  23 + 34 can be solved as (20 + 30) + (3 + 4) = 50 + 7 = 57.
  657 – 234 can be solved as (600 – 200) + (50 – 30) + (7 – 4) = 400 + 20 + 3 = 423.
- **Using tidy numbers with compensation:** The learner rounds a number to the nearest ten or hundred, then compensates for what has been added or subtracted. For example, 46 + 19 can be solved as 46 + 20 – 1 = 65. Alternatively, learners may use a calculator or written algorithm to solve a problem. If so, they are able to justify the solution by demonstrating or explaining why it is reasonable.
- **Standard algorithm explanation:**



65 is reasonable because 37 + 28 is a bit less than 70 (40 + 30).



36 is reasonable because 74 - 38 is a bit more than 34 (74 - 40).

Activity 5

Solve addition and subtraction problems involving decimals and integers, using partitioning strategies *OR* justify the reasonableness of answers to problems solved, using a calculator or algorithm. Learners use partitioning strategies to solve addition and subtraction problems involving decimals and integers. Partitioning strategies include the following:

- **Using tidy numbers with compensation:** For example, a learner solves 3.2 + 1.95 as 3.2 + 2 – 0.05 = 5.2 – 0.05 = 5.15.
- **Place value partitioning:** Learners partition numbers by place value. For example, a learner can solve 6.03 – 5.8 by subtracting 6.03 – 5 to get 1.03, then subtracting 1.03 – 0.8 to get 0.23.
- **Using reversibility:** Learners change a subtraction problem into an addition problem. For example, 6.03 – 5.8 becomes 5.8 + ? = 6.03, and -15 + 64 becomes 64 – 15.

Alternatively, learners may use a calculator or written algorithm to solve a problem. If so, they are able to justify the solution by demonstrating or explaining why it is reasonable.

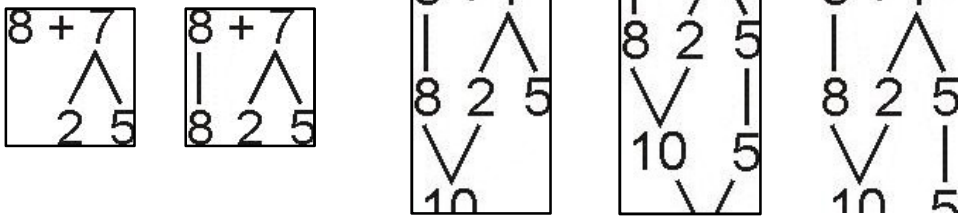
Activity 6

Solve addition and subtraction problems involving fractions, using partitioning strategies *OR* justify the reasonableness of answers to problems solved, using a calculator or algorithm. Learners use partitioning strategies to solve addition and subtraction problems involving fractions. Partitioning strategies include the following:

- **Using equivalent fractions:** Learners use knowledge of equivalent fractions to solve addition and subtraction problems. For example, 5/6 + 7/4 = 10/12 + 21/12 = 31/12.

Alternatively, learners may use a calculator or written algorithm to solve a problem. If so, they are able to justify the solution by demonstrating or explaining why it is reasonable.

- **Make 10 (Bridging):** Make Ten is a key strategy for any addition facts with an 8 or a 9. We want students to think "How many more are needed to make 10?" and then "How many are left over?"
  For example: 8 + 7
  How many more are needed to make 10? 2!
  If the 2 is taken from the 7, how many are left over? 5!
  So, 8 + 7 is 10 + 5, or 15.
  Key sub-skills are knowing how many more are needed to make 10 (bonds of 10), and how much is left after that step (-1 or -2). The near numbers one less and two less should be practiced using ten frames and dot plates. The near number page also has other strategies.
  One way to help students record their thinking is to use branch diagrams to show how they partitioned the numbers. This can also support work done in grade 2 for partitioning multi-digit numbers to add. This ability is also used in later years for multi digit computations, such as 28 + 7. It forms a key sub-skill in developing jump strategies for performing multi-digit addition and subtraction.



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SMEC 14 – AUB – 2012

Creating Mental Math Classrooms

Trainers: Samia Henaine & Zeina Zaatari

Objectives

To provide the elementary math teachers with

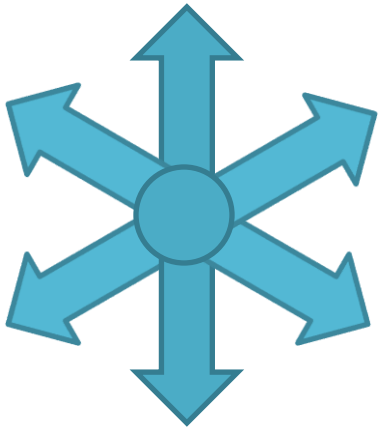
- the main strategies of mental calculation
- the principles for teaching mental math in their classrooms
- the effectiveness of the calculation tactics in assessing the students' knowledge of numbers
- the approach to calculation

Presentation Plan

Introduction

Reflection

Principles of mental calculation



Multiplication and division strategies

Addition and subtraction Strategies

Mental Imagery

"What" is the Mental calculation?

Brainstorming

Mental Calculation

"Why" do we use the Mental calculation?

- A computer can multiply thousands of numbers in less than a second. A human is lucky to multiply two numbers in less than a minute.
- So, why do we need to calculate mentally ?

"Why" do we use the Mental calculation?

- Give two reasons to get good at doing math in your head.

- Give two situations where you might need or want to do math in your head, not with a calculator.

"How" do we calculate mentally?

What do you think?

Statement 1:

The ability to calculate mentally is related to the students' understanding of the number system.

Statement 2:

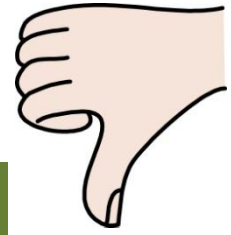
There is a single correct method for calculating.

Statement 3:

Mental math depends on rote memorization.

Statement 4:

Mental calculation doesn't allow the use of paper and pencil neither the hands-on material.



Statement 5:

Speed is an important element of mental calculation.

Approach to calculation

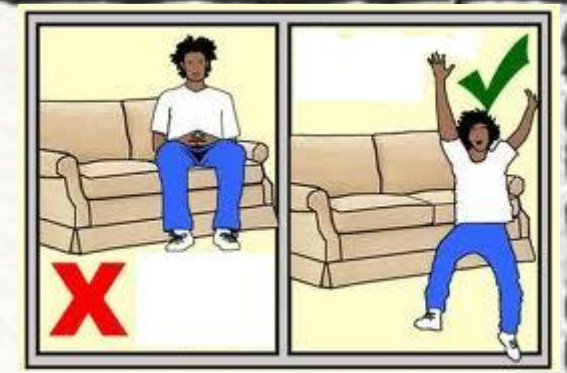
Calculate the following as fast as you can and name the strategies used:

- 42 + 35
- 45 + 46
- 6 + 78
- 37 + 199
- 67 – 32
- 54 – 28
- 60 – 19
- 2005 – 1996

Addition and Subtraction Strategies

1. Counting forwards and backwards
2. Partitioning: compensating
3. Partitioning: using ‘near’ doubles
4. Partitioning: counting on or back
5. Partitioning: bridging a multiple of 10
6. Reordering

1. Counting forwards and backwards



- Stand up
- Count from zero in ones,

one after the other round the class.

- When we clap, you must count **backwards**.
- On the next clap, you count **forwards**, and so on.
- One who will give a **wrong** answer, he/she will **set down**.

2. Partitioning : compensating

- Calculate:

857 – 299 =558

2. Partitioning : compensating

Objective:

Subtract 9 or 11 from a given number using compensating

Needed material

- Playing board
- **Set A** has numbers from 12 to 27.
- **Set B** contains only 9 and 11.

How to play :

- Take turns to choose a number from set A and then one from set B.
- subtract the number from set B from the one from set A and mark the answer on their board. The first person to get three numbers in a row on their board wins.
- Discuss the strategy used to subtract.

2. Partitioning : compensating

‘number square’

Objective:

Add tens or small numbers

Needed material

Number square

31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70

Instruction:

Find 36 + 28 using the number square

2. Partitioning : compensating

‘number square’

Instruction:

To find 36 + 23,

- first find 36 + 20 by going down two rows,
- compensate by going on along that row three places.

31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70

3. Partitioning : using ‘near’ doubles

‘Think of a number’

‘I’m thinking of a number.
I doubled it and added 3.
My answer is 43.
What was my number?’

4. Counting on or back

Place value cards

‘Montessorri ‘

These cards can be used to make a two-digit or a three-digit number by selecting the cards and placing them on top of each other.

For example, to make 273, the following cards can be placed over each other to make:

4. Counting on or back

Place value cards

‘Montessorri ‘

Use the place value cards to calculate the following:

- 1,245 + 5,212
- 345 + 671
- 8,924 – 5,613
- 754 – 189

5. Partitioning : bridging through multiples of 10

‘Use the complement’

6. Reordering

$$2 + 5 + 8 = 8 + 2 + 5$$

or

$$15 + 8 - 5 = 15 - 5 + 8$$

or

$$23 - 9 - 3 = 23 - 3 - 9$$

6. Reordering

‘Investigative approach’

- Find quick ways of finding the answer:

$$1 + 2 + 3 + 4 + \ldots + 98 + 99 = ?$$

4,950

Partitioning + Reordering

- Each group will have numbers cards.
- Find **quick ways** of finding the answer

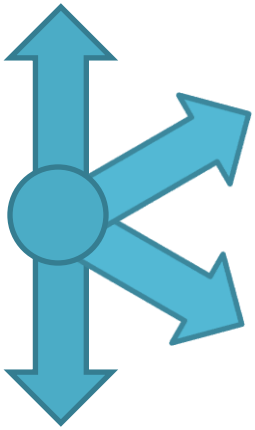
‘Number tree’

Presentation Plan

Introduction

Reflection

Principles of mental calculation



Multiplication and division strategies

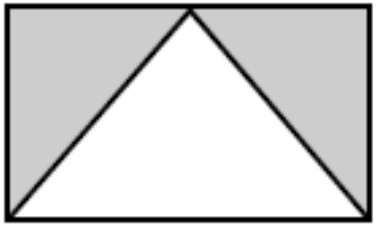
Addition and subtraction Strategies

Mental Imagery

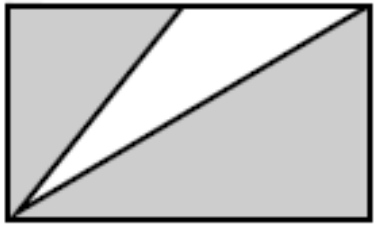
Mental Imagery

- **Objective** : To develop students' powers of mental imagery. This approach could be adapted and used in other subjects.
- **Instruction**:

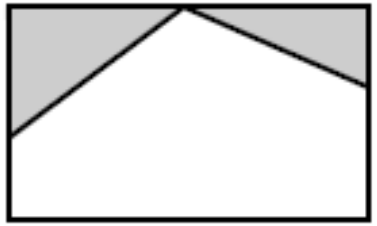
- Close your eyes
- follow the instructions
- Draw your shape



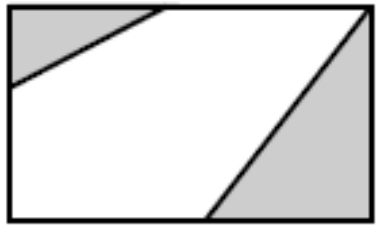
isosceles triangle



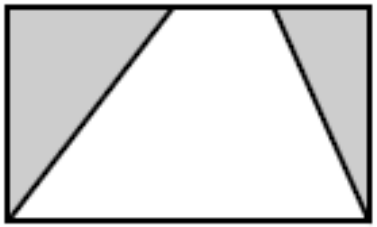
scalene triangle



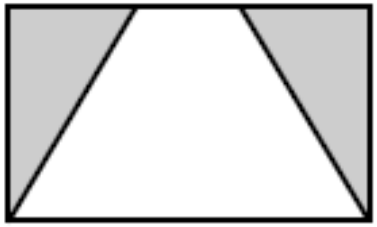
irregular pentagon



irregular pentagon



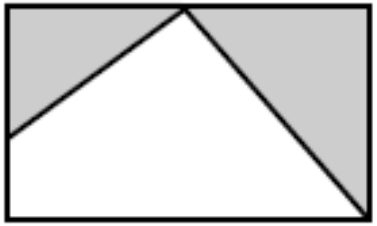
trapezium



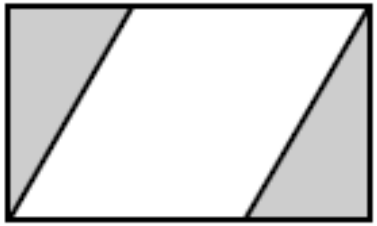
trapezium

irregular hexagon

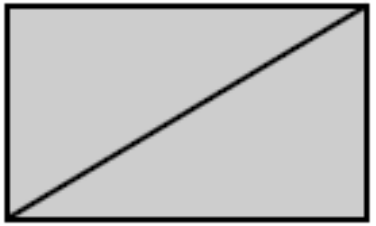
irregular hexagon



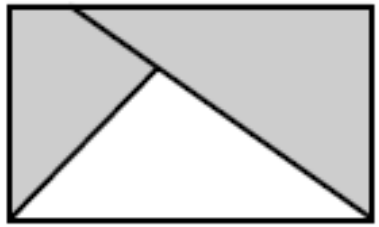
quadrilateral



parallelogram
(or rhombus)



no white shape



overlapped
triangles

Multiplication and Division Strategies

Calculate the following as fast as you can and name the strategies used:

- 540 × 7,000
- 76 : 4
- 43 × 99
- 35 : 25
- 0.25 × 48
- 20% of 540

Loop cards

- One participant starts. He/she read out the multiplication at the top of his/her card
- The participant who has the correct answer reads it out then reads out the question at the top of the card.
- **N.B:** The game works best if the cards form a loop where the question on the last card is linked to the answer on the first, as in the five cards above.

Multiplication table

How to memorize the Multiplication Table of

- 2?
- 3?
- 4?
- 5?
- .....

Multiplication table

X	1	2	3	4	5	6	7	8	9	10	11
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											

Multiplication Tricks

To multiply by	Trick
2	Add the number to itself (example 2 × 9 = 9 + 9)
4	Double a number and then double it again!
5	- The last digit always goes 5,0,5,0,.., - Is always half of 10× (Example: 5 x 6 = half of 10 x 6 = half of 60 = 30) - Is half the number times 10 (Example: 5x6 = 10x3 = 30)
6	-Double the number then find its triple -If you multiply 6 by an even number, they both end in the same digit. Example: 6 × **2** = 1**2**, 6 × **4** = 2**4**, 6 × **6** = 3**6**, etc

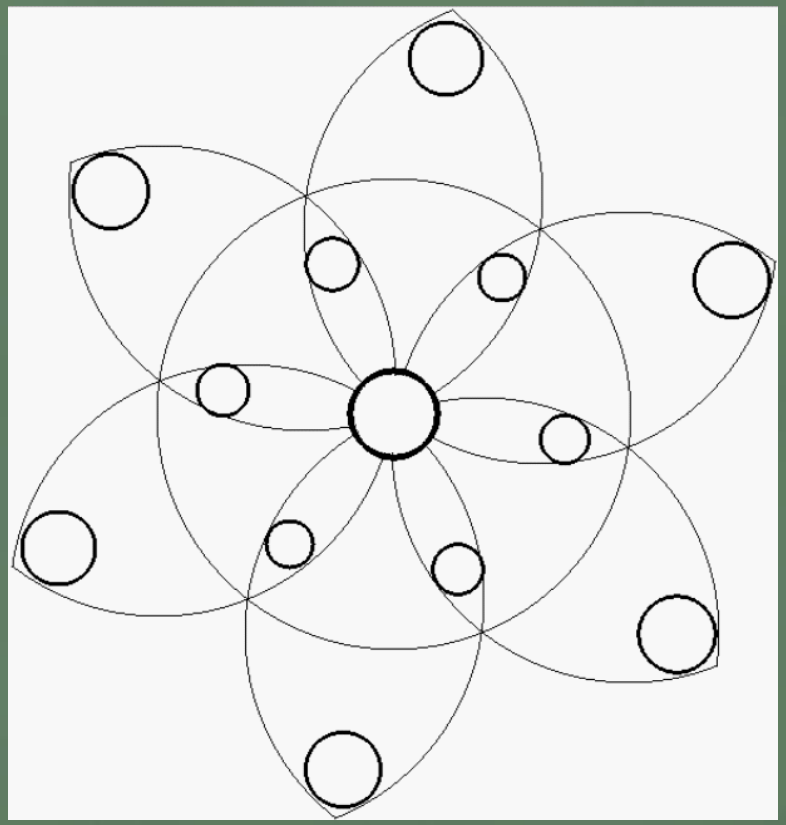
Multiplication Tricks

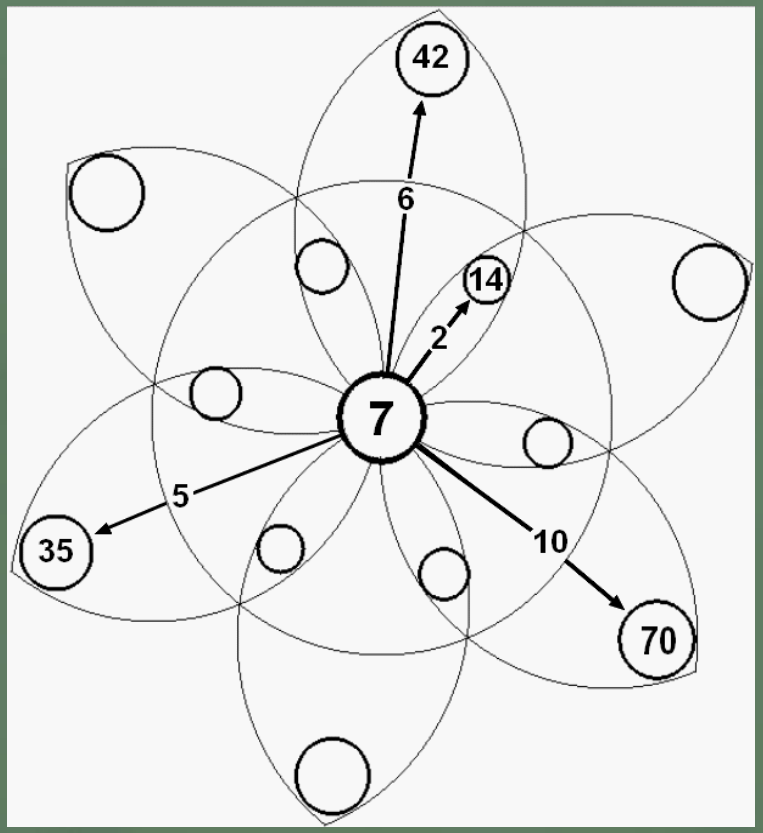
To multiply by	Trick
9	- It is 10× the number minus the number. Example: 9 × 6 = 10 × **6** - **6** = 60 - 6 = 54
	-If you *add* the answer's digits together, you get 9. Example: 9 × 5 = 45 and 4 + 5 = 9. (But not with 9×11=99)
	-Hold your hands in front of you with your fingers spread out. -For 9 × 3 bend your third finger down. (9 × 4 would be the fourth finger etc.) - You have 2 fingers in front of the bent finger and 7 after the bent finger. - Thus the answer must be 27.
10	put a zero after it
11	- Up to 9: just repeat the digit (Example: 4 x 11 = 44) - For 10 to 18: write the sum of the digits between the digits. Example: 15 × 11 = 1*(1+5)*5 = 165

Multiplication table

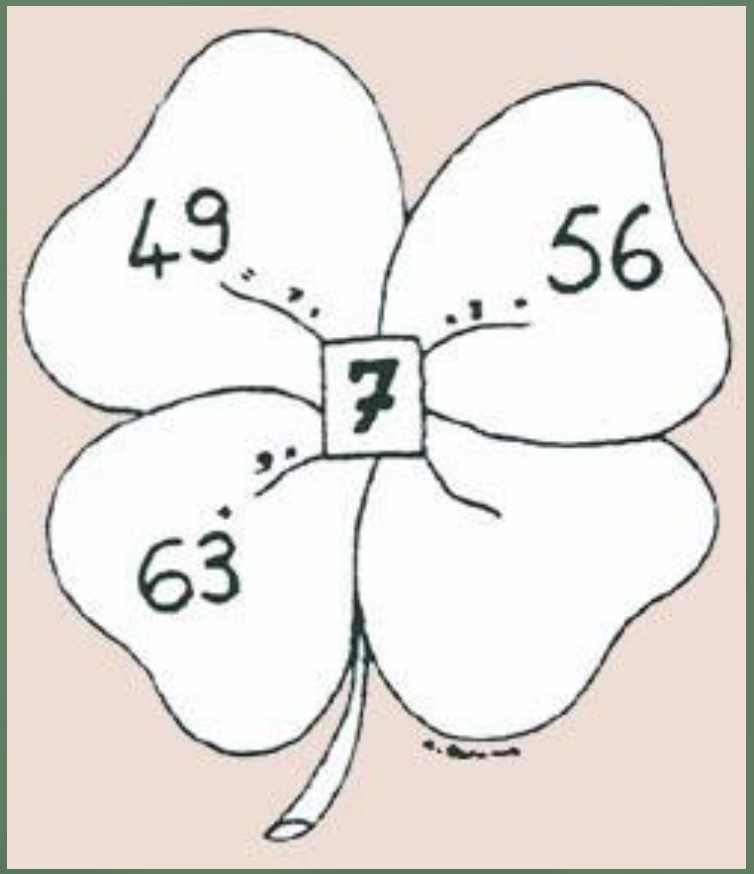
X	1	2	3	4	5	6	7	8	9	10	11
1	1	2	3	4	5	6	7	8	9	10	11
2	2	4	6	8	10	12	14	16	18	20	22
3	3	6	9	12	15	18	21	24	27	30	33
4	4	8	12	16	20	24	28	32	36	40	44
5	5	10	15	20	25	30	35	40	45	50	55
6	6	12	18	24	30	36	42	48	54	60	66
7	7	14	21	28	35	42	**49**	**56**	63	70	77
8	8	16	24	32	40	48	**56**	**64**	72	80	88
9	9	18	27	36	45	54	63	72	81	90	99
10	10	20	30	40	50	60	70	80	90	100	110
11	11	22	33	44	55	66	77	88	99	110	121

Multiplication Tricks





Multiplication Tricks



video

Doubling and Halving

- Ask someone from your group to choose a number.
- Complete the *number chain.*
- The rule is

'If the number is even, halve it; if it is odd, add 1 and halve it.'

- Ask for a new starting number. Continue as before.

How far can you go?

- I will give a small number.
- You are supposed to doubling it by going round the class.
- How far can you go?

Dividing by multiples of 10

Who is the faster ?

- 60 × 3
- 120 : 10
- 25 : 10
- 0,75 × 100
- 673 : 100
- 270 : 3
- 35 : 25

Fractions and percentages

- Children need an understanding of how fractions, decimals and percentages relate to each other. For example:

half of 40	½ × 40	40 × ½
40 × 0.5	0.5 × 40	50% of 40

- Children who are familiar with decimals can be easier familiar with fractions and percentages.

0.5 = ½ = 50%	0.25 = ¼ = 25%	0.75 = ¾ = 75%
0.2 = 1/5 = 20%	0.4 = 2/5 = 40%	0.8 = 4/5 = 80%

Fractions and percentages

How to calculate?

- 50% of 60 → half of 60 = 30
- 25 % of 60 → ¼ of 60 = 60 : 4 = 15
- 20 % of 60 → 60 : 5 = 12
- 40 % of 60 → 12 + 12 = 24

Additional Multiplication strategies

- Each group will have a multiplication problem to do.
- You have 10 minutes to read the instruction and solve the problem.
- You will present the strategies used.

What do you think?

Statement 1:

The ability to calculate mentally is related to the students' understanding of the number system.

Statement 2:

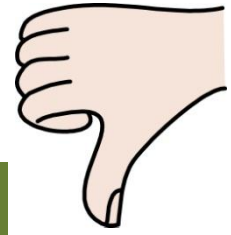
There is a single correct method for calculating.

Statement 3:

Mental math depends on rote memorization.

Statement 4:

Mental calculation doesn't allow the use of paper and pencil neither the hands-on material.



Statement 5:

Speed is an important element of mental calculation.

Exit card

1. **Write one thing you learned today.**
2. **What connection did you make today that made you say, "AHA! I get it!"**
3. **Write a question you'd like to ask or something you'd like to know more about.**
4. **Write one word or one sentence that assesses this workshop.**

Resources

- Teaching children to calculate mentally, The National Strategies Primary
- The Framework for teaching mathematics and the approach to calculation - Numeracy across the curriculum | Unit 5

- http://www.mathsisfun.com/multiplication-tips-tricks.html
- http://math.about.com/od/multiplication/a/Multiplication-Tricks.html

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SCIENCE

Using Popular Science Writing in Science Teaching

Tamer Amin

Abstract

In recent years, science curricula and national standards in a number of countries, including Lebanon, are incorporating goals that go well beyond knowledge of conceptual content like scientific theories, laws and concepts. We now aim to develop a broader scientific literacy including scientific thinking skills, knowledge about science as a way of knowing about the world and appreciation of the links between science, technology and society. Textbooks often do not provide the support needed by the teacher and students to address these more diverse goals. Popular science publications for general readers can provide such support and complement textbooks. In this session, participants learned about a wide range of available popular science publications and how these can be used to support development of a broad scientific literacy.

Introduction

The goals of science education have been expanding substantially in the last two or three decades. In the nineties, educational reform and curricular documents in various countries, including Lebanon, expanded the aims of science education beyond preparation for further studies in science and a science-related career as the ultimate goal. Instead, achieving scientific literacy for all students was added as a key goal of K-12 science education (CERD, 1995; Millar & Osborne, 1998, NRC, 1996). This goal of scientific literacy has continued in recent attempts in the USA to rethink their national standards with the recently published *A Framework for K-12 Science Education* (NRC, 2011). Science education now aims to develop students' skills in scientific practice, knowledge and reflection about science as a way of coming to know about the world, and the ability to engage in science and technology-related social issues in addition to a deep conceptual understanding of core scientific concepts.

While science textbooks have been changing gradually in light of these changes, they have not substantially changed the way science is presented. The emphasis is still on the presentation of "final-form" science, the product of scientists' inquiries to date, with little attention to the process of investigation itself and reflection on the scientific enterprise. In contrast, outside of the context of formal science education books about science geared to the general public are published in increasingly greater numbers. These books often present science in the making rather than simply present final-form science. They can, therefore, complement the use of science textbooks as resources to support science teaching that aims to achieve a broad scientific literacy. The goal of this workshop was to introduce participants to this genre of writing about science for a general readership and examine its value in teaching science for scientific literacy.

Popular Science Writing

Books on science aimed at the non-specialist reader, so called "Popular Science Writing," can be found in most international bookshops and interest in this genre has been gradually

increasing. It is possible to find non-specialist books dealing with virtually any topic of science and technology. Authors of these books can be specialist scientists themselves, journalists specializing in science and other writers about science including playwrights. Popular science writing can vary in format including:

- autobiographical accounts of specific scientific discoveries or technological innovations written by the scientists themselves who contributed to them (e.g. *The Double Helix* by James Watson);
- biographies of the lives of famous scientists (e.g. *The Enigma of Intelligence* by Andrew Hodges, about the life of Alan Turing);
- extended book length explanations of a single idea or theory (e.g. *The information* by James Gleick about the emergence of information theory and technology)
- thematically organized books treating a variety of aspects of a single topic in independent chapters (e.g. *Genome: The autobiography of a species in 23 chapters* by Matt Ridley);
- anthologies compiling excerpts of science writing from many different sources (e.g. *The Oxford Book of Modern Science Writing* edited by Richard Dawkins)
- plays about science related issues (e.g. *Copenhagen* by Michael Frayn about a mysterious encounter between Neils Bohr and Werner Heisenberg during World War II)

These are just some examples of formats of popular science writing that can be found. Every year, new books are published and new formats emerge limited only by the creativity of the authors. What's important for the purposes of this workshop is that many of these publications provide a much wider picture and understanding of science than do most school science textbooks.

Description of Session

This workshop was organized into three main segments: (1) the introduction, in which the genre of popular science writing as described above was introduced and its relevance to achieving broad scientific literacy mentioned; (2) participants read and discussed a variety of excerpts from popular science texts written by renowned science writers; (3) open discussion of how popular science texts can be incorporated into school instruction.

Workshop introduction:

In this part of the workshop, the main aspects of scientific literacy as recently conceived in curricular reform documents were introduced. These include: deep understanding of core concepts and explanatory frameworks, scientific processes and practices, understanding about science as a way of knowing, and understanding the links between science, technology and society. In light of these aspects of literacy, the limitations of most textbooks was pointed out – namely, that they tend to focus on only the first of these aspects. The genre of popular science writing was then introduced. Participants were asked to read the opening page from the astronomer Carl Sagan's *Pale Blue Dot* in which the author poetically described a view of the Earth from space. Participants were asked to reflect on what kind of text this was. The discussion of this text that ensued allowed for the identification of popular science writing as both writing about science and a form of literature, in that it addressed human experience. A more general

introduction to popular science writing and examples of popular authors and publications then followed.

Reading and discussion of text excerpts:

Four excerpts were then read and discussed. These excerpts were selected to illustrate a range of different treatments of science that can be found in popular science writing.

Excerpt 1 – from *Curious Naturalists* by Niko Tinbergen: Participants were asked to read a short excerpt from this book in which Niko Tinbergen, a 20th century ethologist, describes his investigations into the perception and behavior of wasps in the field. He provides an account of his attempt to understand how wasps manage to locate their burrows after traveling a large distance away. Participants were asked to think about what science is learned in the passage read, but also what is learned *about* science and scientists. In addition to what is learned about wasps and their behavior, readers learn about "a day in the life" of a field biologist interested in animal behavior. Experiments conducted in the field are described, inviting the reader to consider experimental design but also to see scientific investigation at work beyond the carefully controlled environment of the laboratory. Moreover, Tinbergen shares his reflections about his changing emotions during the course of his investigations, admitting to a growing sense of power and control as he learned more about the wasps and was able to manipulate their behavior. He admits that the motivations of scientists are not only the search for knowledge; less noble drives can be involved.

Excerpt 2 – from *The Character of Physical Law* by Richard Feynman: Participants were asked to read parts of Feynman's published lecture entitled The Law of Gravitation and consider what is learned about the law that is not usually learned by reading a typical textbook. This lecture along with others compiled in the collection *The Character of Physical Law*, was delivered by Feynman at Cornell University in 1964 to a general audience (available free at http://research.microsoft.com/apps/tools/tuva/index.HTML). The lecture, in using the law of gravitation as an example of a physical law in general, has a much broader scope than textbook treatments of this law. The law is discussed explicitly *as a law*, thus addressing its generality incorporating many distinct facts. Moreover, the lecture integrates a discussion of the law of gravitation with Newton's other laws, thereby giving a sense of Newton's mechanics as a framework of understanding that provides a coherent and wide reaching way of understanding the physical world.

Excerpt 3 – from *Unweaving the Rainbow* by Richard Dawkins: Next, participants read and discussed portions of the essay "Barcodes at the Bar" from the collection of essays by Richard Dawkins entitled *Unweaving the Rainbow*. Based on reading portions of this essay, participants were asked to consider how Dawkins explains difficult scientific concepts and motivates interest in them. This essay introduces the reader to the technology of DNA fingerprinting and discusses the role of this fairly new technology in the legal system. Dawkins uses a variety of vivid analogies to explain many difficult concepts associated with this topic. Moreover, by integrating a discussion of DNA structure and variation within populations within the drama of the courtroom Dawkins brings a difficult and remote topic very much to life. Along the way he exposes common unscientific reasoning that can influence how lawyers and jurors can view the reliability of DNA fingerprinting evidence. That is, in this essay, Dawkins illustrates the contributions of scientific knowledge and reasoning to important decisions in social life.

Excerpt 4 – from *Copenhagen* by Michael Frayn: For this final excerpt from popular science writing, three of the participants in the workshop were invited to engage in a reading of portions of a play entitled Copenhagen by the playwright Michael Frayn. This play deals with a historically documented meeting between the physicist Werner Heisenberg and his former mentor Neils Bohr in 1941. Based on the little that is known about what took place when Heisenberg went to meet Bohr in Copenhagen crossing enemy lines during World War II, Frayn imaginatively constructs a drama of what the two scientists might have talked about. The play consists of three characters: Heisenberg, Bohr and Bohr's wife. A brief reading was carried out during the workshop by three of the participants and then all were asked to consider the question: what do we learn about the personal and moral dimensions of science? The excerpt read was selected to incorporate central themes that are dealt with in this play: personal competition between scientists, including that between former student and mentor; the historical context of technological developments; and the difficult moral questions that can arise in scientific research.

Using popular science in science teaching:

The workshop ended with an open discussion of the possible ways in which popular science writing can serve as a resource in science teaching. This theme was addressed in two parts: popular science writing as a resource for teachers and how to use such texts within instruction. The points emphasized with respect the use of this genre of texts as a resource for teachers were:

- Providing teachers with information related to all the goals of science teaching (complementing textbooks significantly).
- Long term planning of units: sequencing and relating concepts.
- Motivating and explaining abstract ideas.
- Alternative reading material to assign to students.

The last point raises the question of how popular science texts can be used by students in the context of formal instruction and the instructional formats through which they can be incorporated. Some possibilities that were discussed include:

- Assigning reading before a unit to motivate interest in typically "dry" topics.
- Key experiments and evidence for scientific ideas can be read about during units when experiments can't actually be performed.
- Read and discuss integrative readings at the end of units to help students understand relationships between concepts.
- Texts that develop complex arguments can be read to model integrating concepts, thinking skills, applications and decision-making.
- Readings of plays can be conducted in class and science-related social issues discussed.

Conclusion

The main goal of this workshop was to introduce secondary and intermediate level science teachers to the genre of popular science writing. A range of texts were discussed for their contributions to developing different aspects of scientific literacy and how such texts can be used as sources of information for teachers and as texts to be read by students and incorporated into

instruction complementing textbooks. The use of science trade books that target younger readers has been researched and therefore, research-based recommendations for incorporating them into instruction exist. However, this is not the case where popular science writing for older readers is concerned. At this stage in science education research, how popular science writing can be used depends to a large extent on the creativity of teachers. What this workshop aimed to achieve was to familiarize secondary and intermediate teachers with an exceedingly rich repository of wide ranging and engaging sources of information about science.

References

CERD (Centre for Educational Research and Development) (1995). *New Lebanese Educational Ladder.* Beirut: Centre for Educational Research and Development.

Millar, R. & Osborne, J. (1998). *Beyond 2000: Science education for the future*. London: King's College.

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Chemistry Probeware for Enhanced Laboratory Learning

Nizar Mehtar

Introduction

Probeware refers to educational hardware and software used for real-time data collection, processing, and analysis with a computer or calculator. Ample evidence from research confirms that probeware applications enhance students' learning in science laboratories. The aim of this workshop was to illustrate how the integration of chemistry probeware can enhance students' cognitive, meta-cognitive, and epistemological learning outcomes in chemistry laboratories

Description of the session

The session was planned as follows:

(a) *Introduction* **(10 mins)**

- What is a chemistry probeware?
- What is (are) aim(s) of chemistry lab work?
- What is the purpose of the session?

(b) *Reflections on a 'traditional' experimental scenario*

- **Phase 1: Intra-group discussions (10 mins)**

Participants, within their groups, were kindly required to read the instruction sheet 'Kinetic Curves of Chemical Reactions' and then reflect on its value while focusing on the following guiding questions:

- How can this experiment enhance students' learning in the chemistry lab?
- To what extent is this experiment convenient, safe and environment friendly?
- To what extent is this experiment time consuming?
- What 'extensions' can be added to this activity to further students' understanding of chemical kinetics? How will you allocate time for this extension?

- **Phase 2: intergroup sharing of thoughts (10 mins)** Groups were kindly required to share their thoughts with the other groups.

(c) *Using a chemistry probeware in a kinetic study*

- **Phase 1: 'Enjoying' a probeware experience (Group work) (35 mins)**

Groups were kindly required to examine and manipulate the set up prepared on the benches and follow the procedure on page 5. Note that:

- Steps 1- 5 were already done – just examine the connections
- You need to do steps 6-9

- **Phase 2: What else can the software do? (Group work mainly facilitated by the presenter) (25 mins)**

- How can you perform the same experiment at two different temperatures in less than 5 minutes?
- In the Vernier's instructor's manual, this procedure was meant to determine the molar volume of an ideal gas. How can that be plausible? (Check the document 'The Molar Volume of a Gas')

- **Phase 3: A Design activity (Group work) (15 mins)**

Groups are kindly required to outline how the same sensors may be used to respond to the investigation 'Catalysts- Peroxide disposal'.

(d) *Closure* **(15 mins)**

The presenter facilitated a concluding reflection based on the following focus questions:

- What are the learning potentials of probeware based lab work? How does it compare to traditional lab work?

[Increasing reliability of data collection & processing- Self regulation - Increasing potentials of assessment alternatives - Science/technology partnership - Socialization & motivation - Environmental considerations]

- What are the concerns associated with the probeware uses?

[Technical problems – technological model for learning chemistry]

Kinetic Curves of Chemical Reactions

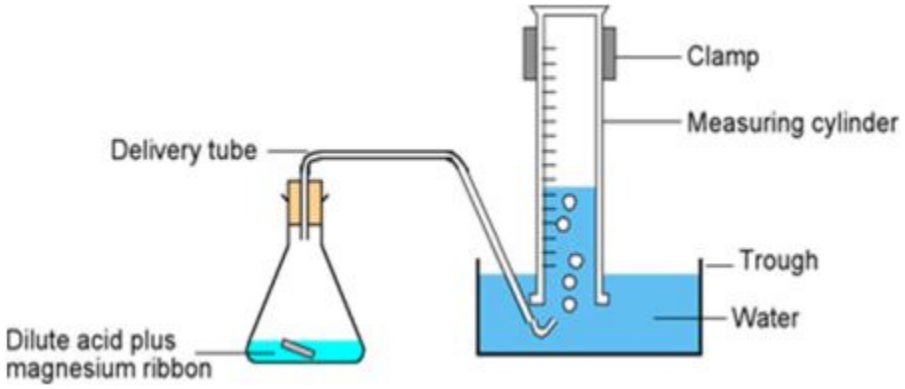
[http://www.nuffieldfoundation.org/practical-chemistry/rate-reaction-magnesium-hydrochloric-acid]

Background

Magnesium reacts with hydrochloric acid according to the following equation:

$$Mg\ (s) + 2HCl\ (aq) \rightarrow MgCl_2\ (aq) + H_2\ (g)$$

The kinetics of the reaction may be studied through experimental scenarios that allow for successive measurements of the volume of the hydrogen gas at regular intervals of time. One of these scenarios is schematized below:

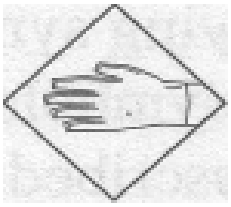
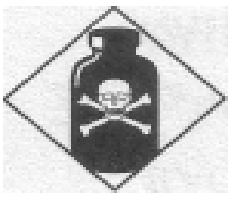
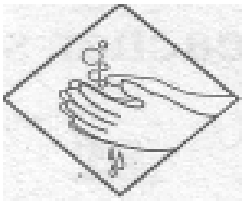


Purpose

This experiment was planned to provide the students with an opportunity to:

- Perform and evaluate an experimental method in which the collected data may be processed towards construction of a kinetic curve and graphical determination of reaction rates.
- Use experimental data to verify the trend of variation of reaction rate with time.

Safety

Wear laboratory aprons and goggles. 	Wear gloves to protect your hands 	Assume that all chemicals used may be harmful or toxic, so handle them with care. 	Keep your hands away from your face and mouth and always wash them before leaving the laboratory 

Procedure

1) Measure 50 cm^3 of 1 $mol.L^{-1}$ hydrochloric acid using one of the measuring cylinders. Pour the acid into the 100 cm^3 conical flask.
2) Set up the apparatus as shown in the diagram in the 'background'. Half fill the trough with water.
3) Fill the other measuring cylinder with water, and make sure that it stays filled with water when you turn it upside down.
4) When you are ready, add a 5 cm strip of magnesium ribbon to the flask, put the bung back into the flask as quickly as you can, and start the stopwatch.
5) Record the volume of hydrogen gas given off at suitable intervals (10 seconds for example). Continue timing until no more gas appears to be given off.

❖ **Dear participants: How would you assess students' performance in this lab experiment?**

Procedure - Adapted from the Vernier's instructor's manual

1. Obtain a piece of magnesium ribbon. Measure and record its length to the nearest mm. Ask your instructor for the mass of one meter of magnesium ribbon, and record this information. Place the piece of magnesium ribbon in a clean and dry 125 mL Erlenmeyer flask.
2. Prepare a room temperature water bath in a large beaker. The bath should be deep enough to completely cover the gas level in the Erlenmeyer flask.
3. Connect a Gas Pressure Sensor to Channel 1 of the Vernier computer interface. Connect a Temperature Probe into Channel 2 of the interface. Connect the interface to the computer with the proper cable.
4. Start the Logger Pro program on your computer. Open the file from the Advanced Chemistry with Vernier folder.
5. Use the clear tubing to connect the white rubber stopper to the Gas Pressure Sensor. Twist the white stopper snugly into the neck of the Erlenmeyer flask to avoid losing any of the hydrogen gas that will be produced in the reaction.
6. Obtain a small amount of 1.0 M hydrochloric acid. Draw 5 mL of HCl solution into the 20 mL syringe. Thread the syringe onto the two-way valve on the white stopper .Submerge the Erlenmeyer flask into the water bath. Position the Temperature Probe in the water bath so that the tip of the probe is not touching the beaker.
7. With the flask still submerged in the water bath, click ▸ Collect to begin data collection. After about 10 seconds, open the two-way valve directly below the syringe, press the plunger to add all of the 5 mL of HCl solution to the flask, and close the two-way valve.
8. Gently swirl the flask, while keeping it immersed in the water bath, as the reaction proceeds. Data collection will stop after around 3-5 minutes. Click ■ Stop to end data collection.
9. Examine the following options (toolbar) can contribute to the processing of data:
   a) Click graph autoscale
   b) Click Analyze, and then
      - Check 'examine'- what does it do?
      - Successively check 'interpolate' and 'tangent' (each at a time) - what do they do?
   c) Click 'options'→ 'graph options' and then type a title for your graph

d) Click 'insert' → 'text', and then type in any comment about the graph
e) Saving the data:
- select the table and save it on a word document or an excel sheet
- select the graph and save it on a work document or an excel sheet

The Molar Volume of a Gas
[Vernier's Instructor Manual]

In this experiment, you will determine the molar volume of a gas by conducting a chemical reaction that produces a gas, as shown in the reaction equation below.

$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

You will react a known mass of solid magnesium with an excess of hydrochloric acid, in a sealed vessel, and use the pressure change to calculate molar volume at STP.

Objectives
In this experiment, you will
- Measure the gas production of a chemical reaction by a pressure change.
- Determine the molar volume of the gas produced in the reaction.
- Calculate the molar volume of a gas at STP.

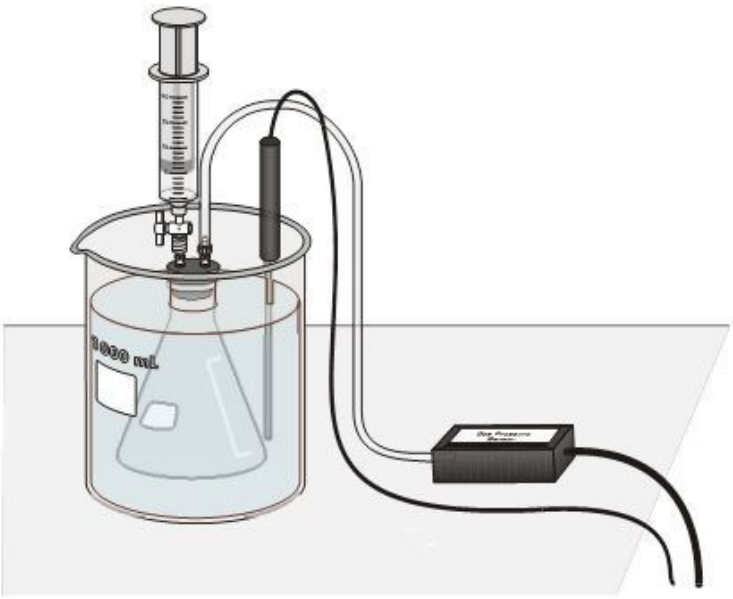


Figure 1

Materials

Vernier computer interface	3.0 M hydrochloric acid, HCl, solution
Computer	small beaker for HCl solution
Vernier Gas Pressure Sensor	magnesium ribbon, pre-cut
Temperature Probe	Ruler
600 mL or one liter beaker	20 mL gas syringe
10 mL graduated cylinder	plastic tubing with two Luer-lock connectors
125 mL Erlenmeyer flask	rubber stopper assembly with two-way valve

Pre-Lab Exercise

Obtain the 125 mL Erlenmeyer flask that you will use for the experiment. Determine and record the available volume of the flask that the hydrogen gas will occupy as it is produced from the reaction of the solid magnesium and the hydrochloric acid solution. Account for the following items when you determine the volume of your flask:

- A 125 mL flask does not have a volume of precisely 125 mL.
- During the experiment, you will seal the flask with a rubber stopper and the stopper will occupy some of the volume of the flask.
- You will add 5 mL of solution (3.0 M HCl solution) to the flask.

Procedure

1. Obtain and wear goggles.
2. Obtain a piece of magnesium ribbon. Measure and record its length to the nearest mm. Ask your instructor for the mass of one meter of magnesium ribbon, and record this information. Place the piece of magnesium ribbon in a clean and dry 125 mL Erlenmeyer flask.
3. Prepare a room temperature water bath in a large beaker. The bath should be deep enough to completely cover the gas level in the Erlenmeyer flask.
4. Connect a Gas Pressure Sensor to Channel 1 of the Vernier computer interface. Connect a Temperature Probe into Channel 2 of the interface. Connect the interface to the computer with the proper cable.
5. Use the clear tubing to connect the white rubber stopper to the Gas Pressure Sensor. (About one-half turn of the fittings will secure the tubing tightly.) Twist the white stopper snugly into the neck of the Erlenmeyer flask to avoid losing any of the hydrogen gas that will be produced in the reaction (see Figure 1). **Important**: Close the valve on the white stopper by turning the white handle so it is perpendicular with the valve stem.
6. Obtain a small amount of 3.0 M hydrochloric acid. **CAUTION:** *Handle the hydrochloric acid with care. It can cause painful burns if it comes in contact with the skin.* Draw 5 mL of HCl solution into the 20 mL syringe. Thread the syringe onto the two-way valve on the white stopper (see Figure 1). Submerge the Erlenmeyer flask into the water bath. Position the Temperature Probe in the water bath so that the tip of the probe is not touching the beaker.
7. Start the Logger *Pro* program on your computer. Open the file "05 Molar Volume" from the *Advanced Chemistry with Vernier* folder.
8. With the flask still submerged in the water bath, click ▶ Collect to begin data collection. After about 20 seconds, open the two-way valve directly below the syringe, press the plunger to add all of the 5 mL of HCl solution to the flask, and close the two-way valve.
9. Gently swirl the flask, while keeping it immersed in the water bath, as the reaction proceeds. Data collection will stop after 5 minutes. You may click ■ Stop to end data collection *before* 5 minutes have elapsed.
10. Carefully remove the white stopper from the flask to relieve the pressure in the flask. **Important**: Do not open the two-way valve to release the pressure in the flask.
11. Examine the pressure data to determine the change in pressure, ΔP, during the reaction. In addition, determine the mean temperature of the water bath during the reaction. Record these values in your data table.
12. From the Experiment menu, choose Store Latest Run to save your data.
13. Rinse, clean, and dry the flask for a second trial. Obtain a new piece of magnesium ribbon and place it in the flask. Repeat the necessary steps to conduct the second trial.

14. Follow the same procedure to conduct a third trial.
15. Use your text, or another appropriate reference, to find and record the water vapor pressure at the temperature of each trial.

Data Table

	Trial 1	Trial 2	Trial 3
Length of Mg (mm)			
Mass of 1 meter of Mg (g)			
Volume of flask (mL)			
Maximum pressure (kPa)			
Initial pressure (kPa)			
Pressure change, ΔP (kPa)			
Temperature (K)			
Vapor pressure of water (kPa)			

Data Analysis

1. Calculate the mass of each piece of magnesium ribbon that you used.
2. Calculate the number of moles of each piece of magnesium that you used.
3. Use your results to calculate the molar amount of hydrogen gas that was produced in your reactions.
4. Calculate the volume of one mole of hydrogen gas (molar volume), using your results. Convert this value to STP.
5. Compare your calculated molar volume, at STP, with the accepted molar volume of an ideal gas at STP, 22.4 L/mol. If the values do not compare well, suggest possible sources of experimental error.

Jaegar, D., & Weisker, S. (1999). *Technique builders and problem-solving experiments*. Austin: Holt, Rinehart and Winston.

INVESTIGATION C20

ChemFile LAB PROGRAM

Catalysts—Peroxide Disposal

May 4, 1995

Mr. Reginald Brown
Director of Materials Testing
CheMystery Labs, Inc.
52 Fulton Street
Springfield, VA 22150

Dear Mr. Brown:

In the synthesis of one of our products, hydrogen peroxide is generated as a byproduct. Disposing of the H_2O_2 in the sewer system is not permitted because it can be harmful to wildlife and can cause excess pressure to build up in clogged pipes. We are considering decomposing the hydrogen peroxide into oxygen and water but need a catalyst to speed up the reaction.

We need your firm to investigate three likely catalysts that could be used to speed decomposition of H_2O_2: sodium iodide, manganese dioxide, and yeast. Sodium iodide and manganese dioxide are inorganic catalysts. Yeast is a fungus that produces enzymes which catalyze the decomposition.

Please identify the most effective and economical method for us to use. We are prepared to pay up to $100 000 for satisfactory work.

Sincerely,

Christopher Sasseen

Christopher Sasseen
Division Manager
Industrial Engineering Systems, Inc.

Memorandum

ChoMystery Labs, Inc.
52 Fulton Street
Springfield, VA 22150

Date: May 5, 1995
To: Theodore Cole
From: Reginald Brown

We've got to give this contract our best shot because Industrial Engineering Systems is a huge conglomerate and a series of contracts with them could give us the stability we need to further expand our customer base.

Before you make a plan, check the solubility of NaI and MnO_2 in a chemical handbook to be sure they will be satisfactory. Test a small amount of yeast to make sure it is satisfactory. Also be sure to note the costs of all three catalysts. Then, before you begin work in the lab, I will need to review the following items.

- one-page plan for your procedure, with data tables
- detailed list of the equipment and materials you need, with total cost

Begin the lab work as soon as your plan is approved. When you have the answers, prepare a two-page letter to Christopher Sasseen, Division Manager, Industrial Engineering Systems, Inc. Be sure to include the following information.

- recommendation of which catalyst is the most effective and why
- summary paragraph explaining how your procedure solved this problem
- rates of decomposition of H_2O_2 using the three catalysts
- graphs of your data
- detailed, organized data table
- detailed invoice for costs of materials and services

Hands-On, Minds-On Biology Activities!!!

Amina Harbali

Introduction

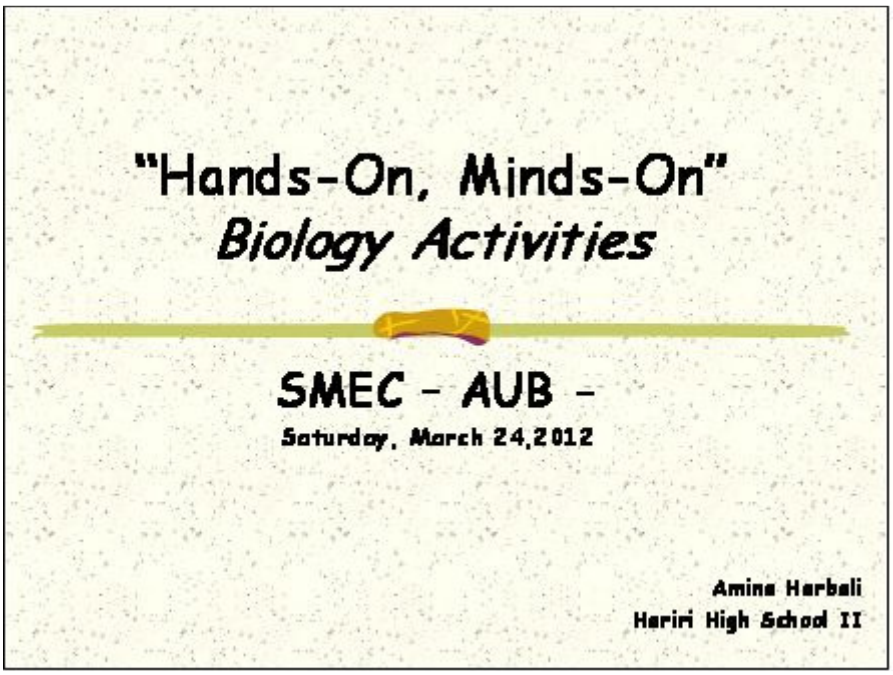
> *"A child best learns to swim by getting into water; likewise, a child best learns science by doing science" (Rillero, 1994).*

Students learn better when they can touch, feel, measure, manipulate, draw, make charts, record data and when they find answers for themselves rather than being given the answer in a textbook or lecture. While doing hands-on activities, the learner is learning by doing but through minds-on learning, the learner is *thinking* about what he/she is learning and doing. So, students should be both physically and mentally engaged in activities that encourage them to question and devise temporarily satisfactory answers to their questions. Interactive engagement methods also give emphasis to hands-on activities (usually) as well as minds-on activities (always), which provide immediate feedback through discussion with peers and/or instructors. From my previous teaching experiences, I have noticed that students prefer activity periods more than lecture periods and that their performances are much better with activities. Therefore, my interest for choosing such a topic is for the sake of students' interest, performance and achievement.

Description of the Session

In this workshop, participants experienced **"**hands-on, minds-on**"** biology activities for different levels. These activities focused on photosynthesis and respiration (grade 7), genetics (grade 9), the nervous system (grade 10) and DNA (grade 11). The session was planned as follows:

(a) Welcome **(5 mins)**
(b) Brain teasers (ice breakers- **8 mins**)
(c) Participants were distributed to four groups (five people per group) and were asked to attend one of the genetics centers. Participants were asked to carry out each of the four activities related to genetics. Each activity lasted for 10 minutes and included:
Activity 1: Traits Bingo
Activity 2: Generation of traits
Activity 3: Tree of Genetic traits
Activity 4: An Inventory of My Traits **(40 mins)**
(d) After participants finished exploring each center, a discussion was done about the following: (i) Why hands-on, minds-on activities? and (ii) Importance of hands-on learning. **(10 mins)**
(e) Participants carried out three more hands-on activities for grades 7, 10 and 11: Synapse activity (Jumpin' the Gap) for **15-20 mins**; DNA activity for **15-20 mins**; and photosynthesis and cellular respiration activity for **10mins**.
(f) Finally, participants were provided with the advantages of hands-on, minds- on activities and their impact on students' achievement. **(10 mins)**



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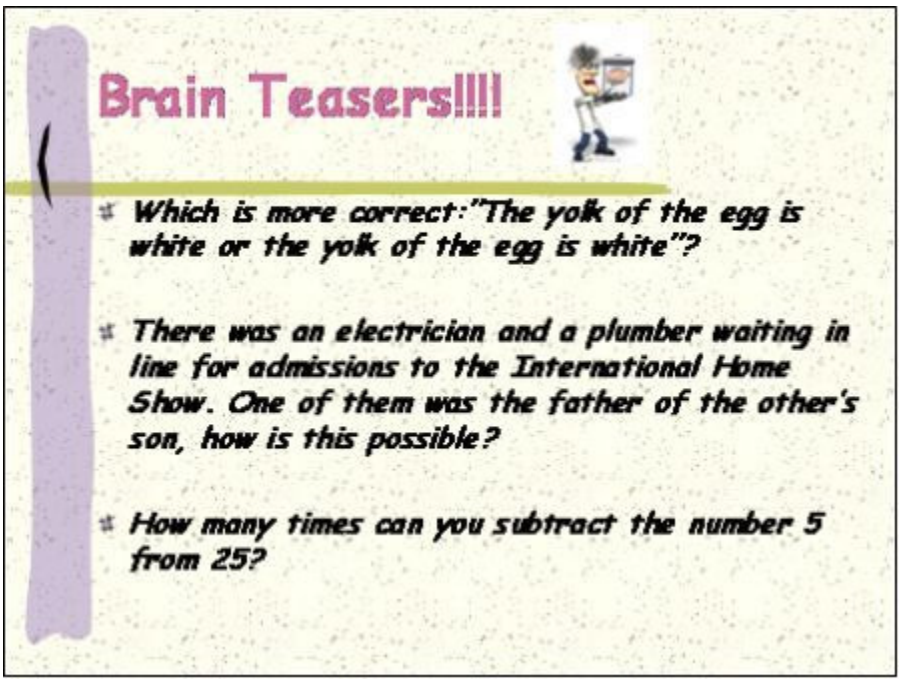

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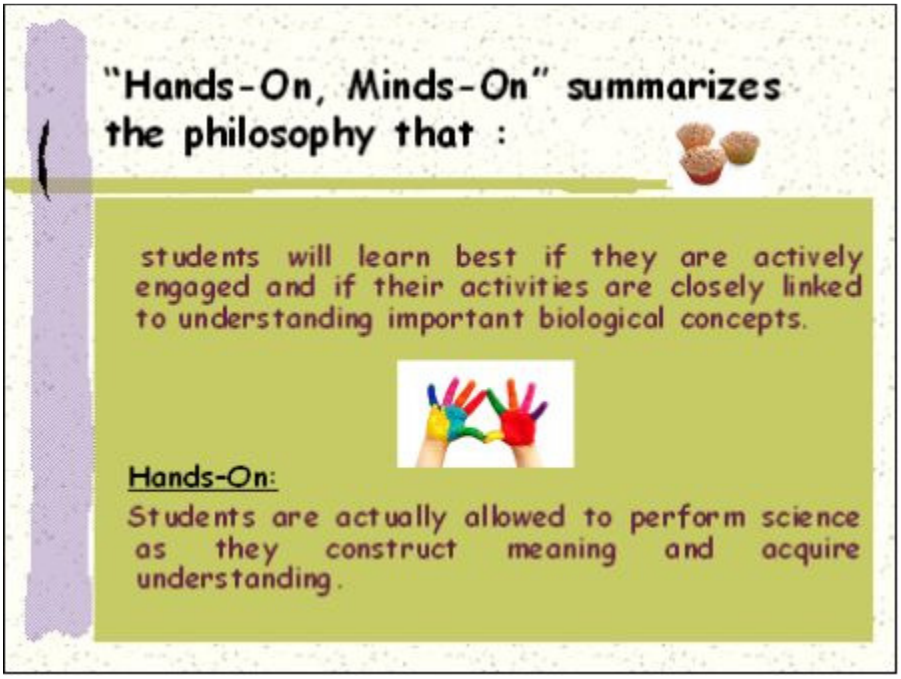

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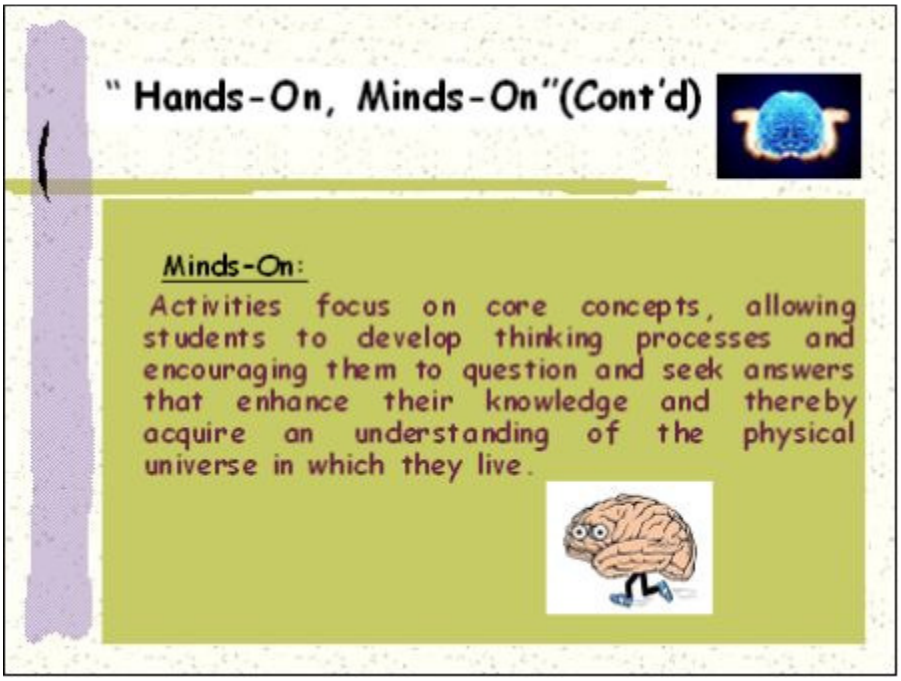

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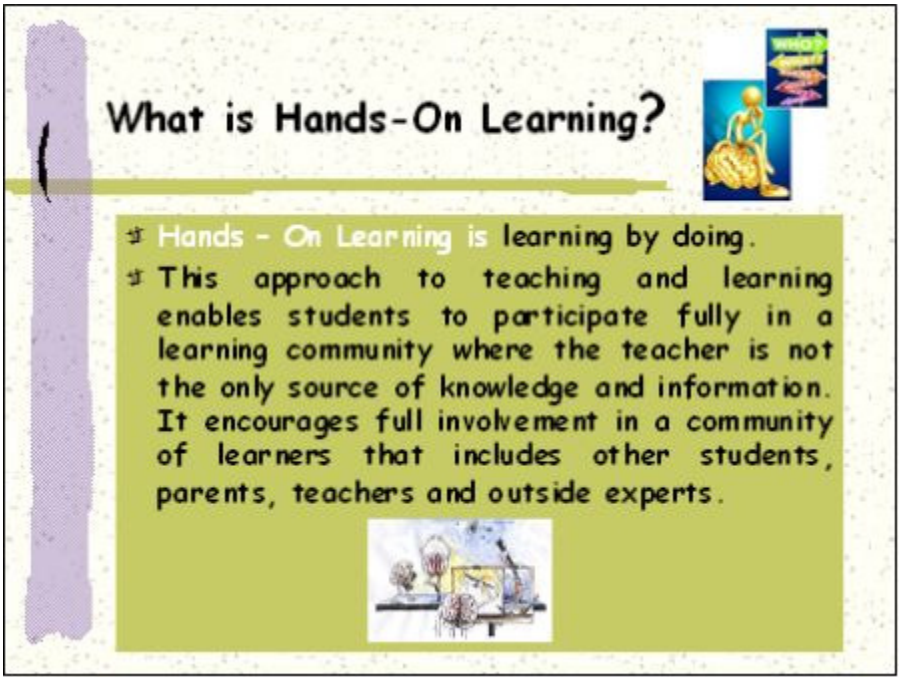

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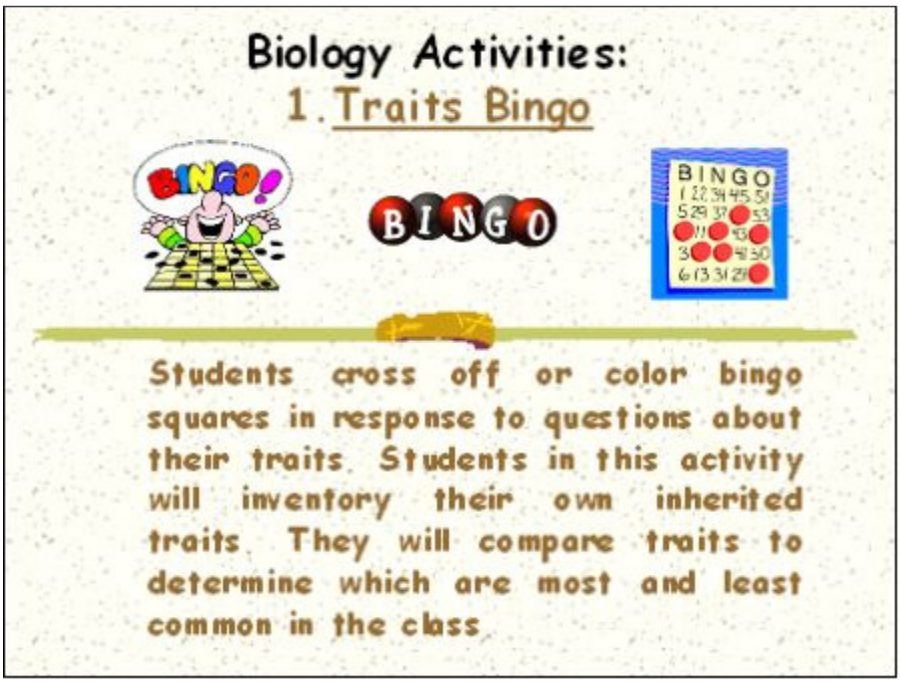

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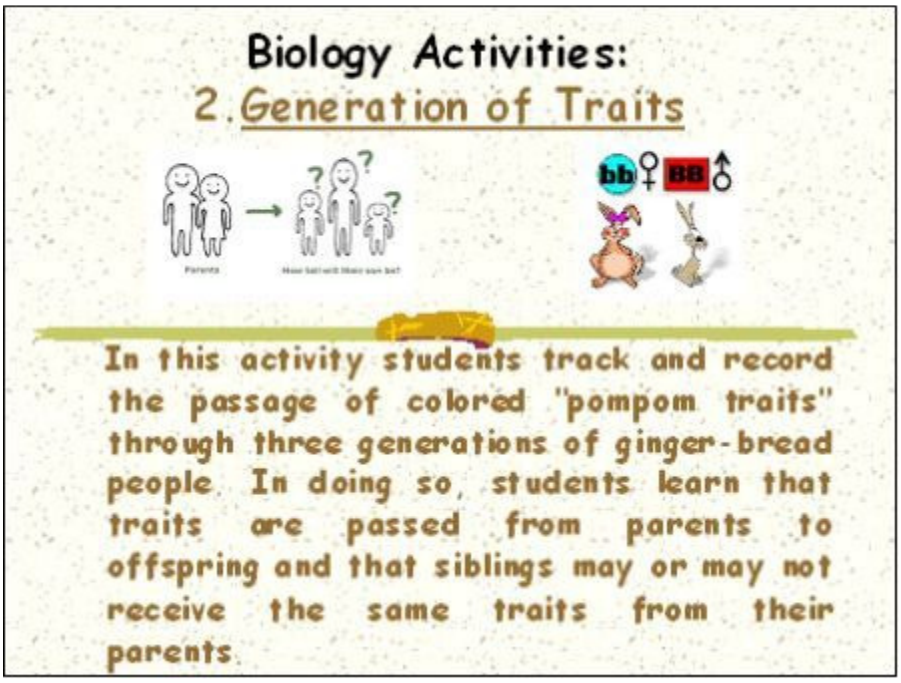


SLIDE 8

Biology Activities:

3. Tree of Genetic Traits

Students mark their traits for tongue rolling, PTC tasting and earlobe attachment on tree leaf cut-outs. They then place their leaves on a large tree whose branches each represent a different combination of traits. When completed, the tree forms a visual representation of the frequency of trait combinations within the class.

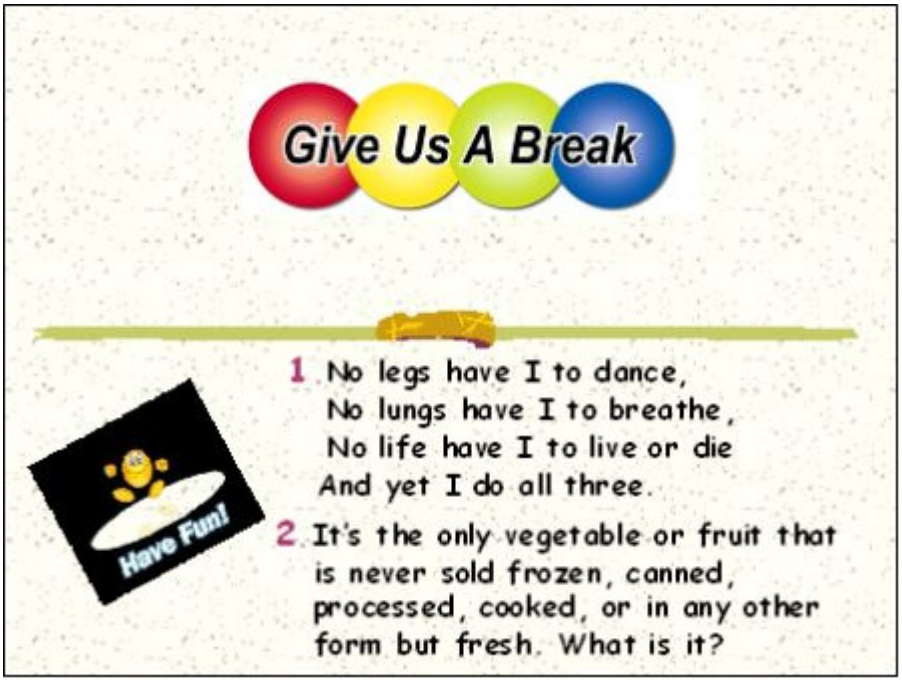
SLIDE 9

Biology Activities:

3. An Inventory of My Traits

Students take an inventory of their own easily-observable genetic traits. Working in small groups, they observe how their trait inventories differ from those of others. Students record their observations in a data table and make a bar graph to show the most and least common traits in the group.

SLIDE 10



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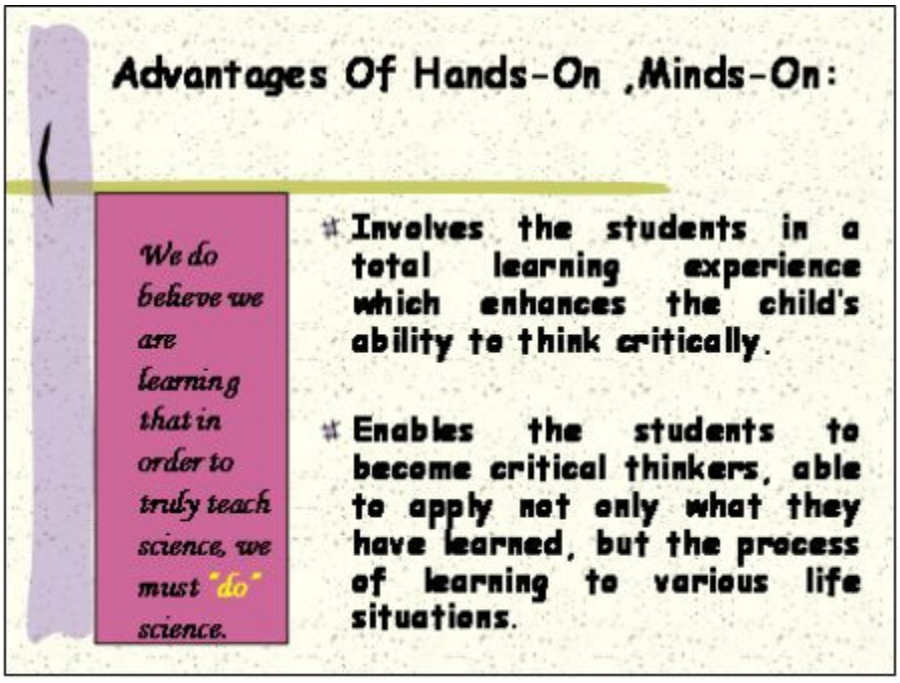

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Advantages Of Hands-On ,Minds-On:(Cont'd)

- Requires students to become active participants instead of passive learners.
- Builds effective techniques for students that enhance their ability to observe, learn the ***what, how, when*** and ***why***, of things with which they interact.
- Has become a slogan and is often used to describe any activities in classrooms that use materials.

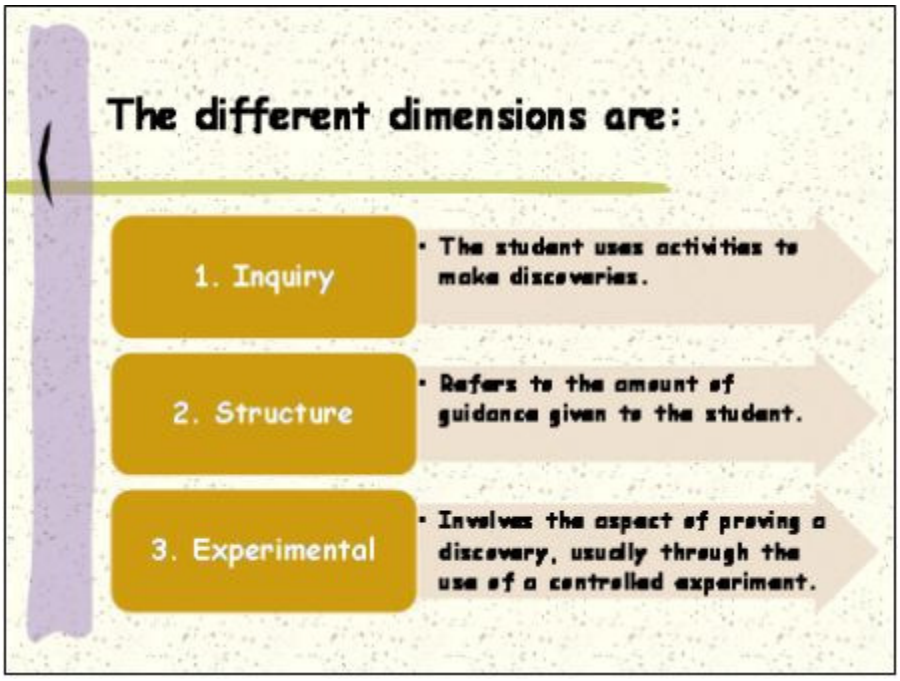
SLIDE 13

Advantages Of Hands-On ,Minds-On:(Cont'd)

- Hands-On learning can be thought of as comprising 3 different dimensions:

- The inquiry dimension,
- The structure dimension,
- The experimental dimension.

SLIDE 14



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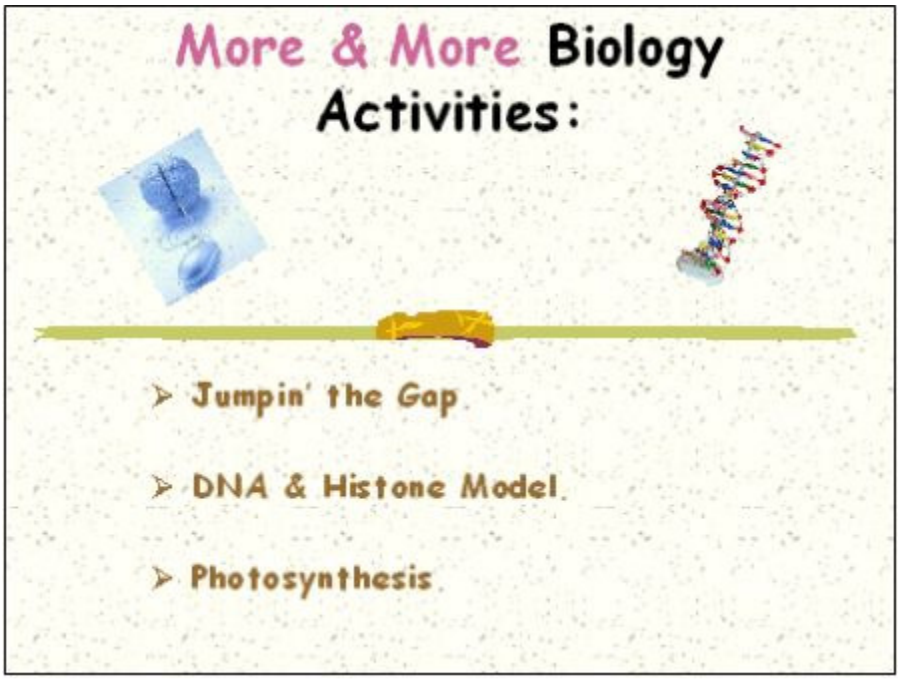

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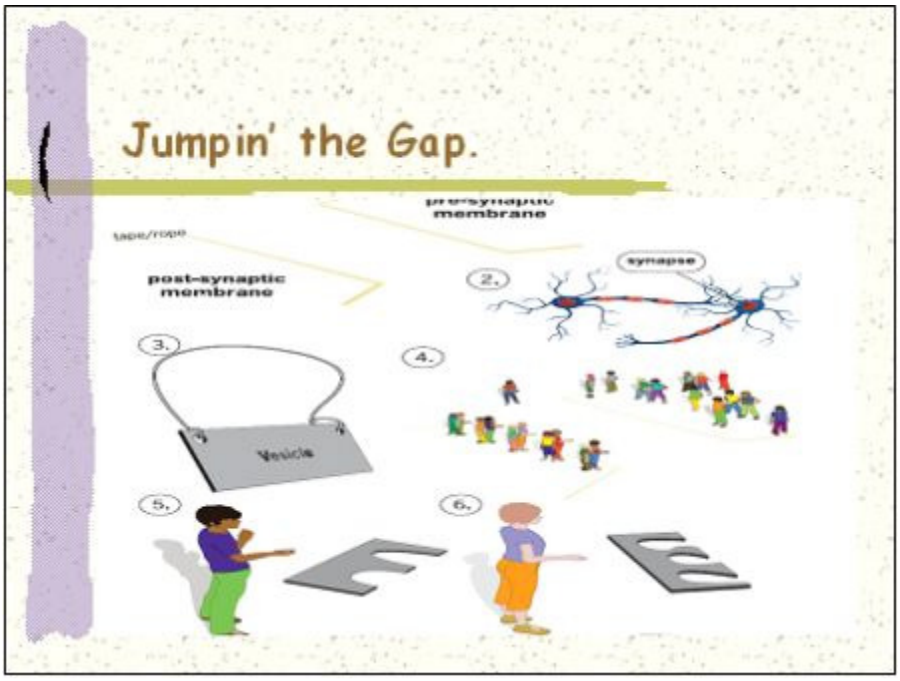

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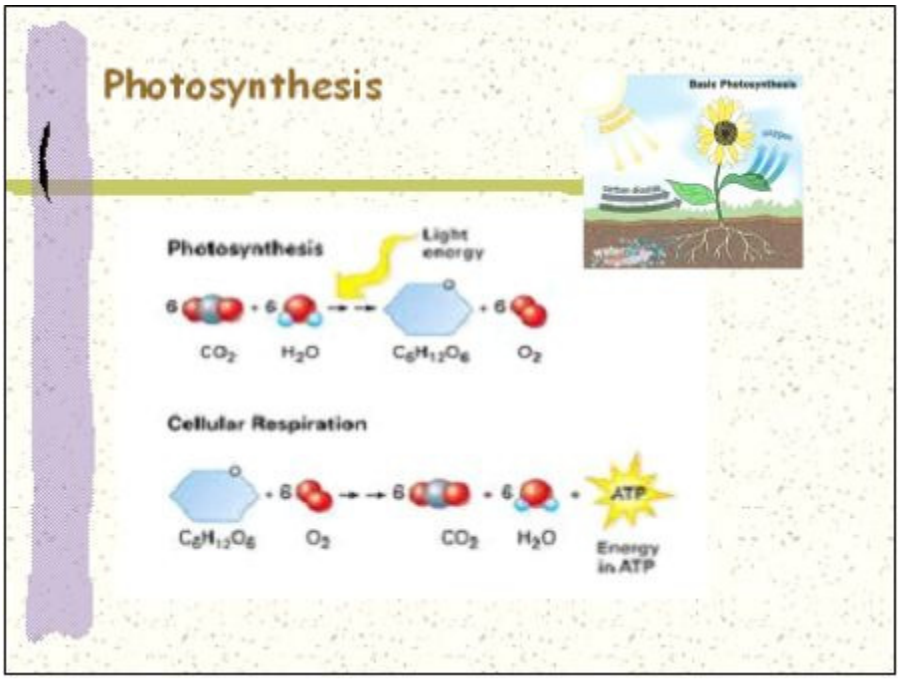

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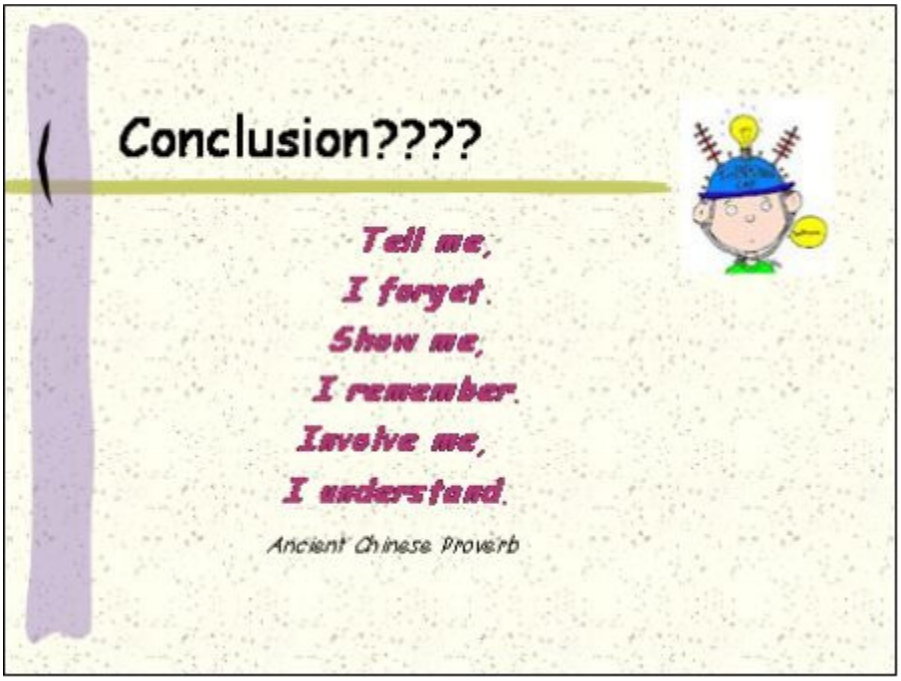


SLIDE 20

Traits BINGO

Purpose:

Students cross off or color bingo squares in response to questions about their traits. This activity is designed to be used as a review following An Inventory of My Traits, Generations of Traits, and A Tree of Genetic Traits.

Learning Objectives:

- Students will inventory their own inherited traits.
- Students will compare traits to determine which are most and least common in the class.

Classroom Implementation:

Note: One of the traits in this activity is the ability to taste PTC. If you have not already tested for this trait in a previous activity follow these steps before beginning:

1. Give each student a piece of PTC paper and instruct them to place the paper on the tip of their tongue to see if they can taste the chemical.
2. Hand out a hard candy to each student, as the taste of PTC is bitter and
   slightly unpleasant.

Instructions:

1. Distribute a Bingo card to each student and instruct them not to mark any squares until told to do so.
2. Read the Bingo questions one by one (in order or randomly), instructing students to mark the squares with an X or color them in.
3. Continue to read Bingo questions until a student obtains a bingo.

Traits BINGO

Color or mark with an **"x"** the squares below **when instructed to do so**
The square marked "free" is a free space.

B	I	N	G	O
Aunt	I have allergies	Straight hairline	Freckles	Mother
I cross my right thumb over my left when I clasp my hands	Can not taste PTC	Curly hair	Neighbor can not taste PTC	Straight hair
Father	Grandmother	Free	Attached earlobes	Dimples
I have a different trait than the person sitting next to me	Cleft chin	Can taste PTC	Uncle	Can not roll tongue
Detached earlobes	Shared trait - Left	Trait in common - Right	I cross my left thumb over my right when I clasp my hands	Least common trait

Bingo Questions

You may ask the questions in order, at random, or have students draw numbers.

1. Color the square marked I cross my right thumb over my left when I clasp my hands if this describes you.
2. Color the square marked Shared trait-Left if you share a trait with the person sitting to your left.
3. Color the square marked least common trait if you have a trait that not many people in the class share.
4. Color the square marked Neighbor cannot taste PTC if you sit next to someone who cannot taste PTC.
5. Color the square or squares naming the relatives from whom you do not inherit traits.
6. Color the square or squares naming the relatives from whom you do inherit traits.
7. Color the square marked I have allergies if you have this trait.
8. Color the square marked Trait in common - Right if you and your neighbor to the right share a common trait.
9. Find the two squares for tasting, or not tasting, PTC and color the one that applies to you.
10. Find the two squares describing earlobes and color the one that applies to you.
11. Color the square marked Straight hairline if you have this trait.
12. Color the square marked cannot roll tongue if you have this trait.
13. Color the square marked I have a different trait than the person sitting next to me if this describes you.
14. Find the two squares describing hair texture and color the one that applies to you.
15. Color the square marked *Freckles* if you have this trait.
16. Color the square marked *Dimples* if you have this trait.
17. Color the square marked *Cleft chin* if you have this trait.
18. Color the square marked *I cross my left thumb over my right when I clasp my hands* if this describes you.

Generation of Traits

Purpose:

In this hands-on activity students track and record the passage of colored "pom-pom traits" through three generations of ginger-bread people. In doing so, students learn that traits are passed from parents to offspring and that siblings may or may not receive the same traits from their parents.

Learning Objectives:

- Traits are observable characteristics that are passed down from parent to child.
- An individual will have many traits they share in common with others, and more so with siblings and parents.
- An individual's overall combination of traits makes them unique.
- An equal number of traits are passed on from each parent.

Classroom Implementation:

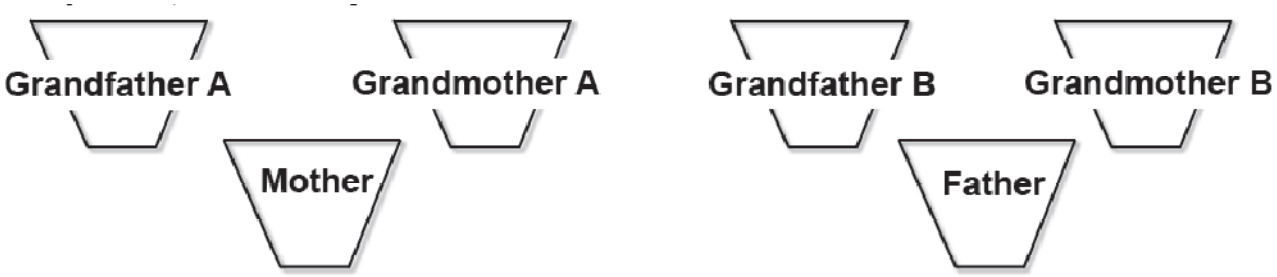
1. Begin class by pointing out that every person in the class has a unique combination of "traits" or observable characteristics. Discuss some examples of traits (eye color, handedness, height, etc.).
2. Invite students to consider why children often resemble their siblings and parents. Explain that these resemblances occur because traits are passed down from parent to child.
3. Divide students into groups of 3 or 4. Give each group a set of materials. Instruct students to carry out the following activity:

4. **Procedure of the Activity:**
   - Create enough sets of cups and pom-poms for students to work in pairs or groups of four. Each set should contain:

     - 6 cups labeled as follows:

"Grandfather A"
"Grandmother A"
"Grandfather B"
"Grandmother B"
"Mother"
"Father"

- 6 brown pom-poms
- 6 red pom-poms
- 6 green pom-poms
- 6 yellow pom-poms



The colored pom-poms are the traits that each of the grand parents have.

- Close your eyes and pick three traits from Grandfather A and three traits from Grandmother A and place them in the cup labeled Mother. These are the traits that Mother inherited from her parents. Color the pom-pom picture on the worksheet to show the traits Mother has.

- Close your eyes again and pick three traits from Grandfather B and three traits from Grandmother B, and place them in the cup labeled Father. These are the traits that Father inherited from

his parents. Color the pom-pom picture on the worksheet to show the traits Father has.

- Mother and Father have four children: Mary, George, Elizabeth and Carl. To determine the traits that Mary will inherit from Mother and Father, close your eyes and take three pom-poms from Mother and three pom-poms from Father. Color the diagram to show the traits that Mary inherited.

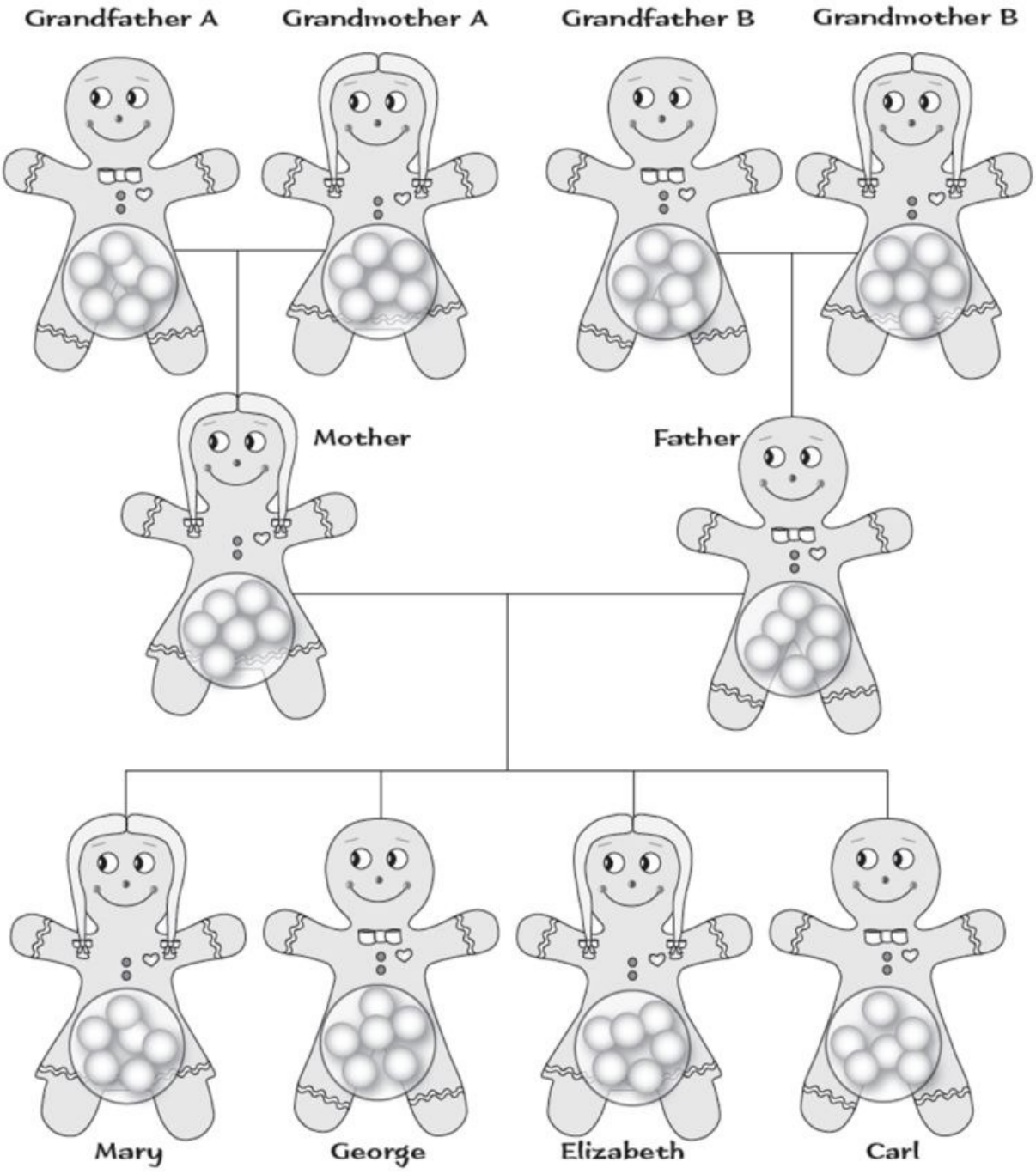
- Next, return the traits that you took from Mother and Father. (Look at your diagram if you forget where each trait came from.) Now, close your eyes again and choose the traits that George will inherit (3 from Mother, 3 from Father). Color the diagram to show George's traits.

- Return the traits you took from Mother and Father and repeat the process to find the traits for Elizabeth and then Carl.

- Suggest that students close their eyes and mix the pom-poms with their hands each time before drawing them out. This will yield a more random and varied result.

- Answer the questions on the Generations of Traits Questions sheet.

Generations of Traits
Worksheet



Generations of Traits

Questions

A. Would Mary, George, Elizabeth and Carl look identical to (have the same traits as) their parents?

B. Did all four children inherit exactly the same traits or is there some variation?

C. How many of the four children inherited a trait from each one of the grandparents?

D. Is there a child that didn't inherit a particular trait? If so, which trait (color) was it?

A Tree of Genetic Traits

Purpose:

Students mark their traits for tongue rolling, PTC tasting (a harmless, bitter chemical), and earlobe attachment on tree leaf cut-outs. They then place their leaves on a large tree whose branches each represent a different combination of traits. When completed, the tree forms a visual representation of the frequency of trait combinations within the class.

Learning Objectives:

- Traits are observable characteristics that are passed down from parent to child.
- An individual will have many traits they share in common with others.
- An individual's overall combination of traits makes them unique.
- Some traits are more common in a population than others.

Classroom Implementation:

1. Choose one of the three types of trees.
    - "Large format" is for printing on large format printers that can print at least 36" across.

- "Overhead" is designed to be projected onto a writable surface and then traced.
- "Puzzle" is meant to be printed on multiple sheets of ordinary 8.5" x 11" paper and then taped together.

2. Post the tree in an easily accessible and visible area of the room.
3. Provide each student with a leaf and instruct them to cut it out.
4. Explain that traits are observable characteristics we inherit from our parents. Demonstrate the tongue rolling and earlobe attachment traits. Have students mark "yes" or "no" on their leaf for these traits as appropriate.
5. Hand out PTC paper. Instruct students to place a piece of PTC paper on the tip of their tongue to see if they can taste anything. The chemical tastes bitter to those who can taste it. For those who cannot taste PTC, the paper has no taste.
6. Instruct students to check "yes" or "no" on their leaves for PTC tasting. Hand out a hard candy to each student to neutralize the taste of the PTC.
7. Demonstrate how to determine where to place the leaves on the Trait Tree starting at the base of the branches and working your way out toward the tips.
8. Call students up in groups to place their leaves on the appropriate branches. The leaves will be clustered around the branch representing the most common combination of traits in the class. Some branches of the tree will remain relatively sparse.

An Inventory of My Traits

Purpose:

Students take an inventory of their own easily-observable genetic traits. Working in small groups, they observe how their trait inventories differ from those of others. Students record their observations in a data table and make a bar graph to show the most and least common traits in the group.

Learning Objectives:

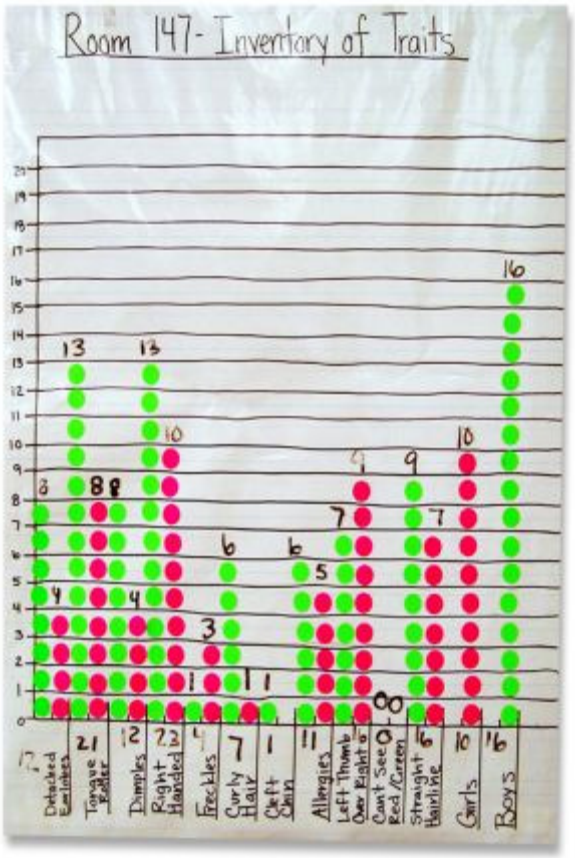
- Traits are observable characteristics that are passed down from parent to child.
- An individual will have many traits they share in common with others.
- An individual's overall combination of traits makes them unique.
- Some traits are more common in a population than others.

Classroom Implementation:

1. Begin by demonstrating one of the traits listed in An Inventory of My Traits: Survey. Ask students who possess this trait to stand. Point out the relative numbers of students standing and sitting for the trait. Continue this process with 2-3 more traits.
2. Explain that traits are observable characteristics we inherit from our parents. Some traits are common in a population (our class) while others are not. And, every person has a different overall combination of traits that makes them unique.
3. Divide students into groups of four or more. Have each student in the group complete An Inventory of My Traits: Survey to determine their unique combination of the traits described.
4. After students complete the survey, have them tally their group information on the data table and draw a bar graph.
5. You may collect the traits data from the whole class by creating a large wall chart (Figure X). Have a representative from each group fill in their data. Once all the

data has been collected, have the students make a bar graph from the class data or make one large graph together.

Figure X



An Inventory of My Traits - Data Table

- How many people in your group have each trait?
- Fill in the data table below by counting the number of people who marked "yes" and the number of people who marked "no" for each trait.

TRAIT	YES	NO
Detached earlobes		
Tongue rolling		
Dimples		
Right-handed		
Freckles		
Naturally curly hair		
Cleft chin		
Allergies		
Cross left thumb over right		
See the colors red and green		
Have a straight hairline		

An Inventory of My Traits - Survey

What combination of these traits do you have? Complete the survey to find out.

Make a bar graph showing how many people in your group answered "yes" for each trait. Be sure to label each trait under the bar you draw for it.

1.	I have detached earlobes	☐ Yes	☐ No
2.	I can roll my tongue	☐ Yes	☐ No
3.	I have dimples	☐ Yes	☐ No
4.	I am right-handed	☐ Yes	☐ No
5.	I have freckles	☐ Yes	☐ No
6.	I have naturally curly hair	☐ Yes	☐ No
7.	I have a cleft chin	☐ Yes	☐ No
8.	I have allergies	☐ Yes	☐ No
9.	I cross my left thumb over my right when I clasp my hands together	☐ Yes	☐ No
10.	I can see the colors red and green (I am not color blind)	☐ Yes	☐ No
11.	The hairline on my forehead is straight.	☐ Yes	☐ No
12.	I am a:	☐ Male	☐ Female

Jumpin' the Gap

Purpose:

Turn your classroom into a giant synapse as students act out communication at the neural level by behaving as pre-synaptic vesicles, neurotransmitters, postsynaptic receptors, secondary messengers and re-uptake transporters. Neurotransmitters and receptors interact via "lock-and key" manner.

Materials:

1. (2) 15-foot sections of rope or masking tape
2. Classroom set of Job Assignment Tags (included)
3. String for Job Assignment Tags
4. Neurotransmitter/Receptor complex puzzle pieces (included)
5. CD or tape player, music

Learning Objectives:

- Nerve cells communicate with each other at a junction called a synapse.
- When stimulated by an action potential, a neuron releases neurotransmitters into the synapse.
- Receptors on the outside of the receiving cell (post synaptic cell) fit synaptic neurotransmitters similar to a "lock and key".
- Once neurotransmitters "lock" into the appropriate receptor, a secondary messenger is released in the receiving cell.
- After neurotransmitters have done their job, they are released from the receptors and sent back through the cell through re-uptake transmitters.
- In the sending cell, neurotransmitters are packaged in vesicles.

Classroom Implementation:

1. Place masking tape or rope on the floor of your classroom, hallway, basketball court etc… to represent pre- and post- synaptic membranes. The membranes need to be arranged in an area large enough for several of your students to move back and forth from one side to the other comfortably.
2. Review the structure of a neuron, including: cell body, nucleus, axon, synapse and dendrites. Focus student's attention on the terminal end of the axon and the synapse. **Show Overhead A**. Explain that this activity will focus on this area and its role in communication between neurons.
3. Place **Overhead B** on top of **Overhead A** to show how student roles correlate with structures in the synapse. Assign students their roles and give the students the appropriate Job Assignment tag.
4. Position the students around the membranes you've created on the floor accordingly. Give the students who are dopamine neurotransmitters a dopamine neurotransmitter puzzle half.
5. Give students who are dopamine receptors a dopamine receptor puzzle half.
6. The two students who are serotonin receptors should also be given a serotonin receptor puzzle half. There will be no complementary puzzle half for these.

Procedure:

1. The vesicles (standing in the axon terminal) must link arms with the dopamine neurotransmitters in preparation for an action potential. There will be some "free floating" dopamine neurotransmitters that do not have a vesicle.
2. Next, the DJ turns on music for a brief, startling period of time to simulate the action potential traveling down the neuron.
3. Upon the start of the music, the vesicles attached to dopamine neurotransmitters move toward the synapse and come into contact with the pre-synaptic membrane.
4. Once the vesicles reach the axon terminal membrane, they release their dopamine into the synapse.
5. The neurotransmitters that were released into the synapse move across the synaptic cleft to the dopamine receptors on the post-synaptic membrane.
6. The vesicles remove themselves from the membrane and fl oat back into the axon terminal to refill with any available neurotransmitters. Vesicles and neurotransmitters should hook elbows in preparation for another action potential to signal their movement.
7. The dopamine neurotransmitters find the receptor with which their puzzle piece matches, indicating the specificity of receptors for a particular neurotransmitter.
8. Once the dopamine neurotransmitters match with their receptors, the second messengers (attached to the dopamine receptors) should let go and continue to carry the message down the post-synaptic membrane. The second messengers attached to the serotonin receptors should not be released but should remain attached to their receptors.
9. Once the second messengers have been released from the dopamine receptors: the connection between the dopamine neurotransmitters and the dopamine receptors is broken, and the dopamine neurotransmitters are released into the synapse to diffuse back toward the presynaptic membrane.
10. Free-floating neurotransmitters are pulled back in to the pre-synaptic axon terminal by uptake transporters.
11. Available 'empty' vesicles will again link arms with available neurotransmitters.

Jumpin' the Gap: Worksheet

Answer the following questions following the Jumpin' the Gap activity

1. What structure is responsible for "recycling" neurotransmitters back into the axon terminal once they have done their job?

2. How do the vesicles "know" when to move to the membrane to dump their contents into the synapse?

3. How does the message continue past the post-synaptic membrane?

4. Diagram, label and describe the action of dopamine while communicating a pleasure or reward message across the synapse.

DNA and Histone Model

Purpose: A 3-D cut-and-paste model depicting how histone, acetyl and methyl molecules control access to DNA and affect gene expression.

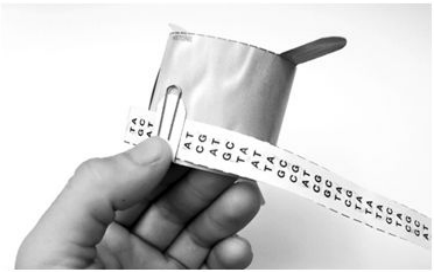
Materials:

1. Copies of molecule cut outs and student directions
2. Scissors
3. Tape
4. Paperclips

Procedure: Making DNA Inaccessible (steps: 1-7) & Making DNA Accessible (steps: 8-13).

1. Gather all the cut out molecules, 8 paperclips, the DNA ribbon and histone spools.

2. In the cell, DNA is wound around spool-like molecules called histones. Attach one end of the DNA ribbon to a histone. Fold one of the histone tails over the DNA ribbon to help hold it in place. Secure it with a paperclip.



3. Attach the remaining histones Along the DNA ribbon at a distance of 2 strips of DNA apart (roughly 16 cm).

4. Hold the first histone upright in one hand. Wind the DNA ribbon clockwise around it roughly two times or until you bump in to the next histone. Fold all of the histone tails over the DNA ribbon to help hold it in to place and secure with a paperclip. In a real cell, a length of DNA wraps around a histone roughly 1.7 times and histone tails wrap around the wound DNA similarly.

5. Trying not to fold or bend the DNA ribbon, wind it around the next histone. Again, fold the histone tails around the DNA ribbon and secure with a paperclip. Repeat until all of the DNA ribbon has been wound. The histones should begin to stack on top of one another as you wind.

6. When DNA is wound tightly around histones, there tends to be a lot of methyl molecules bound to it. The methyl molecules cover the DNA, making it unreadable to gene reading machinery. Use tape to attach the methyl molecule cut outs to exposed areas of your DNA ribbon.

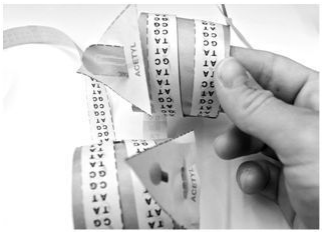
7. Genes become active when gene reading molecules attach and move down a length of accessible DNA, "reading" the DNA code as they go along. Try to attach and move the Gene Reading Machinery cut-out to any length of the DNA ribbon that is not spooled around a histone or covered by methyl. Can the machinery read any significant stretch of DNA? Would this be an active or inactive gene?

8. DNA is wound around spool-like molecules called histones. At times, acetyl molecules bind to histone tails. Attach two acetyl molecules to each histone at different locations. To attach the molecules, pull a histone tail trough the cut in the center of the acetyl molecules. Now your histones are "acetylated".

9. Attach an acetylated histone to one end of your DNA ribbon, secure it with a paperclip. Attach the remaining acetylated histones along the length of the DNA ribbon at distances of 2 DNA strips apart (roughly 16 cm).

10. Hold the first histone upright in one hand. Wind the DNA ribbon clockwise around it two times or until the first histone touches the next one.

11. In a real cell, the addition of acetyl molecules causes the histones to distance themselves from one another. Be sure that no part of the neighboring histones, including the acetyl molecules are touching. If they are, unwind the DNA ribbon a little bit to put some space between the histones. Secure the DNA ribbon with a paperclip.



12. Wind the DNA ribbon clockwise around the next histone. Again, be sure that no part of neighboring histones is touching then secure the DNA ribbon with a paperclip. Repeat until the DNA ribbon has been wound around all the histones.

The histones and DNA should be spooled loosely, with some space between histones.

13. Genes become active when gene reading molecules attach and move down a length of accessible DNA, "reading" the DNA code as they go along. Try to attach and move the Gene Reading Machinery cut-out to any length of the DNA ribbon that is not spooled around a histone. Can the machinery read any significant stretch of DNA? Would this be an active or inactive gene?

Investigating Photosynthesis and Respiration

Purpose:

To provide middle or high school students with a situation in which they can explore the relationship between photosynthesis and respiration.

Objectives:

Part I

Students will be able to:

1. recognize the photosynthesis equation is basically the respiration equation "backwards."
2. realize that the very same carbon molecules that heterotrophs breathe out are the carbon molecules that make up the backbone of the glucose molecule.
3. write the equations for photosynthesis and respiration with coefficients and subscripts .

Part II

Students will be able to:

1. infer that humans breathe out carbon dioxide and plants take in carbon dioxide and give off oxygen (during the light reactions).
2. conclude that bromothymol blue turns yellow in the presence of carbon dioxide and turns back to blue in the presence of oxygen.

Materials:

Part I

- three pieces of blue construction paper (cut each piece in half so you have six pieces on which to write "C" to represent carbon [six molecules of carbon])
- six pieces of red construction paper (cut each piece in half so you have 12 pieces on which to write "H" to represent hydrogen [12 molecules of hydrogen])
- nine pieces of green construction paper (cut each piece in half so you have 18 pieces on which to write "O" to represent oxygen [18 molecules of oxygen])

- one piece of yellow construction paper (draw a sun to represent energy coming from the sun)
- one piece of white construction paper with a "+" on it
- one piece of white construction paper with an arrow to represent the yields sign in the equation
- poster board with the equation for photosynthesis on one side and the equation for respiration on the opposite side (to be held up so that students know where to position themselves).
- one piece of construction paper that reads "carbon dioxide"
- one piece of construction paper that reads "water"
- one piece of construction paper that reads "glucose"
- one piece of construction paper that reads "oxygen"

Part II

- bromothymol blue (approximately 3 ml)
- one sprig of Elodea (or other aquatic plant that does not have needle-like leaves)
- two 50-ml beakers
- 20 ml of water
- carbonated water
- one straw

Procedure:

Part I:

- Each student is given the role of a molecule of carbon, hydrogen, or oxygen. Depending on the size of your class, some students may need to be assigned the role of two molecules of the same element. For example, you may need to give one student two "H's" instead of one "H." If you have a large open area in your classroom, you can conduct this part of the activity inside. Otherwise, you will need to plan to go outdoors, into the hallway, or even to the school gymnasium or cafeteria.
- Once you arrive at your destination, hold up the poster board with the equation for photosynthesis facing the students.
- First, instruct the students to position themselves so that they represent the **reactants of the photosynthesis equation**. (Remember to assign a student to the role of "sun," "+" and "yields".)

- Once students have gotten into the correct positions give each group of molecules the name of the substance that they represent (carbon dioxide or water).
- Next, have the students position themselves so that they represent the **products of the photosynthesis equation**. Once the students have positioned themselves correctly give each group of molecules the name of the substance they represent (glucose or oxygen). The idea is that students will realize that the very same carbon atoms that make up carbon dioxide make up the backbone for the glucose molecule.
- Now hold up the respiration equation. First have the students position themselves to represent **the reactants for respiration**. Again, when they are correctly positioned, give the names of the substances that they represent to the groups of molecules (oxygen and glucose). Next, have the students position themselves so that they **represent the products of the respiration equation**. Once the students have positioned themselves, give the groups of molecules the names of the substances they represent (carbon dioxide and water).

Part II:

Each group is provided with an instruction sheet and materials. Instructions are sparse by design so that students can have a chance to figure out what bromothymol blue indicates instead of being told..!

I. Construct Your Puzzle Pieces

1. Obtain 9 squares of paper – these will be your puzzle pieces.
2. In each square, you will write in the chemical formula for one of the molecules involved in the processes of photosynthesis and cellular respiration. Use the following terms:

i. CO_2 _____
ii. H_2O _____
iii. $C_6H_{12}O_6$ _____
(food/carbohydrate/sugar)
iv. O_2 _____
v. **ENERGY**

3. In the spaces provided above, write the NAME of the molecule next to its chemical symbol for your reference.

4. In the remaining squares on your paper, write in symbols you will need to complete your chemical reaction. You will need 3 "+" symbols and one "→" symbol.
In a chemical reaction, what does the "→" signify?

_____
_____
_____

II. Put Your Pieces Together: PHOTOSYNTHESIS

1. Arrange your pieces into the chemical equation for photosynthesis. Write this equation below:

_____ + _____ + _____ → _____ +_____

2. (Use the NAMES of the molecules) According to your equation, the process of photosynthesis uses _____, _____ and _____to produce _____ and _____.

3. What type of energy is used in photosynthesis?

_____

4. Photosynthesis typically occurs in what type of organism?

_____

5. Where are CO_2 and O_2 found in our environment?

_____

6. Given what you know about plants, why does your position for CO_2 and O_2 in the equation make sense?

7. Interpret the chemical reaction - what is the overall purpose of photosynthesis?

III. Put Your Pieces Together AGAIN: CELLULAR RESPIRATION

1. From the equation for photosynthesis, rearrange your pieces into the chemical equation for cellular respiration. Write this equation below:

_____+ _____ → _____ + _____ + _____

2. (Use the NAMES of the molecules) According to your equation, the process of cellular respiration uses _____and _____ to produce _____ _____ and release _____.

3. In cellular respiration, chemical energy is released from _____ molecules and transferred to _____ molecules, which cells can use to provide energy for cellular processes.

4. Was it difficult to rearrange your pieces to produce the equation for cellular respiration? Why or why not?

5. Cellular respiration occurs in both plants and animals. Given what you know about animals, why does your position for CO_2 and O_2 in the equation make sense?

6. Interpret the chemical reaction - what is the overall purpose of cellular respiration?

7. What are the two main differences between the chemical reaction for photosynthesis and the chemical reaction for cellular respiration?

IV. Extension Questions:

1. Cellular respiration occurs in BOTH plants and animals. Why do plants need cellular respiration?

2. Plants produce carbon dioxide as a product of cellular respiration. But you know that plants release oxygen, not carbon dioxide. Develop a logical argument for how this is possible.

HINT: Think about both chemical reactions and the speeds at which they could occur.

3. Plants can make their own food through photosynthesis and then break it down for usable energy through the process of cellular respiration. Analyze how your life might be different if you could make your own food through photosynthesis.

Photosynthesis:

6 CO_2 6 molecules of carbon dioxide	+	6 H_2O 6 molecules of water	(sunlight) → (in the presence of sunlight yields)	$C_6H_{12}O_6$ 1 molecule of glucose	+	6 O_2 6 molecules of oxygen
-------Reactants-------				-------Products-------		

Respiration:

6 O_2 6 molecules of oxygen	+	$C_6H_{12}O_6$ 1 molecule of glucose	→ yields	6 CO_2 6 molecules of carbon dioxide	+	6 H_2O 6 molecules of water	+	energy (ATP)
-------Reactants-------				----------Products----------				

Thinking about Thinking
Sahar Harakeh and Lamis Adada

Introduction

Teachers expect their students to think about what they learn and to learn to be good thinkers. Visible thinking is a flexible and systematic research-based approach to integrating the teaching and development of students' thinking within content learning across different subject matters. Visible thinking makes extensive use of learning routines that are “thinking-rich”. It emphasizes several ways of making students' thinking visible to themselves, their peers and to the teacher and thus providing an opportunity to improve their thinking. Through it, teachers can help students become better thinkers by following several thinking routines, which are simple protocols for exploring ideas in any topic. The easiest way to get started with visible thinking is to simply start using thinking routines such as:

See, Think, Wonder
Think, Pair, Share
I used to think but now I think

Description of the Session

In this workshop, participants explored and implemented several strategies of visible thinking which allow learners to speak, write and deepen their understanding. In addition, participants learned how to design Biology, Chemistry and Physics lessons that integrate visible thinking strategies and how to become adept at using literacy strategies which may help students comprehend informational texts. Finally, participants were provided with a large pool of ideas to work with as they developed their own activities.

The planned schedule for the workshop was as follows:

(a) *Brainstorming:* **(10 mins)**
- Making a web or mind map that shows ideas about "good thinking"
- Participants completed the "Are you a right or left brained thinker" activity
- Participants shared some results of the activity and reflected on the results.

(b) *Introduction:*
- The concept of visible thinking which includes attention to four "thinking ideals": understanding, truth, fairness and creativity was introduced **(5 mins)**
- General activity for all science teachers: "The moon is made of green cheese" **(10mins)**
- A large range of "thinking routines" in the four ideals and several examples of each were given. (**15mins)**

(c) *Interactive activity one:*
- Participants were divided into groups of four to explore three prepared activities in Biology, Chemistry and Physics. **(20 mins)**
- The findings were discussed in order to deduce the basic elements of the visible thinking strategy. **(10mins)**

(d) *Interactive activity two:*
- Participants were divided into specialized groups of four: Biology, Chemistry or Physics.
- Each group was provided with a prepared activity in their specialization and was asked to find out the thinking routine(s) involved in the activity and indicate if the routines could be modified or other routines could be introduced.
- Finally, each group presented their findings. **(20mins)**
- Then, the participants chose any two thinking routines and tried to introduce them in any lesson of their choice. This was then discussed with the other groups. **(15 mins)**

(e) *Discussion of questions*: **(5mins)**
- How can teachers benefit when they see students thinking?
- What is uncovered by visible thinking?

(f) *Reflection* on the impact of implementing visible thinking in our classrooms was done by displaying the results of a study done on the application of thinking routines in our classes. **(10 mins)**

<u>The Activities</u>

When you are doing your best thinking, in order to understand something, what different kinds of thinking do you do? Make a web or mind map that show your ideas.

Good Thinking

Are You A Right or Left-Brained Thinker?

The left and right brain functions are responsible for differences in people and how they process information. Whether you use your left brain and right brain together or have a dominant half explains a great deal about how you learn and express yourself. While many people think artists are right brained, this isn't always the case. For example, some artists plot out their painting long before the first brush stroke, which would indicate left brained planning.

Circle True or False in the following questions:

1. When given a task or assignment, you want to know why it's important.
   True
   False
2. You get a great deal of pleasure in creating "to do" lists and checking off each item as it is completed.
   True
   False
3. You prefer molding clay into pottery over Sudoku puzzles.
   True
   False
4. When shopping for a new car, you look at fuel efficiency and crash safety ratings over aesthetics.
   True
   False
5. When travelling, you like to have your itinerary completely planned out to the last detail.
   True
   False
6. You prefer lectures to textbooks.
   True
   False
7. You can remember a person's face but not necessarily his name.
   True
   False

8. Your office is neatly organized with a place for everything. Little time is spent "looking around" for lost items.
   True
   False
9. When trying a new software program you install it and immediately begin experimenting with it.
   True
   False
10. You are almost always on time (if not early) for meetings and appointments.
   True
   False

Scoring: Total up the number of right brain and left brain responses. Read about your thinking/brain functions on the Right/Left Brain Traits handout.

Right	Left
1. T----------	F
2. F----------	T
3. T----------	F
4. F----------	T
5. F----------	T
6. F----------	T
7. T----------	F
8. F----------	T
9. T----------	F
10. F----------T	

Right / Left Brain Traits

Primarily a RIGHT-BRAIN thinker. Right brainers prefer an overview or a general understanding of the big picture first. They tend to be more conceptual and visual rather than logical. For this very reason, right brainers tend to remember a person's face, but not always his name. When it comes to work, the right brain dominant person is more likely to experiment with something new and & how it works rather than break out the instruction manual right away. Her office may have the appearance of disorganization, with piles of paperwork and few systems in place. But don't discount this as failure! Right brainers have an uncanny ability to pull things off at the last minute. They rarely need to plan out every detail of a trip or vacation unlike their left brain friends who feel more comfortable with the details. Right brainers are more impulsive in that way, and can enjoy a surprise trip. They are open to seeing what's appealing when they arrive at their new destination.

Right Brain Traits

1. When given a task or assignment, you want to know why it's important because you like the big picture.
2. You don't need to do lists you like to wing it!
3. You prefer molding clay into pottery over Sudoku puzzles because it is more creative.
4. When shopping for a new car, you pick what looks best, rather than what drives best because you are into aesthetics.
5. When traveling, you like to impulsive adventure. Why plan it all out and ruin it?
6. Because you are visual, you prefer textbooks to lectures.
7. You can remember a person's face but not necessarily his name.
8. Your office is not necessarily organized, but you find what you need, eventually.

9. When trying a new software program, you install it and immediately begin experimenting with it.
10. You aren't always on time, but you mean well.

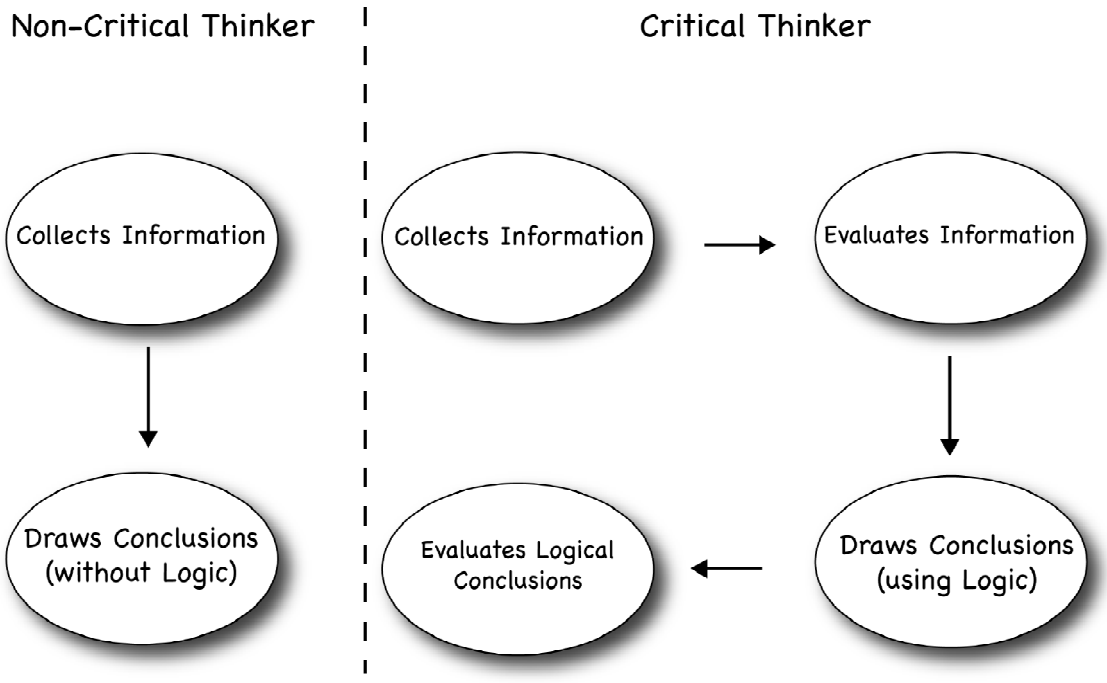
Primarily a LEFT-BRAIN thinker. Left-brained individuals are linear thinkers who like order and sequence. Logical rather than visual, choosing a car based on the numbers versus its shiny paint and leather seats is a left brained, rational approach. Left brainers prefer making plans ahead of time and are not much into the surprise of a plan-free vacation. They like their workspaces neat and orderly and are more likely to read the instruction manual before winging it. Because left-brained individuals respond to verbal cues instead of visual, there is usually a preference for lectures over textbooks. Left brainers tend to be punctual while right brainers often run late. For a brief look at your answers, see what choices make you left brain dominant:

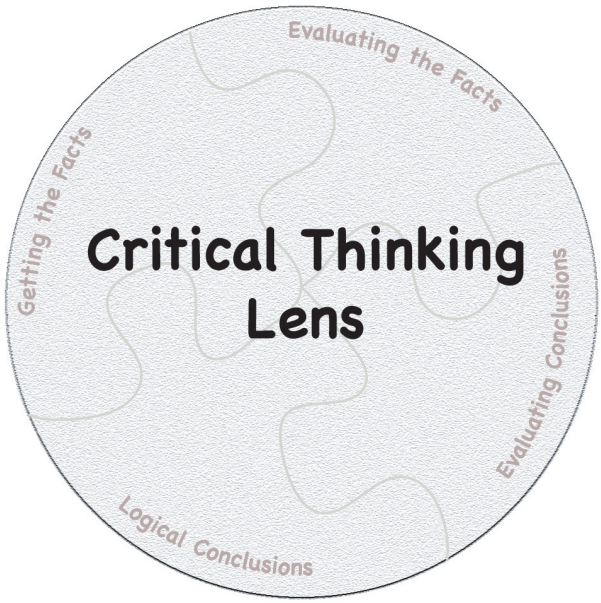
Left Brain Traits

1. When given a task or assignment, you don't always need to know why it's important.
2. You get a great deal of pleasure in creating "to do" lists and checking off each item as it is accomplished.
3. You prefer Sudoku puzzles over getting messy with clay.
4. When shopping for a new car, you look at fuel efficiency and crash safety ratings over aesthetics.
5. When traveling, you like to have your itinerary completely planned down to the last detail.
6. Because you respond to verbal cues, you prefer lectures to textbooks.
7. You are good at remembering names.
8. Your office is neatly organized with a place for everything. Little time is spent looking around for lost items.
9. When trying a new software program, you prefer to use the instruction manual before playing with the parts.
10. You are almost always on time or early for meetings and appointments.

You are in the middle: You're a person who shares both right brain and left brain abilities and uses both of them in everyday decisions. It would benefit you to read the results of both right and left brainers so that better understand the attributes you share with each of them. Congratulate your brain for wanting to do it both ways!

Thinking Critically





<u>Scientific claim</u>: The moon is made of green cheese.

1. What does this claim make you wonder? (Data collection)
   ---
2. When was it discovered? (Data collection)
   ---
3. How was it discovered? (Data collection)

   ---

4. Who discovered it? (Data collection)
   ---
5. What evidence supports this claim? (Evaluating facts)
   ---
6. What evidence does not support it? (Evaluating facts)
   ---
7. Is the above claim or conclusion substantiated by observations? (Drawing a conclusion)
   ---
8. Is this a scientifically valid claim? (Evaluating a conclusion)

Visible Thinking

• Thinking happens mostly in our heads and is invisible to others.
• Make thinking visible – meaning externalize the thoughts through speaking, writing or drawing.
• Visible Thinking is a flexible and systematic research-based approach to integrating the development of students' thinking with content learning across subject matters.
• It includes a number of ways of making students' thinking visible to themselves, to their peers, and to their teachers so they get more engaged by it.

Goals of the Visible Thinking Approach

1. Deepen the learning in content areas.

2. Foster thinking skills.

3. Greater motivation for learning.

4. Development of learners' thinking and learning abilities.

5. A shift in classroom culture toward a community of enthusiastically thinkers and learners.

Thinking Ideals

Visible thinking is organized around a set of thinking ideals that are generative in nature in that they are easily accessible to students, provide many opportunities for making connections, and often propel conversations and thinking in new and interesting directions. The thinking ideals are: **understanding, truth, fairness,** and **creativity**. The investigation of each ideal provides a frame for the examination, investigation, and integration of different types of thinking.

Thinking Routines

Visible thinking makes extensive use of learning routines that are thinking rich. These routines are simple structures, for example a set of questions or a short sequence of steps, that can be used across various grade levels and content. Routines are patterns of action that can be integrated and used in a variety of contexts. You might even use more than one routine in teaching a single lesson. These routines enhance what you are trying to do in the classroom. Thinking routines form the core of visible thinking. What makes these routines work to promote the development of students' thinking and the classroom culture are that each routine:

- Is goal oriented in that it targets specific types of thinking
- Gets used over and over again in the classroom
- Consists of only a few steps
- Is easy to learn and teach
- Is easy to support when students are engaged in the routine

- Can be used across a variety of context
- Can be used by the group or by the individual

I. Understanding Routines

Engage students in reflection and communication that fosters the thinking skills involved in developing understanding.

1. *Connect -Extend -Challenge:* A routine for connecting new ideas to prior knowledge

2. *Headlines:* A routine for summarizing and capturing the essence of an idea, concept, topic…etc

3. *What makes you say that?* A routine used for reasoning with evidence.

4. *Think- Pair- Share:* A routine for active reasoning and explanation. It involves posing a question to students, asking them to take a few minutes of thinking time and then turning to a nearby student to share their thoughts.

5. *Think-Puzzle-Explore:* A routine that sets the stage for deeper inquiry by activating prior knowledge, wondering and planning.

6. *See-Think-Wonder:* A routine for exploring works of art and other interesting things. It is good with ambiguous or complex visual stimuli.

7. *Question Starts:* A routine for creating thought-provoking questions. It uncovers prior knowledge and ideas. Use these question-starts to help you think of interesting questions:

Why...?
How would it be different if...?
What are the reasons...?
Suppose that...?
What if...?
What if we knew...?
What is the purpose of...?
What would change if...?

8. *Generate- Sort-Connect-Elaborate:* A routine for organizing one's understanding of a topic through concept mapping.

II. Truth Routines

Increase students' awareness of the many issues of truth and evidence that come up both in academic studies and in everyday life. Teach students how to navigate through situations of confusion, doubt and conflict regarding truth.

1. *Stop- Look -Listen:* A routine for clarifying claims and seeking sources and hear what the sources tell you with an open mind.

2. *Tug for Truth*: A routine for exploring tensions of truth by identifying and building both sides of an argument or dilemma.

III. Fairness Routines

Engage students in reflection and communication that fosters different thinking skills involved in the solution of daily moral and ethical issues that they face.

1. *Circle of Viewpoints:* A routine for identifying diverse perspectives around an issue or problem

2. *Tug of War:* A routine for exploring the complexity of dilemmas through reasoning and identifying complexities.

IV. Creativity Routines

Increase students' awareness of the opportunities to think creatively and to see the creativity around them. Teach students to notice how things and ideas are put together and to think creatively about how they could be put together differently.

1. *Creative Questions:* A routine for generating and transforming questions

- *What would it be like if…*
- *How would it be different if…*
- *Suppose that ...*
- *What would change if ...*
- *How would it look differently if …*

2. *Step Inside: Perceive-Know-Care about:* A routine for getting inside perspectives

What is uncovered by visible thinking?

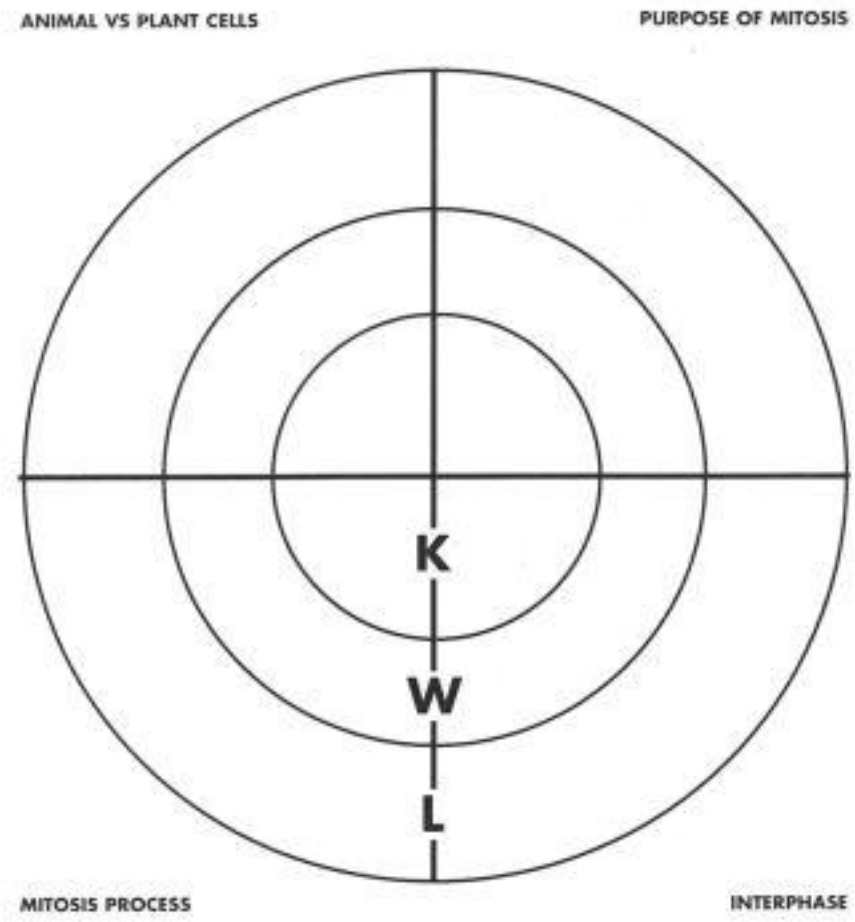
- Misconceptions
- Prior knowledge
- Reasoning ability
- Degrees of understanding
- More accurate assessment of student understanding

Biology Activities

Subject: Biology **Grade Level**: Grade 9 & 11
Activity: Mitosis

What We Know

Before watching a video about mitosis, provide students with an opportunity to share what they know about mitosis using this KWL chart.



Think-Pair-Share

Given the following questions:

1. Why is mitosis important to all living things?
2. How do animal and plant cells behave differently during mitosis?
3. What are the four stages of mitosis?
4. How do traits of a mother and father get passed on to their offspring?
5. What is the relation between interphase and mitosis?

Steps of the activity

Think

1. You are asked to think and write the possible answers for the given questions in the box below.

2. Generate additional questions about mitosis.

Pair

3. Discuss the questions and answers with your partner.

4. Write down three of the most interesting questions on note cards.

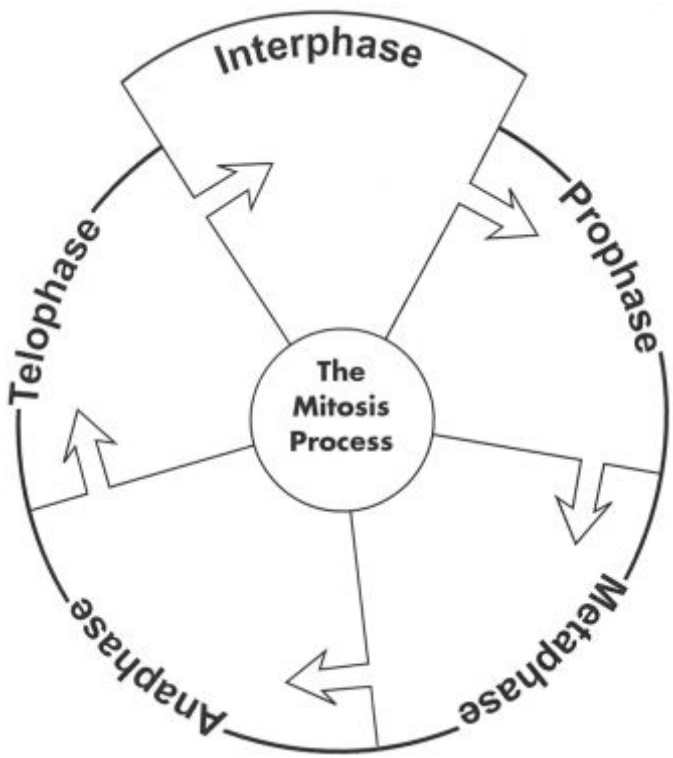
Share

5. Ask each group to stack their cards with their best question on top.

6. Each group will share their top question, and then continue with more questions.

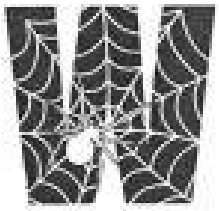
Sequencing Wheel Graphic Organizer

Complete the graphic organizer as you watch the video about mitosis**.**



The "What" Web Organizer

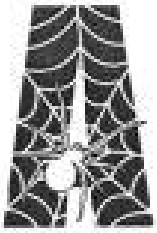
After watching the video about mitosis, fill in the "What" Web organizer.



- What is mitosis?

- What is the purpose of this process?

- What happens before cell division can take place?



- What are the stages of mitosis?

- What do chromosomes have to do with mitosis?

- What is the reason this process is so important to all life?

Extra! Extra! Read All About it!

Go back in time to the moment scientists discovered the process of mitosis! Imagine what the front page of a major newspaper would look like. Create a headline, lead article, and illustration that shares key information.

Headline

Illustration

Objectives

By the end of this activity students will be able to

- Recognize that DNA is found in all cells.
- Perform the steps needed to isolate DNA from a cell.
- Extract DNA from the cell

Background

DNA is in every cell of living thing. DNA molecules are long tangled strands. A single DNA molecule is too small to see. But if you have enough of them, they will tangle together into a clump big enough to see. These clumps of DNA are pale white and feel a little slimy. In this experiment, you will see DNA appear out of nowhere from clear liquid.

Materials

Strawberry
Salt
Dishwashing liquid
Pine apple juice
Isopropyl alcohol
Blender
Strainer or sieve
Test tube
Container
Glass rod

Procedure

- Step 1: Blending Strawberry
  - Put strawberry in blender
  - Add 1/4 teaspoon table salt
  - 1 cup cold water

  Blend for 15 second.

  *The blender separates strawberry cells from each other.

- Step2: Soapy Strawberry
  - Pour strawberry soup through a strainer into another container.
  - Add 2 tablespoon liquid detergent (about 30ml) and swirl to mix.
  - Let the mixture sit for 5-10 minutes. Pour the mixture into test tubes, each about 1/3 full.

- Step 3: Pine apple juice
  Add few ml of pine apple juice (enzyme) to each test tube and stir gently. Be careful, if you stir too hard, you will break up the DNA, making it harder to see.

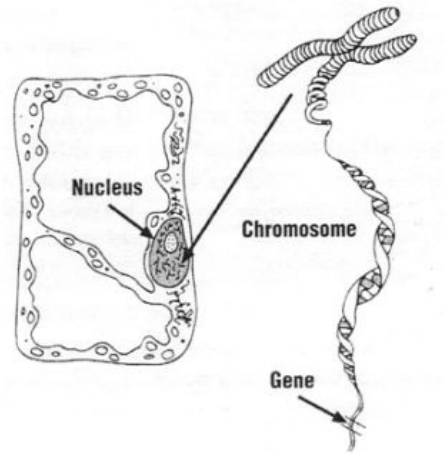
- Step 4: Alcohol Separation
  Tilt your test tube and slowly pour cold rubbing alcohol into the tube down the side so that it forms a layer on top of the strawberry mixture. Pour until you have about the same amount of alcohol in the tube as strawberry mixture.
  Alcohol is less dense than water, so it floats on top. Look for clumps of white stringy stuff where the water and alcohol layers meet.

- Step 5: What is that Stringy Stuff?
  After 2-3 minutes, insert a stirring rod into the test tube and gently swirl around. This will spool the DNA around the rod.
  You can save your DNA in a small container filled with alcohol.

Subject: Biology **Grade Level**: Grade 11
Activity: Strawberry DNA Extraction

Introduction

Have you ever wondered what DNA looks like? You are going to break apart the cell membrane of a strawberry and separate the DNA from the nucleus.
Take a look at the sketch of the plant cell below. The chromosomes which are made of DNA are in the nucleus. This is the place where most of the DNA is located.



Procedure

- Work together in groups of four.
- Read through the entire procedure and follow steps 1&2 in the activity sheet: Extraction of DNA from Strawberries.
- As you wait for your solution to settle, complete the following questions.

1. List what you know about DNA.

_____
_____
_____

2. List what you want to know about DNA.

_____
_____
_____

3. What do you think the DNA will look like when you extract it from the plant cell? (Write a brief description)

_____
_____
_____

4. What was the purpose of mashing up the strawberry?

_____
_____

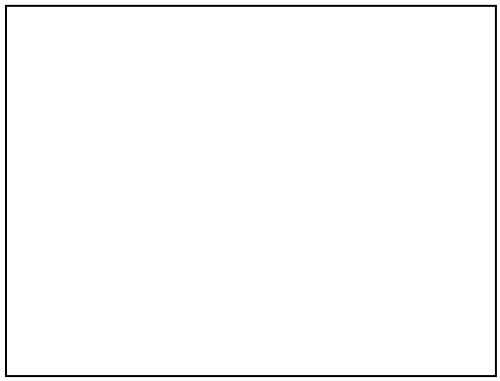
5. What does the soap do to the preparation of mashed strawberries? (Hint: What does soap do when you wash your hands?)

_____
_____
_____

- Perform steps 3, 4 & 5.
- Continue the questions.

6. What happened when you added the filtrate to the alcohol? Sketch what you see in the box below and indicate any other observations.

_____
_____
_____



7. What does the DNA look like?

_____
_____

8. A person cannot see a single cotton thread four meters away. But of you wound thousands of threads together into a rope; it would be visible at the same distance. How is statement an analogy to our DNA extraction?

_____
_____
_____
_____

9. Is DNA found in all living or once living cells?

_____
_____

10. Since the strawberries were once living and we extracted DNA from them, what does this mean about the foods you eat?

_____
_____
_____
_____

11. Look at the plant cell in the first page of this worksheet. Remember that genes are found on chromosomes, and genes control traits. Give at least two examples of traits that are expressed in the strawberry.

_____
_____

Subject: Biology **Grade Level**: Grade 10
Activity: Transpiration

Introduction

Plants lose gallons of water every day through the process of transpiration, the evaporation of water from plants through pores in their leaves. Up to 99% of the water absorbed by roots is lost via transpiration through plant leaves. This water loss allows the plant to access CO2 for photosynthesis and to cool itself.

Procedure

1. Introduce the first worksheet (What do you know?)

2. Students will work in pairs to answer the questions by referring to the animation displaying transpiration.

3. Distribute the third activity sheet, and assign it as homework.

What do you know?

Think-Pair-Share

Given the following questions:

1. Complete the blanks in the sentence below:
   A plant absorbs water through its_____ , and loses water through its _____.

2. Name one way in which loosing water helps the plant.
   _____

3. What is transpiration?
   _____

4. What are stomata?
   _____

5. What are guard cells?
   _____

Steps of the activity

Think

7. You are asked to think and write the possible answers for the given questions in the given space.

Pair

8. Now, pair up with your partner to exchange ideas?
9. What answers did you have in common? Write those answers on note cards.

Share

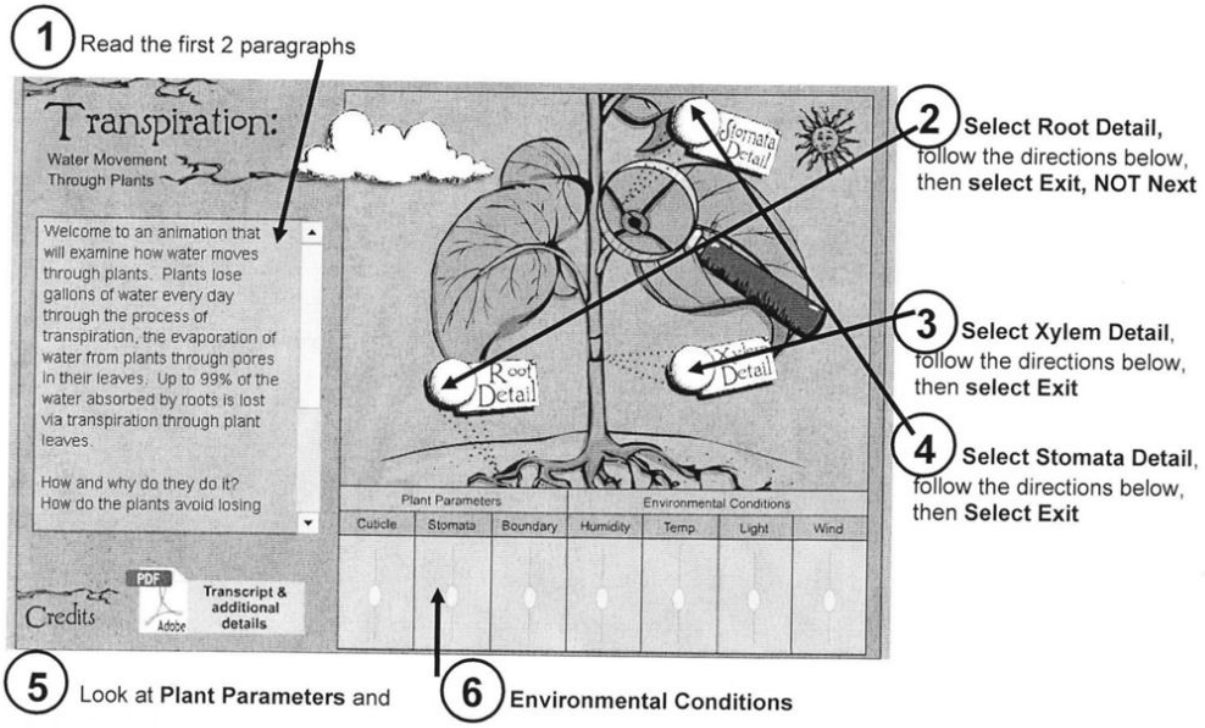
10. Each pair will share with the whole class his answers

See, Think, Explore

Refer to the animation displaying the process of transpiration.

Instructions

Follow the instructions for each section to answer the questions. The image below shows you where you will need to go for each section



Part 1: Transpiration: Refer to the first 2 paragraphs on the introductory screen and answer the questions below.

1. What is transpiration?

   _____

2. What part of the plant absorbs water and what part of the plant is water lost from?

_____

Part 2: Root Detail: Select Root Detail and read the large yellow text box that appears.

3. How does water enter the roots of a plant?

_____

Part 3: Xylem Detail: Select Xylem Detail and read the text in the column on the left hand side of the screen. Look at the large diagram in the circle on the right and answer the questions below.

4. What is xylem?

_____

5. Why do you think the xylem is the longest pathway water must take on its way to the leaves of a plant?

_____

Part 4: Stomata Detail: Select Stomata Detail and read the text in the column on the left hand side of the screen. Next, read the yellow text box at the bottom of the screen. Finally, Select the Top button to show a side view of Stomata. Select the Closed and Open buttons to show this action in the stomata.

6. What are stomata?

_____

7. Name 3 reasons why plants loose 99% of water they absorb through transpiration.

_____

8. Why stomata are usually found on the underside of leaves?

_____

9. After viewing the side view of the stomata and watching them open and close:

   a. Describe the exact role that guard cells play.
   b. Draw schematic diagrams of the stomata when they open and close in the box below.

Part 5: Plant Parameters: Look at each plant parameter by using the sliders to increase the size/rate of the parameter or decrease it. When you click on a parameter, you will see blue lines representing water rising from the roots to the leaves. Move the sliders to see if the water moves quickly or slowly through the plant as conditions change. The questions will give you further directions on what to do.

Select the Cuticle box until it appears green.

10. What is the cuticle and what is its role in the plant?

_____

Move the slider as far to the top of the box as it can go to thicken the cuticle.

11. Does a thicker cuticle increase or decrease the rate of transpiration? Why?

_____

Select the Stomata box until it appears green.

12. Move the slider down to close the stomata. Describe what happens to the water in the plant.

_____

Part 6: Environmental Conditions: Look at each environmental condition by selecting it, reading the text in the left hand column, and using the sliders to increase the rate of the condition. When you click on a condition, you will see blue lines representing water rising from the roots to the leaves. Move the sliders to see if the water moves quickly or slowly through the plant as conditions change. The questions will give you further directions on what to do.

13. Complete the table below.

Connect, Extend, Challenge

I. Circle the correct answer. Justify your choice.

A. What type of environment would result in the greatest rate of respiration?

1. Cloudy, humid conditions.
2. Warm, humid conditions.
3. Warm, light-breezy conditions
4. Cool, humid conditions.

Environmental factors	**Increase or Decrease rate of Transpiration**
High Humidity	
High Temperature	
Large amount of Light	
Strong Wind	

B. If guard cells in a plant were deficient in K^+, which of the following would be most likely to occur?

1. Wilting would become more visible.
2. Photosynthesis would decrease.
3. Transpiration would increase.
4. Food transport would decrease.

C. Several factors account for the movement of water up through the xylem vessels. Which factor is most important in pulling water toward the top of a tall tree?

1. Evaporation of water through the stomata.
2. Osmosis in the root.
3. Capillary action.
4. Atmospheric pressure.

D. All the following enhance water transport in terrestrial plants EXCEPT:

1. Hydrogen bonds linking water molecules.
2. Capillary action due to adhesion of water molecules to the walls of the xylem.
3. Evaporation of water from the leaves.
4. K^+ being transported out of the guard cells.

E. In which part of a transpiring plant would water potential be the lowest, in the presence of bright light.

1. Xylem vessels in the leaves.
2. Xylem vessels in the roots.
3. Root hairs.
4. Spongy mesophyll of the leaves.

II. Compare the behavior of stomata of a plant in the desert and a plant in the rain forest. Justify your answer.

Physics Activities

Subject: Physics **Grade Level:** Grade 9

Activity: Electric Power

Connect, Extend, Challenge

1. Display the different items in the classroom: incandescent lamp, fluorescent lamp, egg beater, hair dryer, CD player, cell phone charger, toaster.

2. Distribute the blank tables, and then the students will read the labels of the electrical items on display.
   Students complete the first column of the table. Afterward, students note that some items use far more electrical power than others. Students add the heading to the 2nd column: **BIG Users (>200 W)**, and check off the ones that use >200 W. "Can you make generalizations as to the BIG users?" (Heating items use a lot of power) Students put in the heading on the 3rd column: **On > 1 hour/day**, and check the ones that apply. Note that some of the big users, like an egg beater, are on so little that in our electric bills, they do not count for much, but some small users, like a porch lamp, do count for a lot.

3. Define kilowatts and explain how to change watts to kilowatts. 1000 w = 1 kW.

4. Discuss as a class: "Now we will come up with the formula that is used to measure electrical energy. What determines how much electrical energy I use?" [An item's power, and how long it is left on.] We need both of these to get the formula:
   Energy = Power x time
   kWh = kW x hrs.

8. Complete the column in the table (Hours left on/day). Based on class discussion, students will estimate that the number of hours per day that the electrical items in their table is left on. Use decimal hours for times less than one hour. Estimates are okay, as all we are doing is approximating.

9. Students will calculate the energy use per day and fill in the column with heading Energy/day.

10. Give this formula:
    Cost = rate x energy, which contains these units: $ = $/kWh x kWh

    Students calculate the cost per day or the first several items. Then later complete the entire column with the heading Cost/day. Then the students also complete the Cost / year, by multiplying the cost per day by 365.

NOTE: *1. It is very important to note now that the energy ratings on the labels of appliances are not how much power they actually draw continually, but the maximum that they draw. For example, a refrigerator uses the amount it says only when the compressor is on, a TV only when it is being turned on and at maximum volume, a printer only while it is printing, a heater when it is set to maximum. So our numbers for some items in the table may be too high. This could be true for anything with a dial or that is digital. Better numbers can be obtained with a wattmeter.*

2. Discuss as a class reasons for conserving electrical energy. Reasons may include: saving limited energy resources for future generations, reducing pollution from coal and gas power plants, reducing greenhouse gas emissions, saving money.

Assignment

Students make an energy inventory of their own homes, after the pattern of the table made in class, and add to their own recommendations for electrical energy conservation and an estimate as to how much money can be saved per year.

Watt does it cost to use it?

Item	Power needs	Big Users (>200 W)	On > 1 hour/day	Hours left on/day	Energy/day	Cost/day	Cost/year
Incandescent lamp							
Fluorescent lamp							
Hair dryer							
CD player							
Cell phone charger							
Toaster							

Subject: Physics **Grade Level:** Grade 8

Activity: Speed

To determine the speed of an object, you need to know the distance traveled and the time taken to travel that distance.

Example:

What is the speed of a cheetah that travels 112.0meter in 4.0seconds?

Looking for Speed of the cheetah	**Solution** Speed= d/t=112.0 m/4.0 sec = 28m/sec
Given Distance=112.0meters Time=4.0sec.	
Relationship Speed=d/t	

Practice

1. A snail can move approximately 0.30 meters per minute. How many meters can the snail cover in 15 minutes?

2. Suppose you are walking home after school. The distance from school to your home is five kilometers. On foot, you can get home in 25 minutes. However, if you rode a bicycle, you could get home in 10 minutes.

   a. What is your average speed while walking?
   b. What is your average speed while bicycling?
   c. How much faster you travel on your bicycle?

3. You have trained all year for a marathon. In your first attempt to run a marathon, you decide that you want to complete this 26-mile race in 4.5 hours.

   a. What is the length of a marathon in kilometers (1 mile = 1.6 kilometers)?
   b. What would your average speed have to be to complete the race in 4.5 hours? Give your answer in kilometers per hour.

4. The speed of light is about 3.00 × 105 km/s. It takes approximately 1.28 seconds for light reflected from the moon to reach Earth. What is the average distance from Earth to the moon?

5. You ride your bike for a distance of 30 km. You travel at a speed of 0.75 km/ minute. How many minutes do this take?

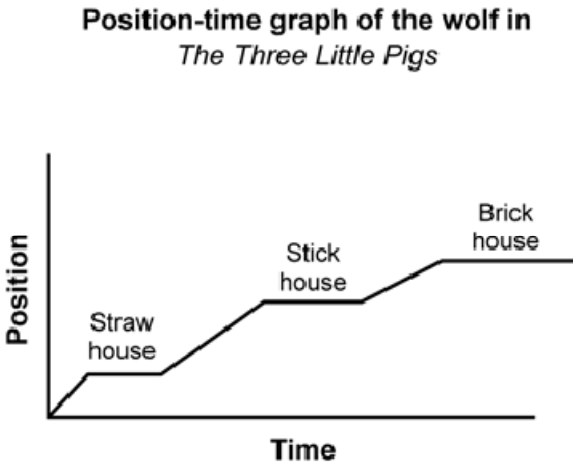
NOW

Make up three speed problems of your own. Give the problems to a friend to solve and check their work.

a. Make up a problem that involves solving for average speed.
b. Make up a problem that involves solving for distance.
c. Make up a problem that involves solving for time.

Position-time graphs

The graph at right represents the story of "The Three Little Pigs." The parts of the story are listed below.



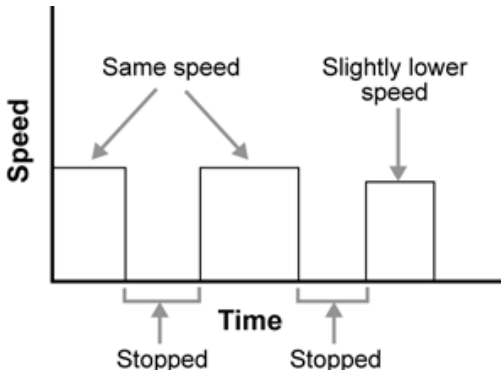
- The wolf started from his house. The graph starts at the origin.
- Traveled to the straw house. The line moves upward.
- Stayed to blow it down and eat dinner. The line is flat because position is not changing.
- Traveled to the stick house. The line moves upward again.
- Again stayed, blew it down, and ate seconds. The line is flat.
- Traveled to the brick house. The line moves upward.
- Died in the stew pot at the brick house. The line is flat.

The graph illustrates that the pigs' houses are generally in a line away from the wolf's house and that the brick house was the farthest away.

Speed-time graphs

A speed-time graph displays the speed of an object over time and is based on position-time data. Speed is the relationship between distance (position) and time, $v = d/t$. For the first part of the wolf's trip in the position versus time graph, the line rises steadily. This means the speed for this first leg is constant.

If the wolf traveled this first leg faster, the slope of the line would be steeper.



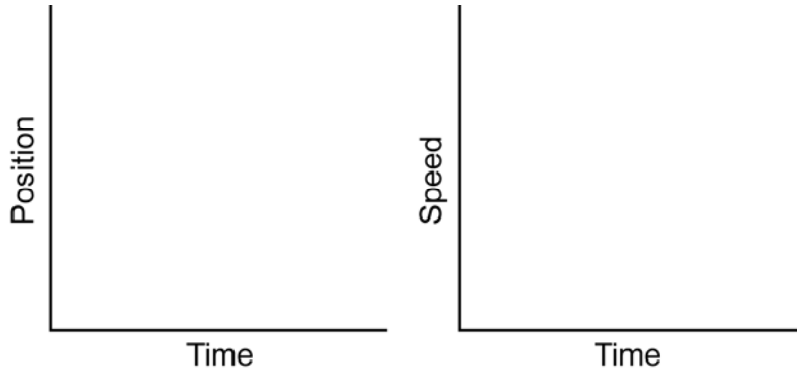
The wolf moved at the same speed toward his first two "visits." His third trip was slightly slower. Except for this slight difference, the wolf was either at one speed or stopped (shown by a flat line in the speed versus time graph.)

Practice

First Exercise

Read the steps for the following story. Sketch a position-time graph and a speed-time graph for the given story.
Graph Red Riding Hood's movements according the following events listed in the order they occurred:

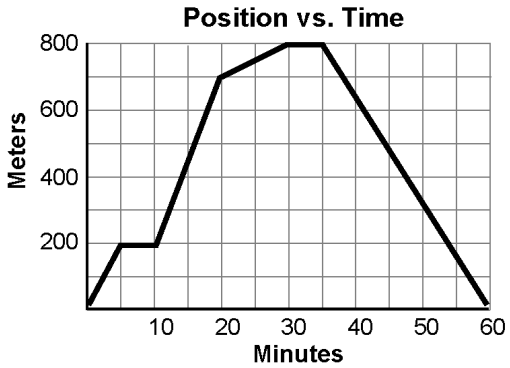
- Little Red Riding Hood set out for Grandmother's cottage at a good walking pace.
- She stopped briefly to talk to the wolf.
- She walked a bit slower because they were talking as they walked to the wild flowers.
- She stopped to pick flowers for quite a while.
- Realizing she was late, Red Riding Hood ran the rest of the way to Grandmother's cottage.



Second Exercise

A story told from a graph

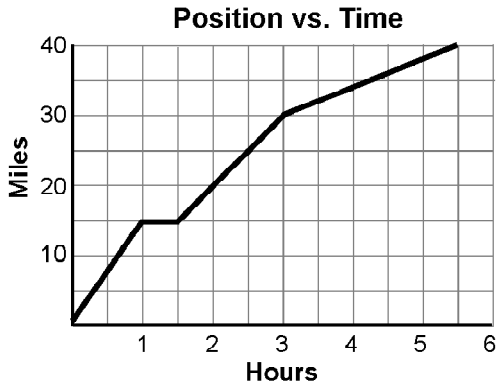
Tim, a student, was determined to ask his friend for a movie date. Use the given graph that represents his movements from his house to his friend's house to write the story.

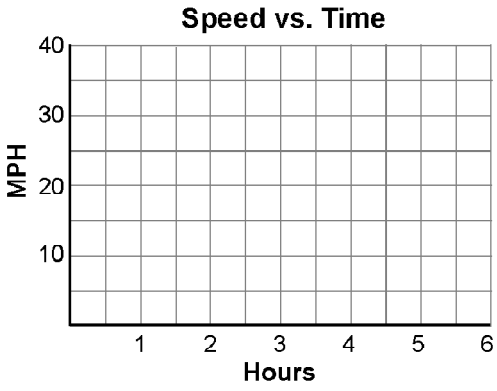


Third Exercise

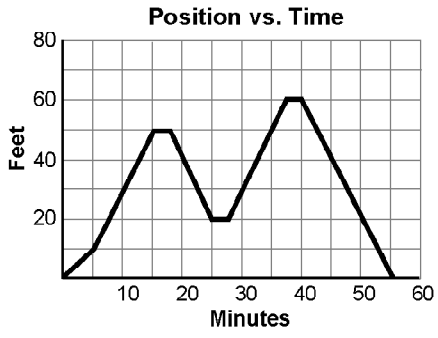
For each position-time graph, calculate and plot on the speed-time graph to the right.

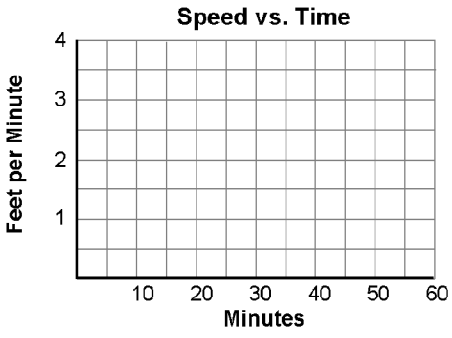
1. The bicycle trip through hilly country.





2. Strolling up and down the supermarket aisles





Subject: Physics **Grade level:** Grade 9

Activity: Series and Parallel Circuits

Generate, Sort, Connect, Elaborate

1. **Generate** is a list of ideas that comes to your mind when you think about **series circuit.** (Current, voltage, resistance…)
2. **Sort** your ideas to how central or tangential they are.
3. **Connect** your ideas by drawing connecting lines between ideas that have something in common. You can write in a short sentence how the ideas are connected.
4. **Elaborate** on any of the ideas you have written so far by adding new ideas that expand, extend, or add to your initial ideas.

Perform the same steps for the concept of **parallel circuit**.

Construct the table of differences between **parallel circuits** and **series circuits**.

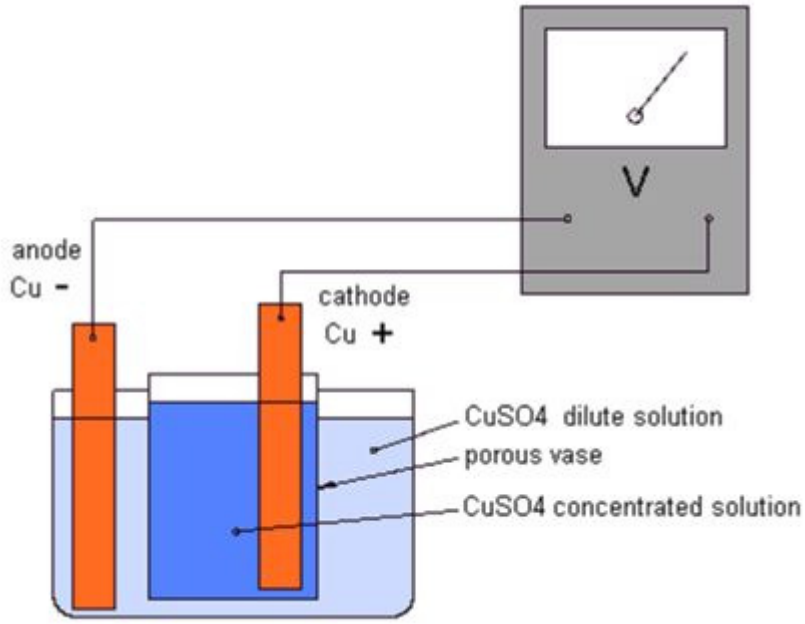
parallel circuits	series circuits

Chemistry Activities

Subject: Chemistry **Grade Level:** Grade 11

Activity: Battery

Observe carefully the set-up of the battery shown below.



1. Write the materials and chemicals used in the above set-up.
   _____
   _____

2. Is the above battery functioning? What do you see in the above set-up that puts in evidence your answer.
   _____
   _____

3. To what kind of apparatus or devices does the above set-up remind you?
   What makes you say that?
   _____
   _____

4. Do you think that an oxidation – reduction reaction is taking place in the above set-up? Why?
   _____
   _____

5. What does the above set-up make you wonder?
   Give a list of some questions that emerged in your mind after you observed this set-up.
   _____
   _____
   _____
   _____
   _____

6. What do you think is creating the potential difference in the above apparatus?

   _____
   _____

7. When do you think the above battery will be dead?
   _____
   _____

8. How can you put in evidence your answer in part (7)?

   _____
   _____

Subject: Chemistry **Grade Level:** Grade 7

Activity: Dissolution

Background

Solutions are homogeneous mixtures in which one or more solute(s) dissolve(s) in a solvent.

Liquid solutions involve solid, liquid or gaseous solute(s) dissolving in a **liquid solven**t.

Dissolution is the process of dissolving of a solute in a solvent.

In fact, during dissolution, the molecules of the solvent become in contact with the particles (atoms, molecules or ions) of the solute.

The dissolution process can be affected by many factors.

Task

Students are divided into groups of three.

Each group is provided with 3 tablets of M&M's of same color. M&M's have a sugary coating.

Their target is to let the M&M's sugary coating dissolve in water.

Process

1. Which factor(s) do you think would affect the dissolving of M&M's in water?

   _____

2. Do you think temperature affect the amount of coating that dissolves?

   _____

3. How could you investigate whether the temperature of water affects the amount of coating that dissolves from an M&M's?

   _____

   _____

4. List the variables that you should control during the experimental investigation?

   _____

5. Each group must now present his plan and the variables that he consider to control. **A discussion** is then carried on to come to a consensus about the procedure and the variables to be taken care off during the experiment.
6. The teacher will supply each group with all the needed materials.
7. Each group then conducts his experiment and is required to record his observation for about 1 minute.
8. Answer the following questions:
   a. Does the temperature of water affect the amount of colored coating that dissolves from an M&M's? How do you know?

      _____

      _____

   b. Based on the fact that dissolution is due to the contact between the water particles and the molecules of sugar, why do you think sugar dissolves better in hot water than in cold water?

      _____

      _____

9. **Making predictions**
   Do you think that hot water dissolves **salt** better than cold water, similarly to sugar?

   _____

   _____

10. Observe the following demonstration carried by the teacher:
    Two transparent cups contain equal volumes of cold water.
    Pour one tablespoon of salt and one tablespoon of sugar in each of the two cups.
    Keep the 2 cups at rest.
    The same demonstration is repeated with 2 cups containing equal volumes of hot water.

11. Does your observation agree with your prediction?

_____

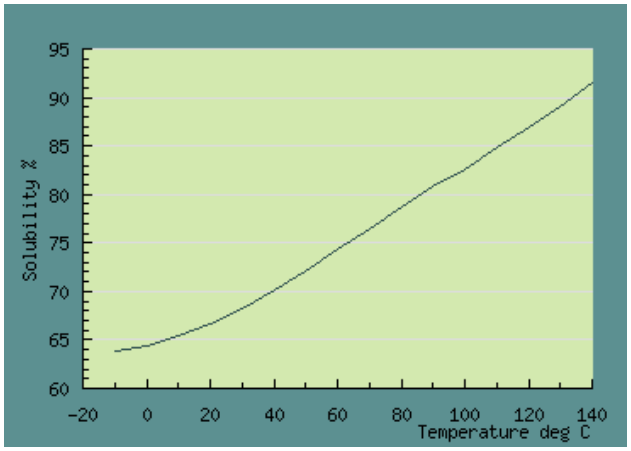
_____

12. Based on the experimental work previously done, which of the following solubility graphs (A) & (B) corresponds to sugar and which to salt? Justify.

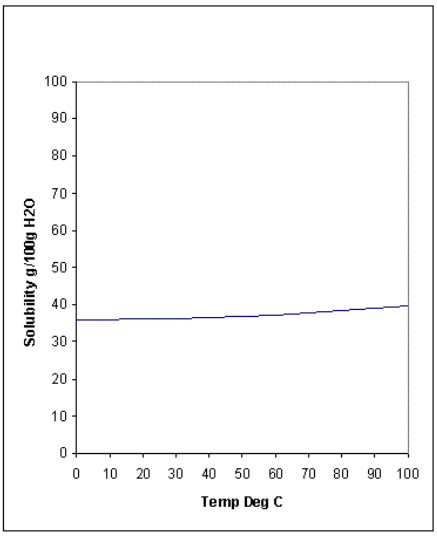
_____

_____

_____



Graph (A)

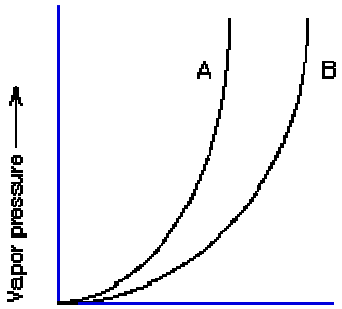


Graph (B)

Subject: Chemistry **Grade Level:** Grade
Activity: Vapor Pressure

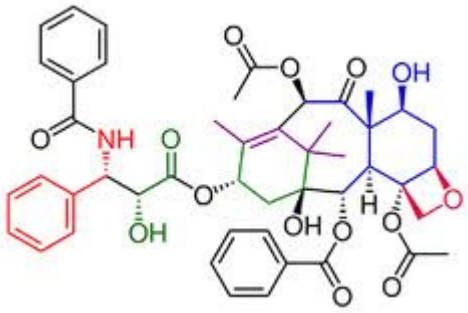
Think Pair Share

- You can use an **overhead projector** to challenge your students' minds.
- Discuss with your students whether all liquids possess the same volatility.
- Put the light off and let your students observe the following demonstration:
- Drops of water and ethanol are placed on an overhead projector.
- Each student must discuss with a nearby classmate the observation and the probable conclusion he can draw.
- Allow the different pairs their thoughts with other groups in class.
- A graph that compares the vapor pressures of ethanol and water is given.



- Each pair of students must answer the following question: Which curve corresponds to ethanol? Justify.

Subject: Chemistry **Grade Level:** Grade 11
Activity: Organic Compounds



Activity 1: (5 min.)

Work in pairs and write down in **descending order** which elements you think are most abundant in both the human body and the earth's crust.

Elements in the Earth's Crust	Elements in the Human Body
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.

Activity 2: (5 min.)

Generate, Sort, Connect, Elaborate

Work in pairs to:

5. **Generate** is a list of ideas that comes to your mind when you think about organic compound.
6. **Sort** your ideas to how central or tangential they are.
7. **Connect** your ideas by drawing connecting lines between ideas that have something in common. You can write in a short sentence how the ideas are connected.
8. **Elaborate** on any of the ideas you have written so far by adding new ideas that expand, extend, or add to your initial ideas.

Activity 3: (12 min.)

Think, Pair, Share

Observe the given lists of two groups of compounds; then work in pairs to answer the questions that follow.

Group I	Group II
• Glucose sugar $C_6H_{12}O_6$ • Lactose sugar in milk $C_{12}H_{22}O_{11}$ • Butane gas C_4H_{10} • Octane gasoline C_8H_{18} • Benzene C_6H_6 • Ethanoic acid CH_3COOH • Propanol C_2H_5OH • Vitamin C ($C_6H_8O_6$) • Alanine Amino acid ($C_3H_7O_2N$) • Dimethyl sulfoxide $CH_3S(=O)CH_3$ • Carbon tetrachloride CCl_4 • ATP molecule in cells $C_{10}H_{16}N_5O_{13}P_3$ • Rubber • Plastics • Wood • Oils • DNA & RNA Etc…	• Water H_2O • Gases like O_2, NH_3,… • Glass • Cement • All salts like NaCl, $MgSO_4$, $CuBr_2$,… • Bases like NaOH • Metals like Fe, Cu, Zn… • Silicon • Rocks • Sand • Diamond Etc…

A. What is the common element among all of the compounds in **group I**?

_____

B. List all the other elements that may be found in compounds of **group I**.

_____

C. What is the physical state that a compound of **group I** can have at room temperature?

_____

D. Do you think that all compounds of **group I** are natural? Give examples.

_____

E. Where do you think compounds of **group I** come from or might be found?

_____

F. Indicate the type of bonding (covalent or ionic) in compounds of **group I**.

_____

G. Do you think that "**Petroleum**" and its derivatives belong to **group I** or **II**? Justify.

_____

H. Based on the 2 previous activities, classify compounds of each group as organic or inorganic compounds.

_____

I. Define "Organic Compounds".

_____

_____

Extend

A. List one new idea or concept you have learned it today about organic compounds.

_____

B. Can you think of an inorganic compound that might contain Carbon?

_____

C. What do you think about the importance of organic compounds in our life? Give two main importances.

_____

_____

_____

Activity 4 (12 min.)
Elemental Analysis of an Organic Compound
The Qualitative Analysis of an Organic compound

Observe the animated virtual lab experiment to answer what follow.

1. What is the purpose behind the qualitative analysis of an organic compound?

   _____

2. What two elements are being identified in the displayed experiment?

   _____

3. List the materials used during the experimental procedure.

   _____

   _____

4. Briefly describe the experimental procedure.

   _____

   _____

5. Write your observations

   _____

   _____

6. What do you think the role of cupric oxide (CuO)?

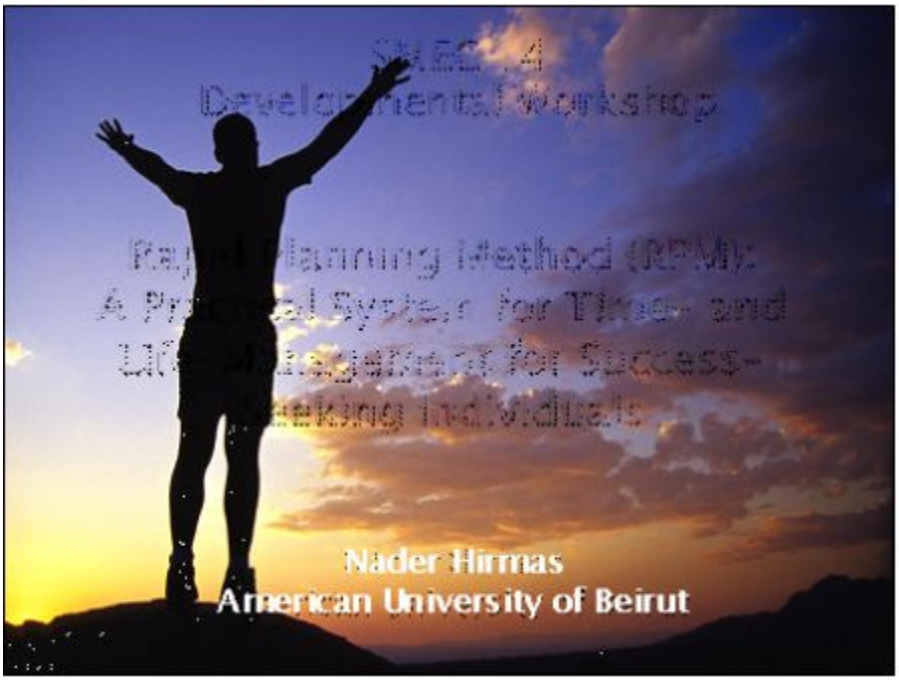
   _____

7. Write the balanced equations involved in the experimental procedure described.
   a. _____
   b. _____
   c. _____

MATHEMATICS AND SCIENCE

Rapid Planning Method (RPM): A Practical System for Time- and Life-Management for Success-Seeking Individuals

Nader Hirmas



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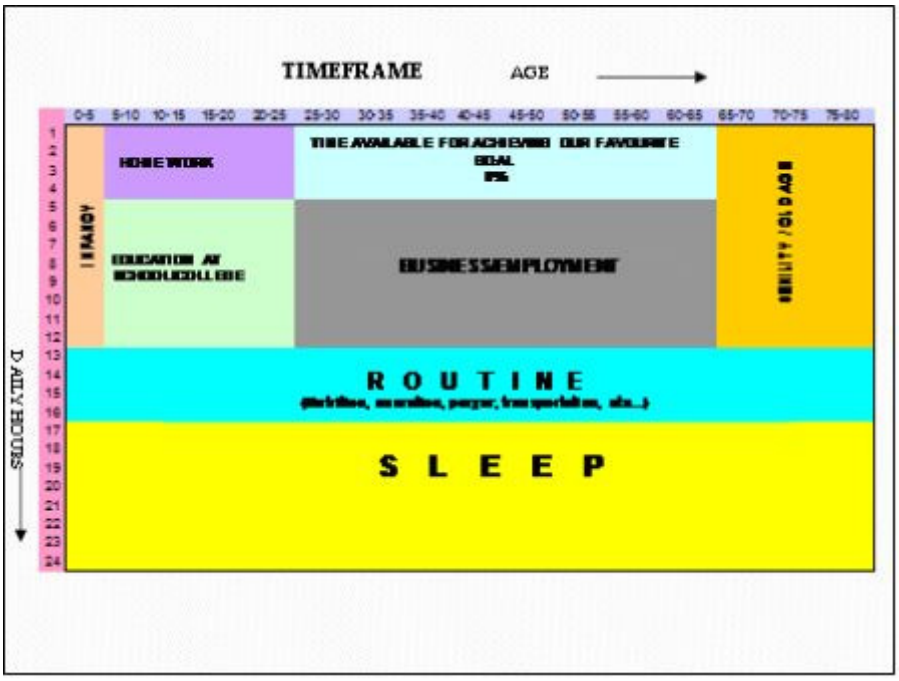

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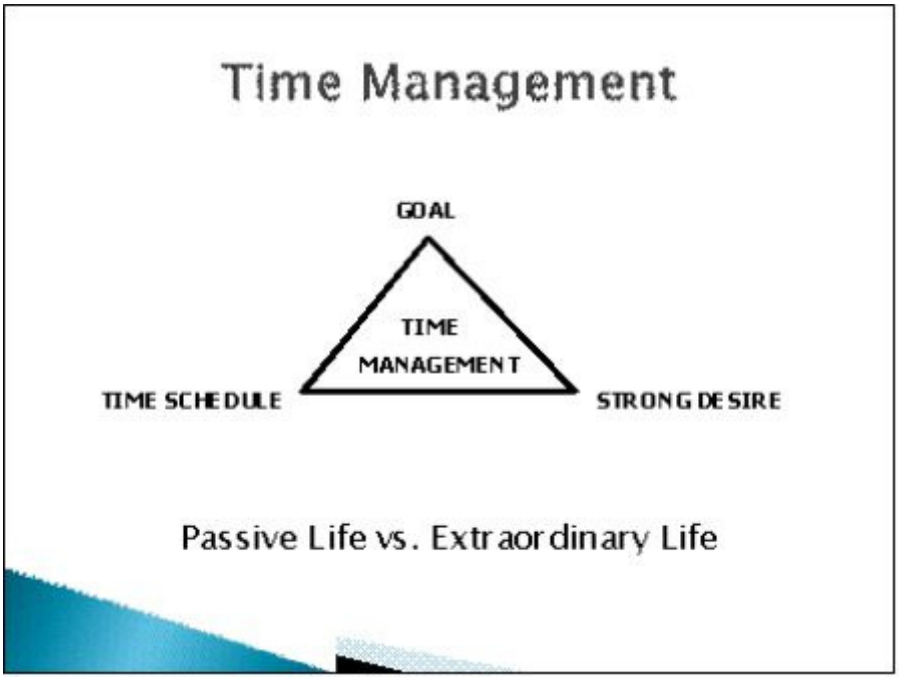

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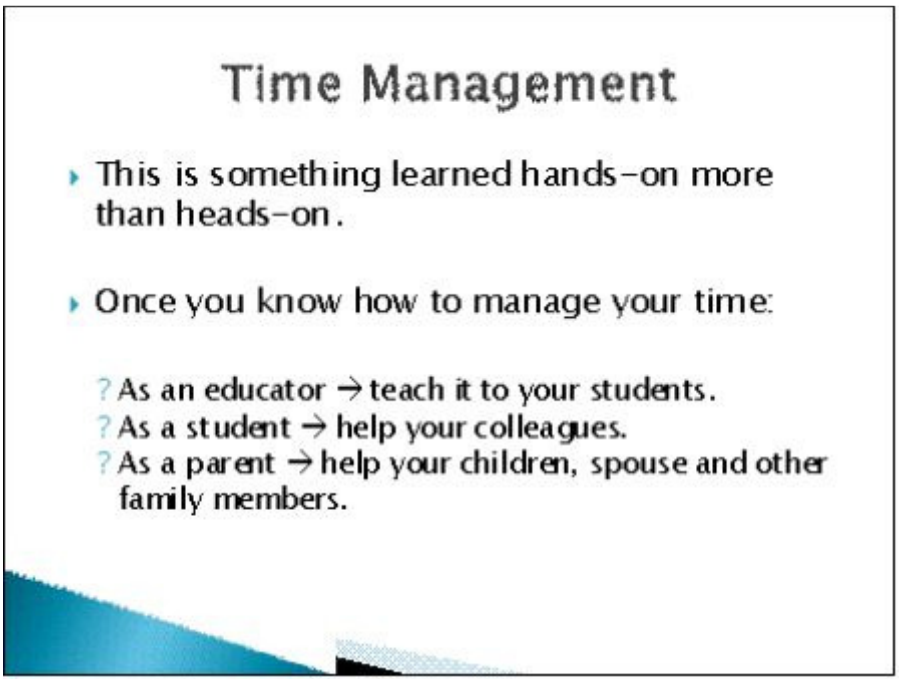

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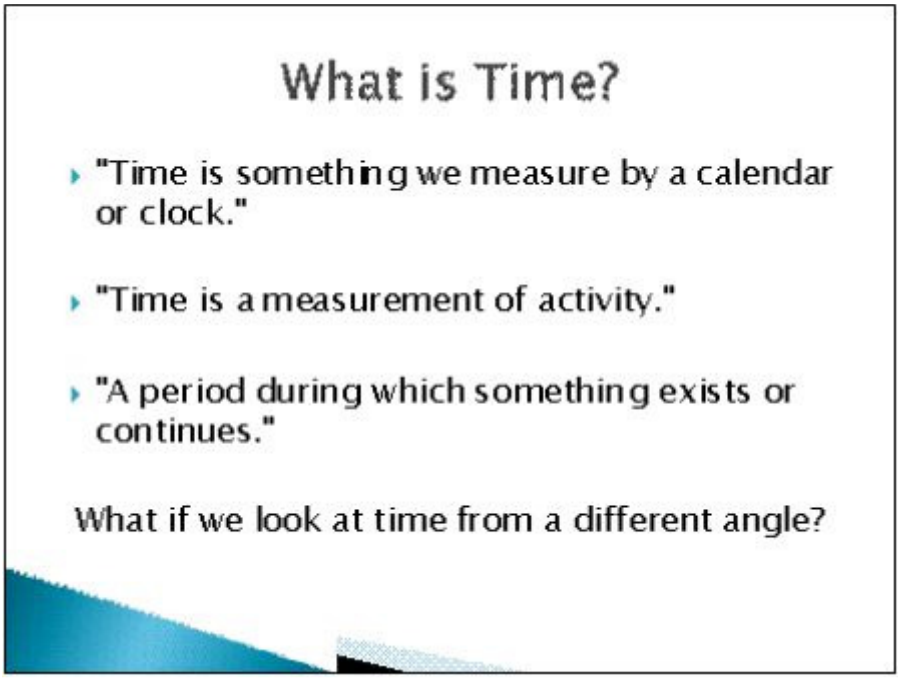

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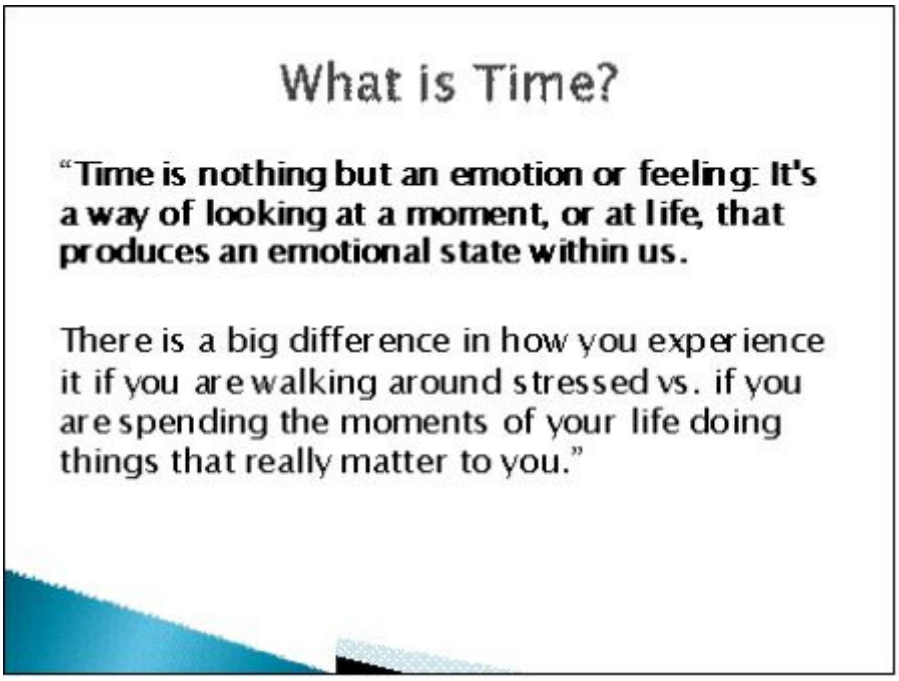

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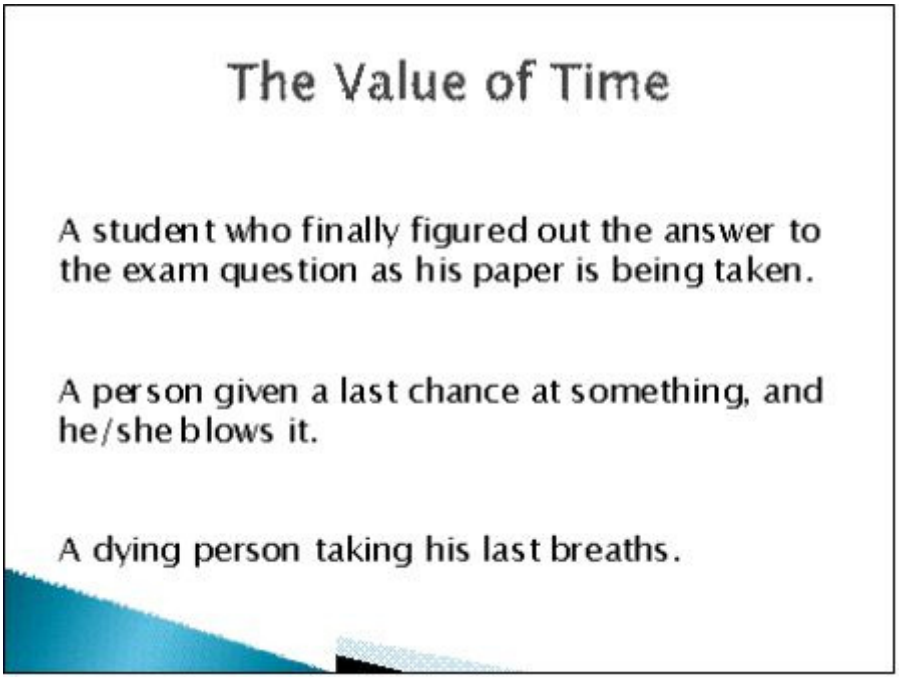

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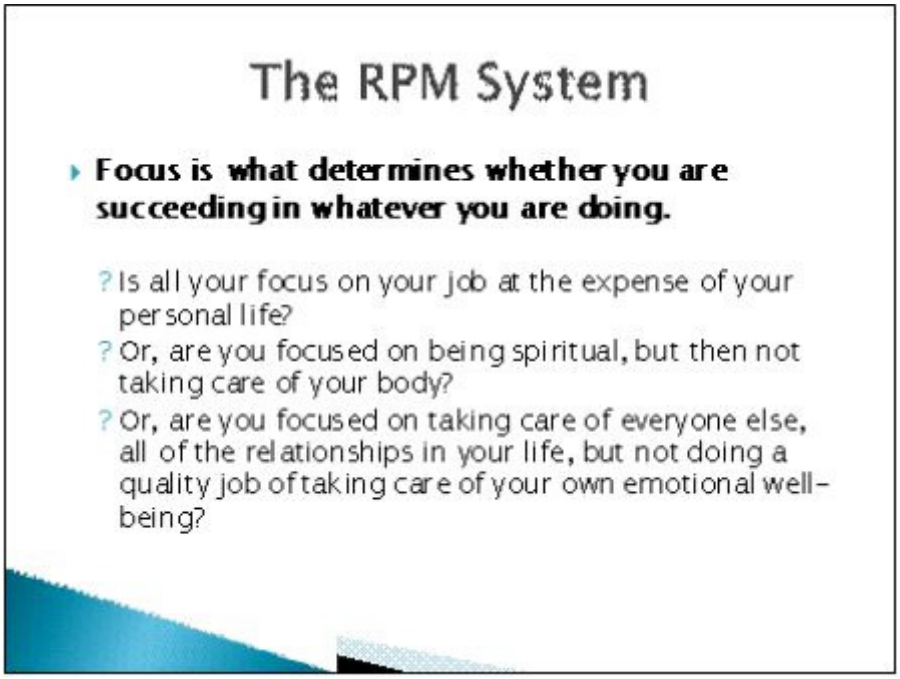

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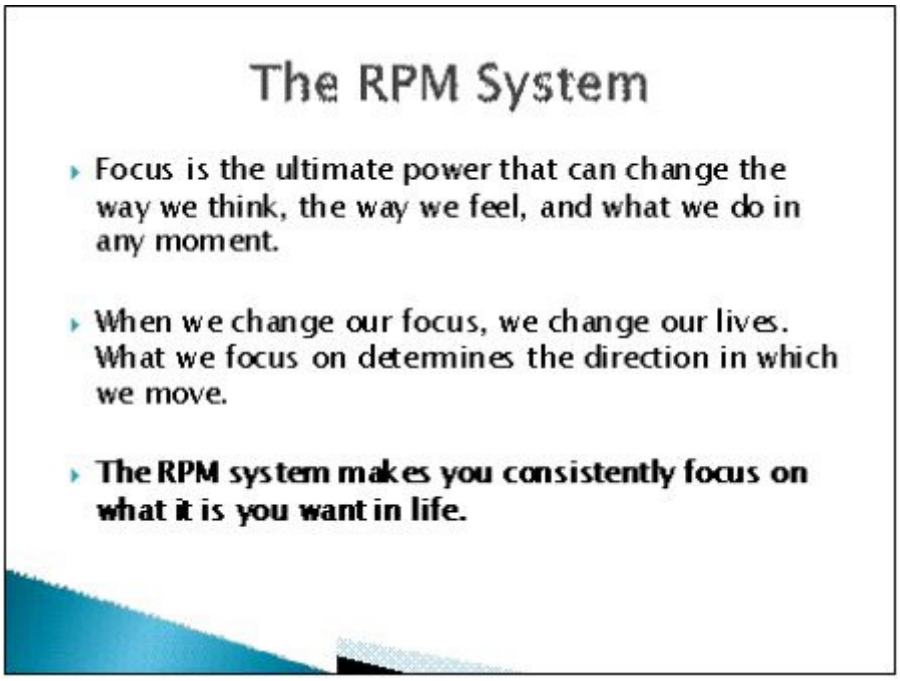

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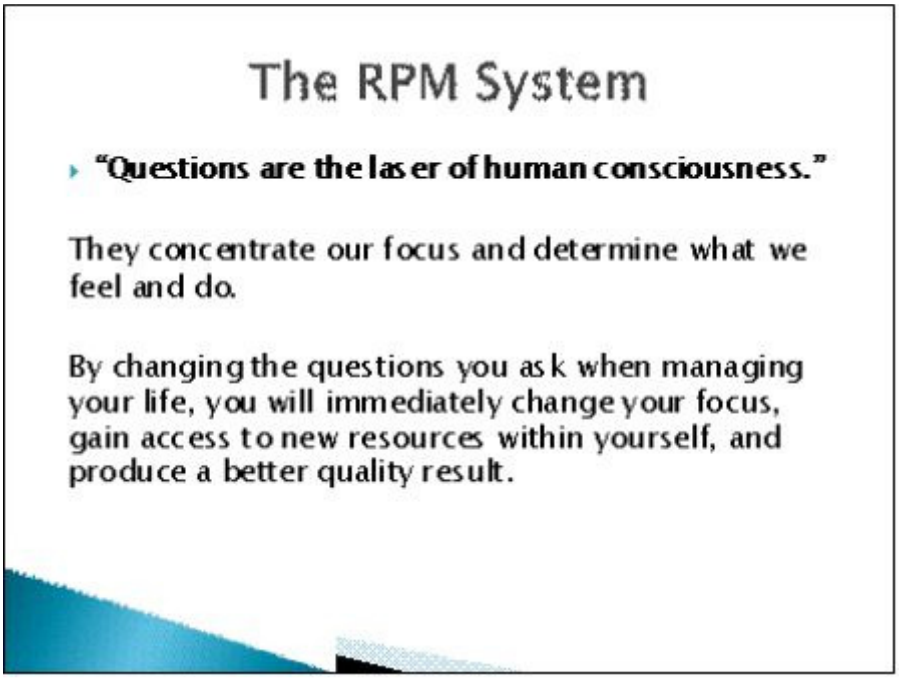

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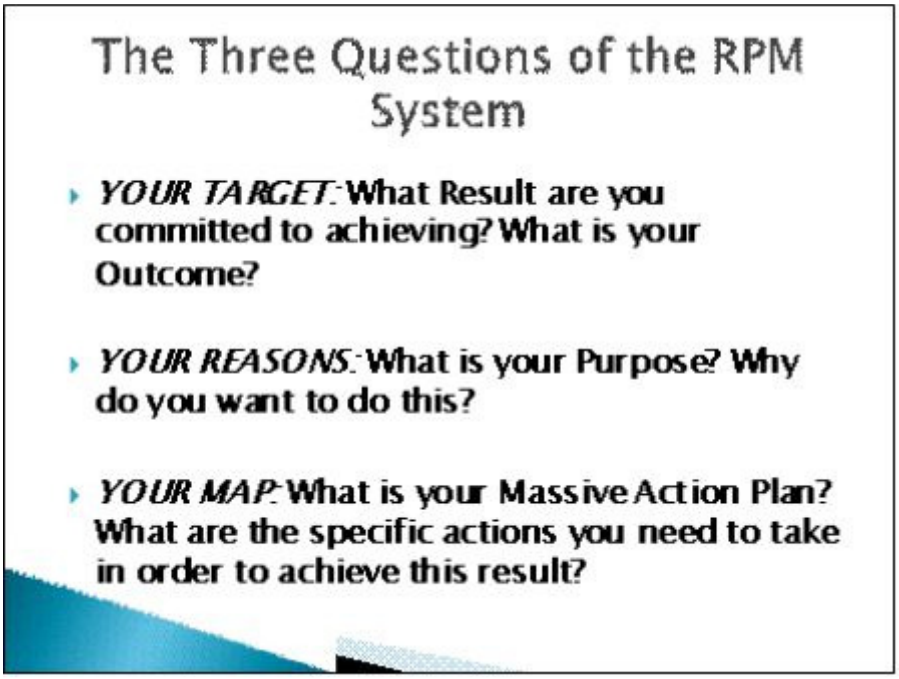

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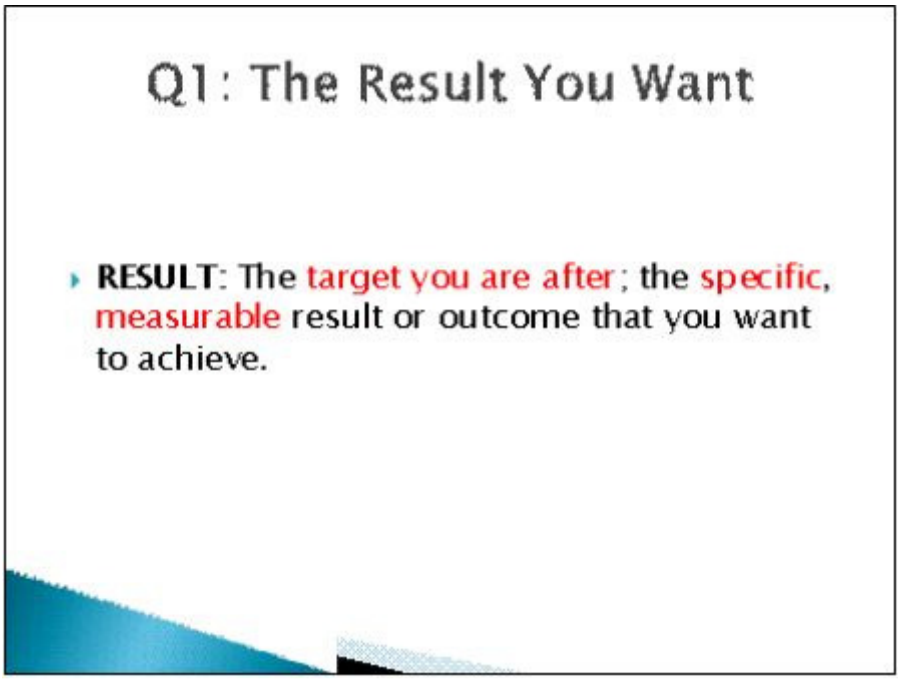

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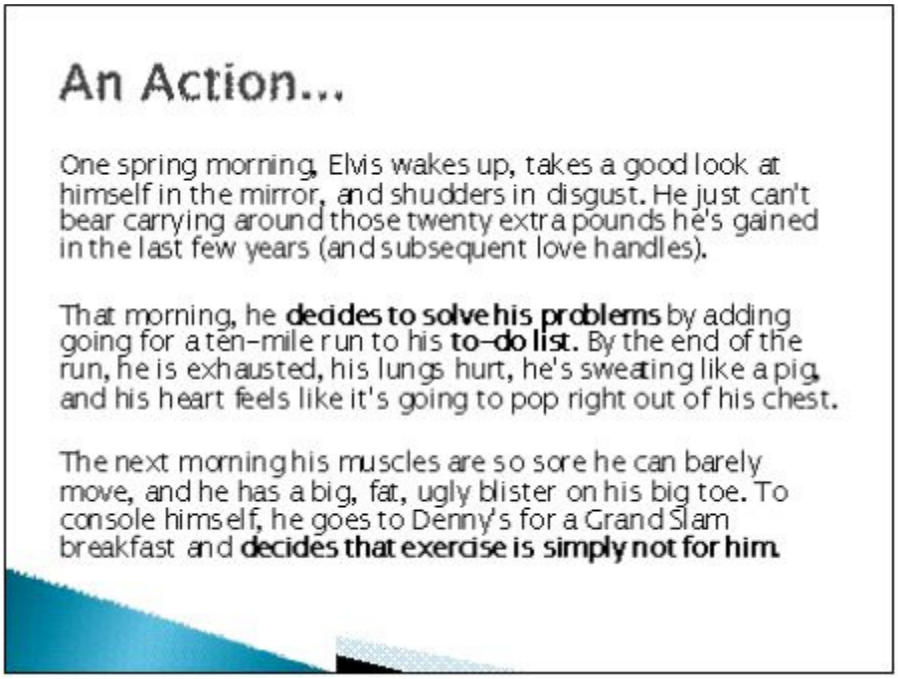

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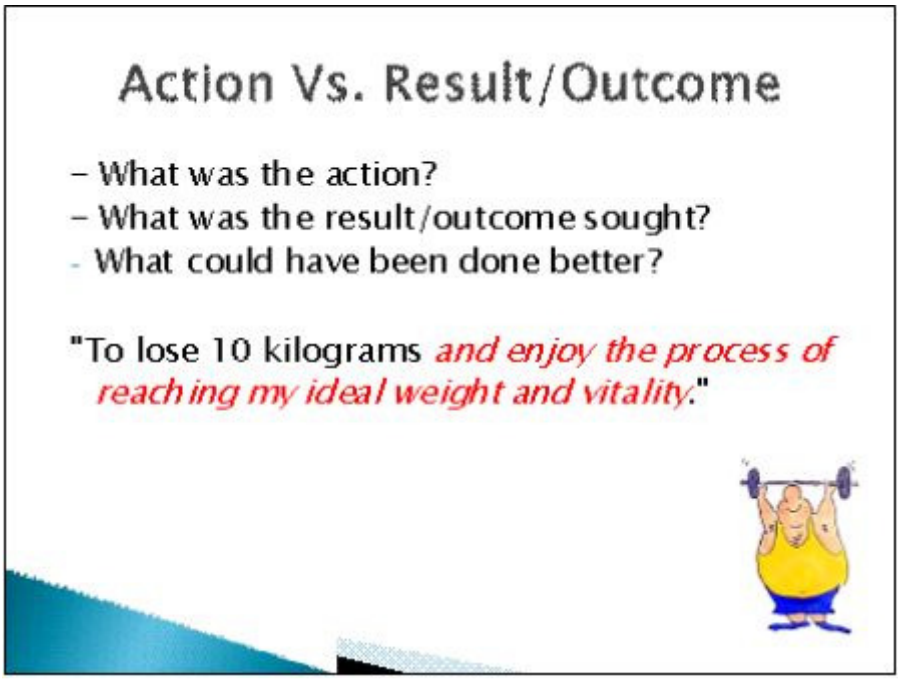

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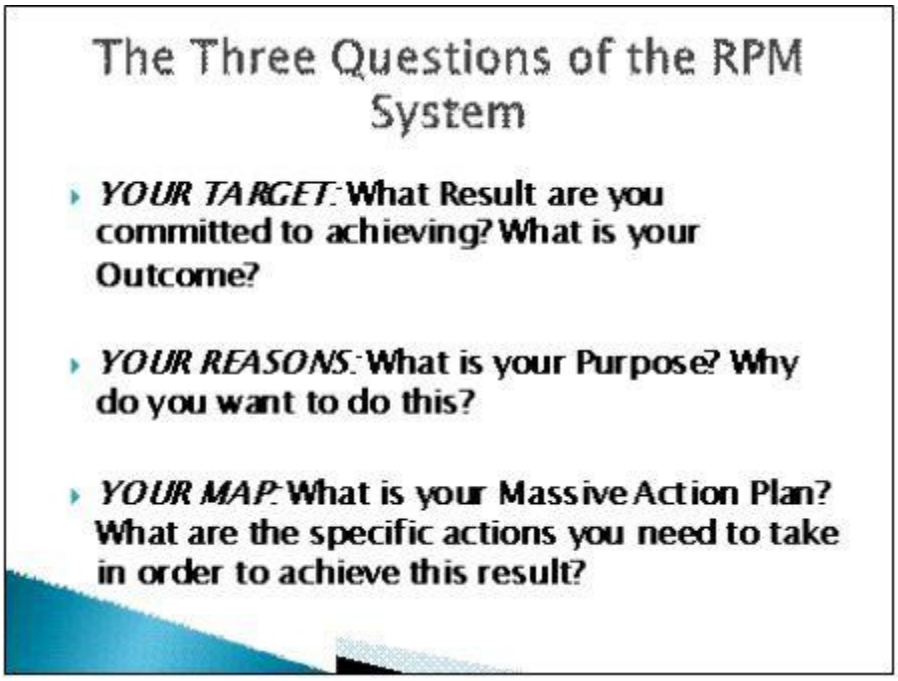

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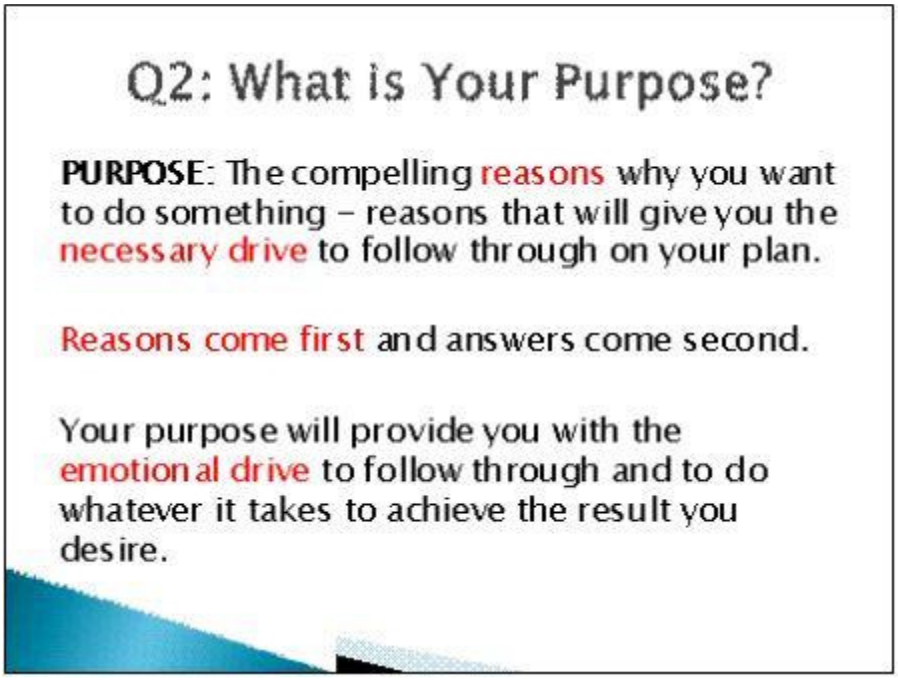

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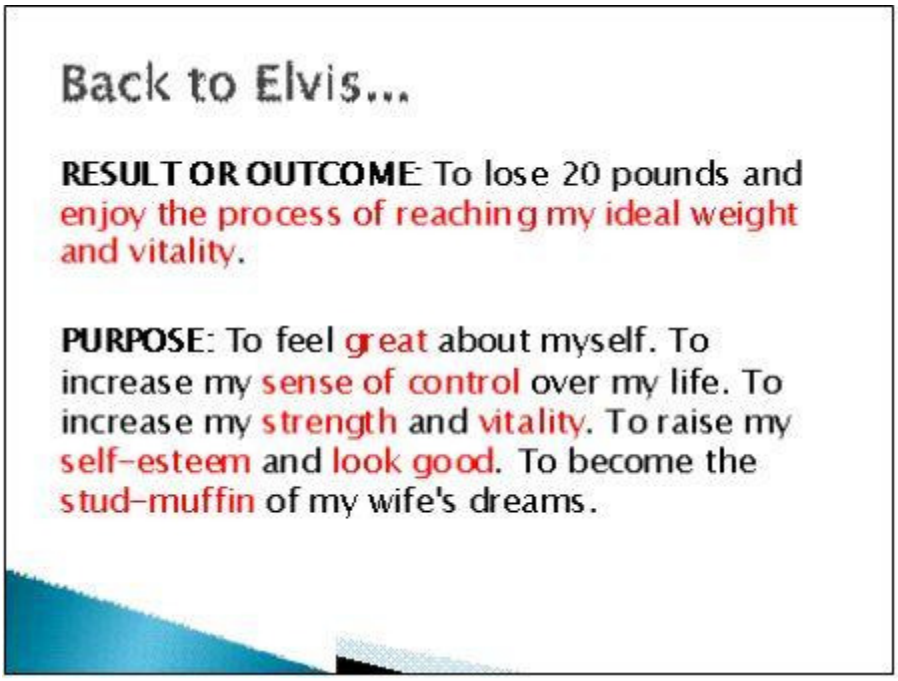

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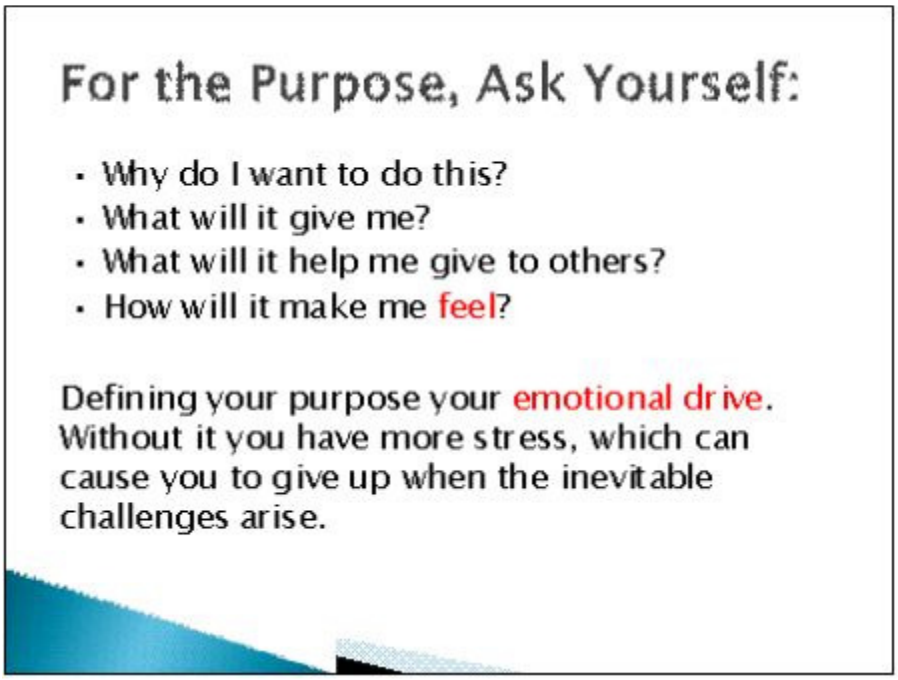

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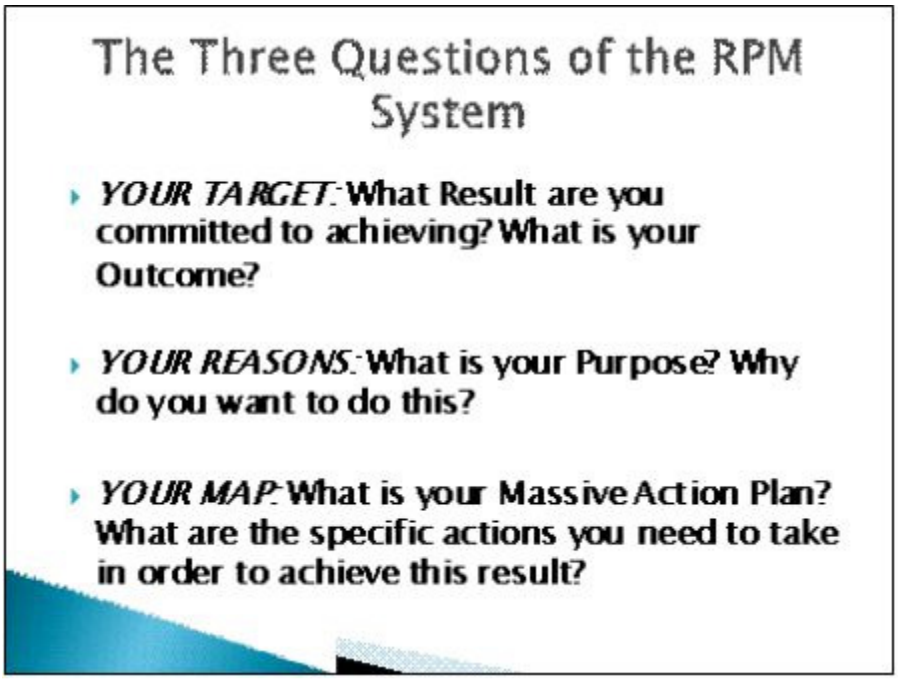

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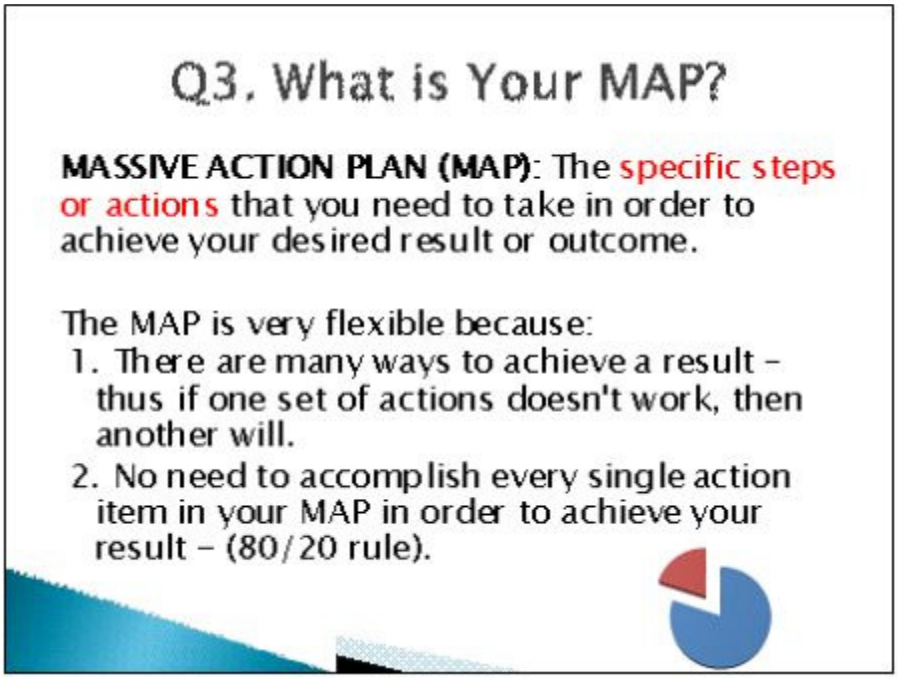

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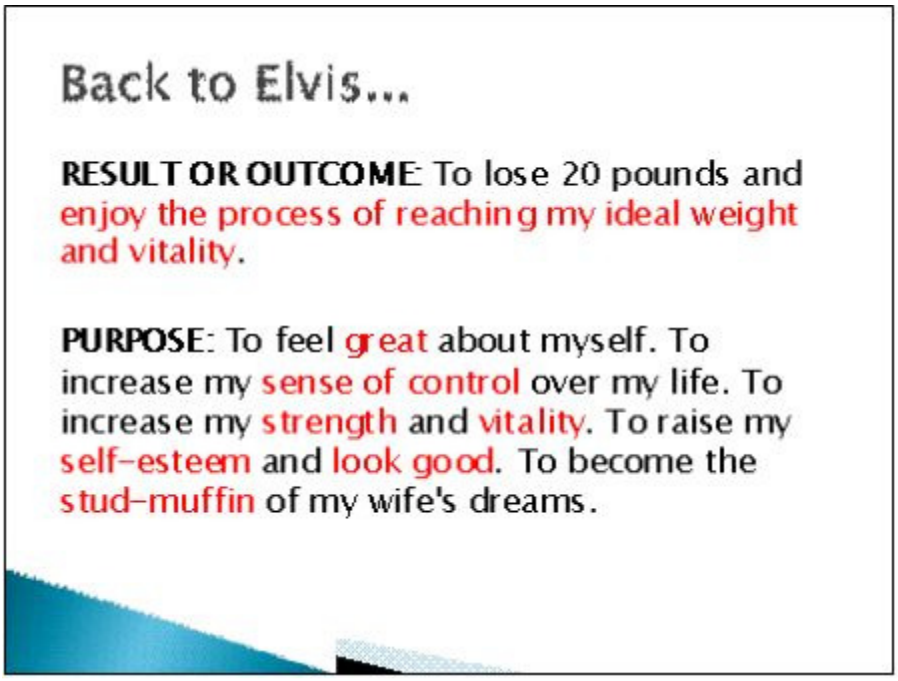

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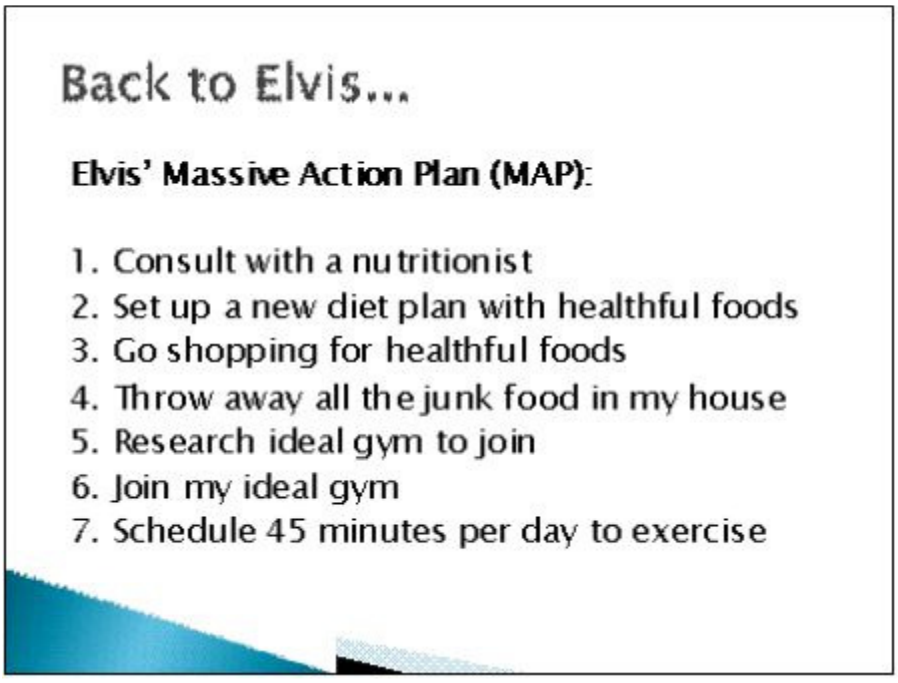

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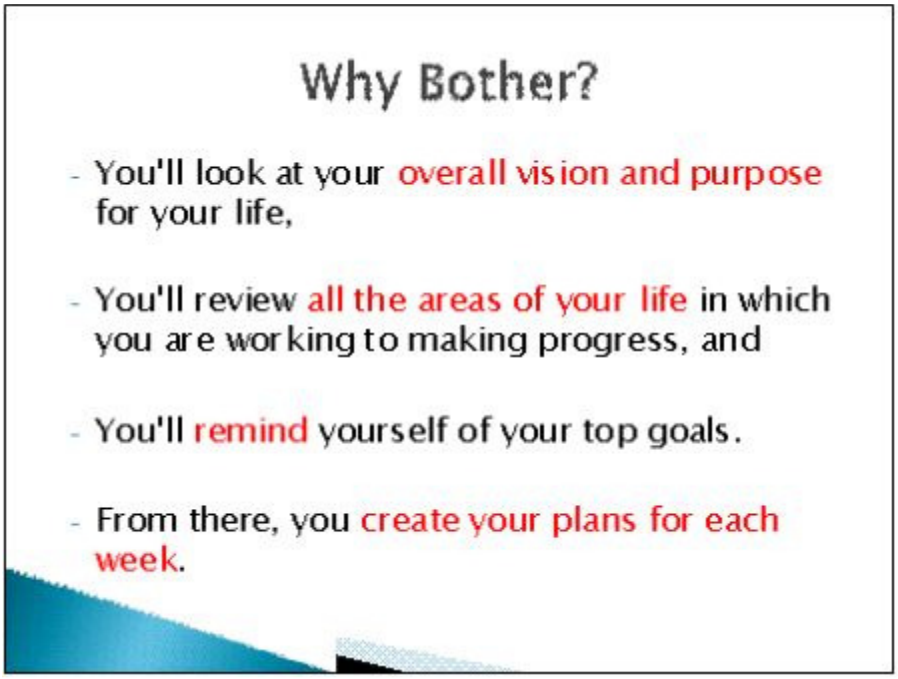

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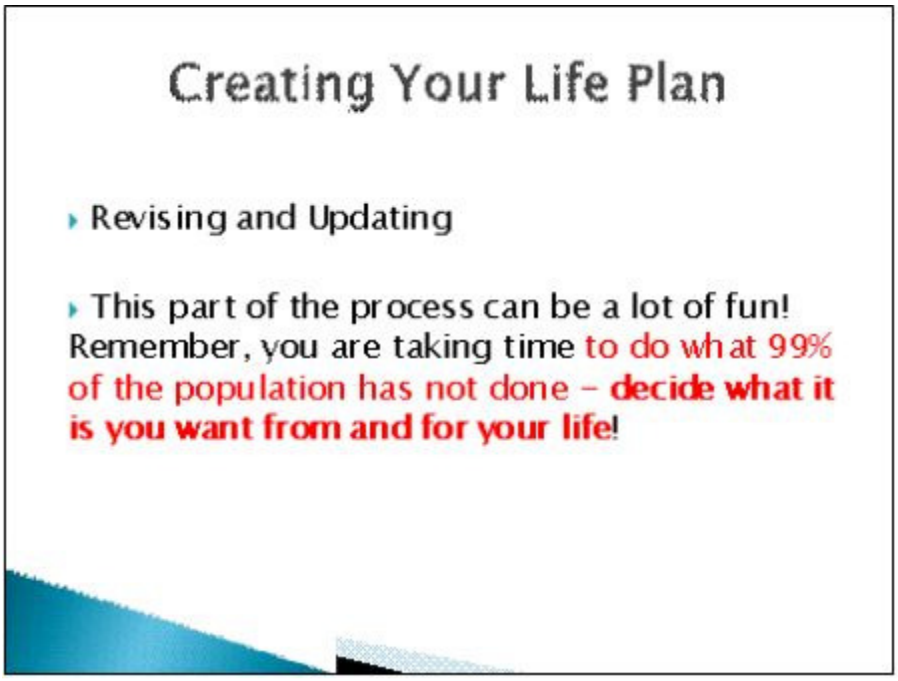

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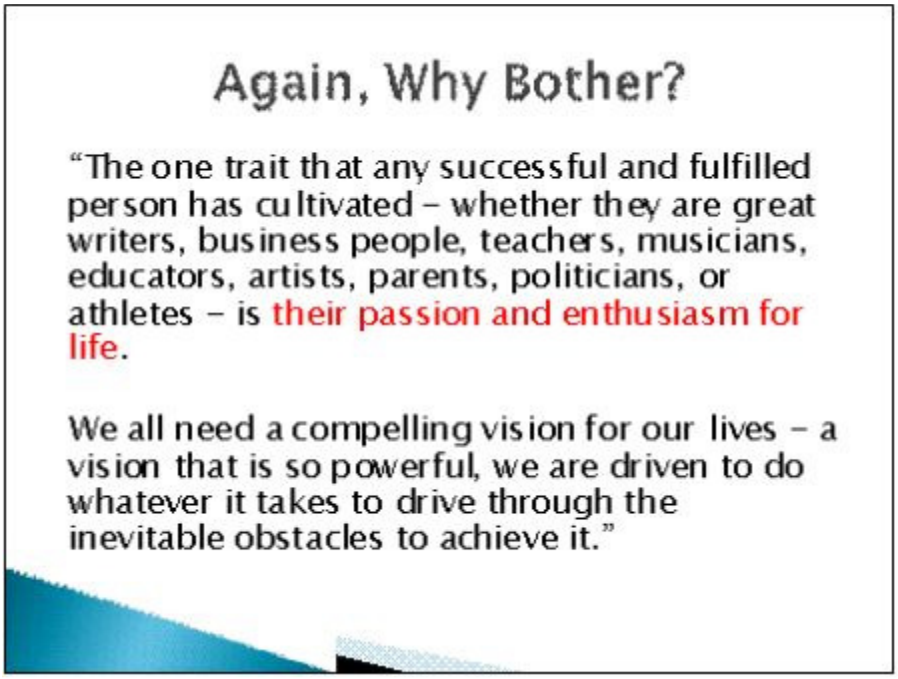

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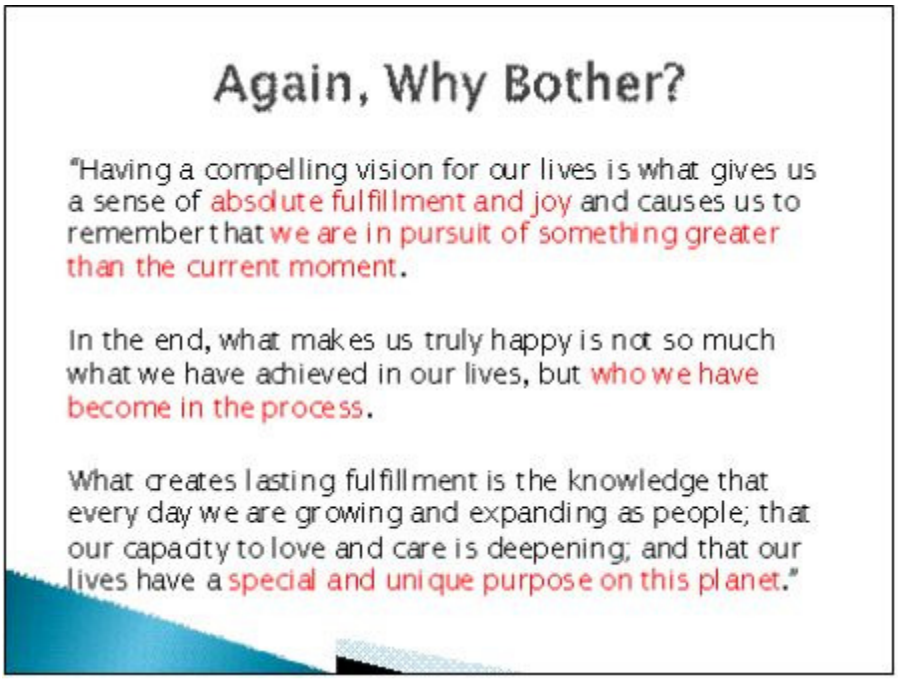

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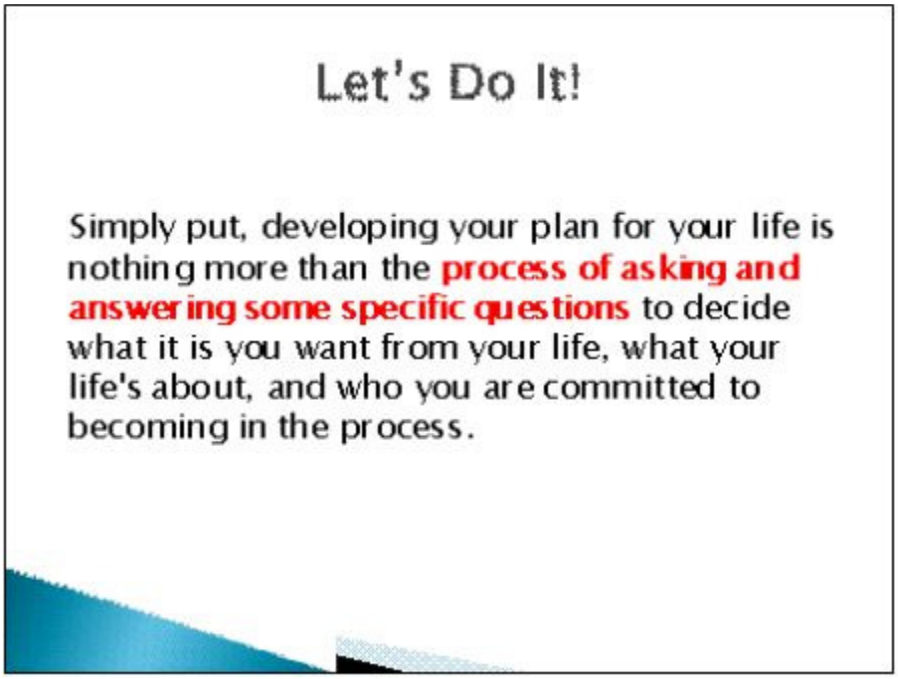

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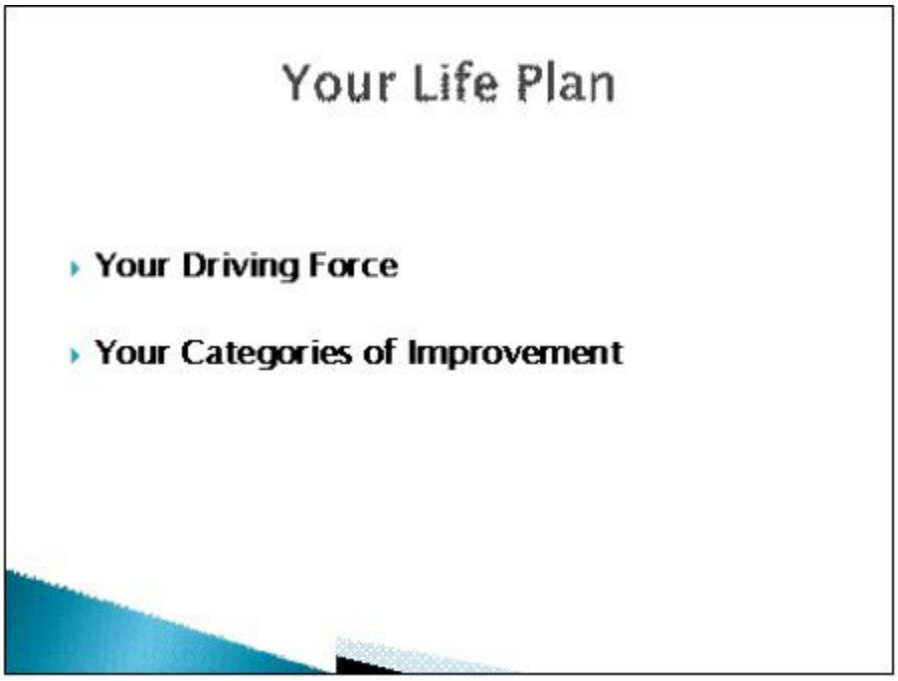

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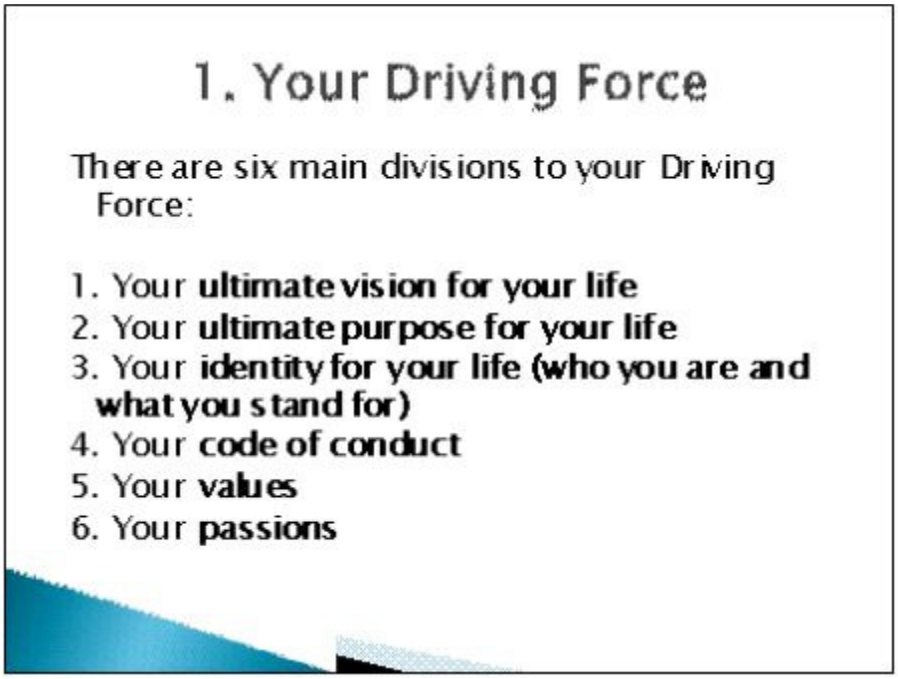

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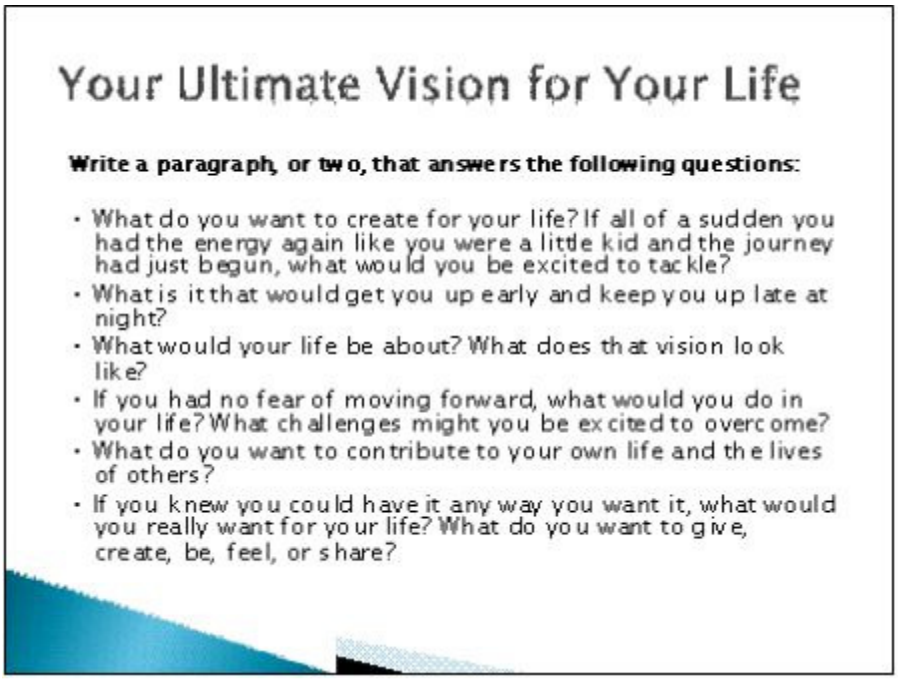

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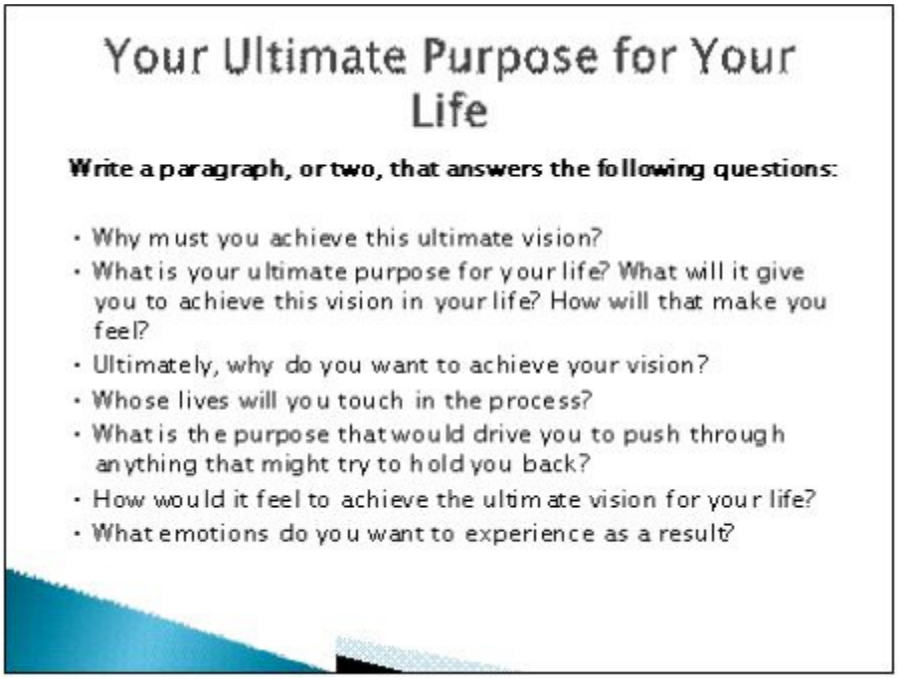

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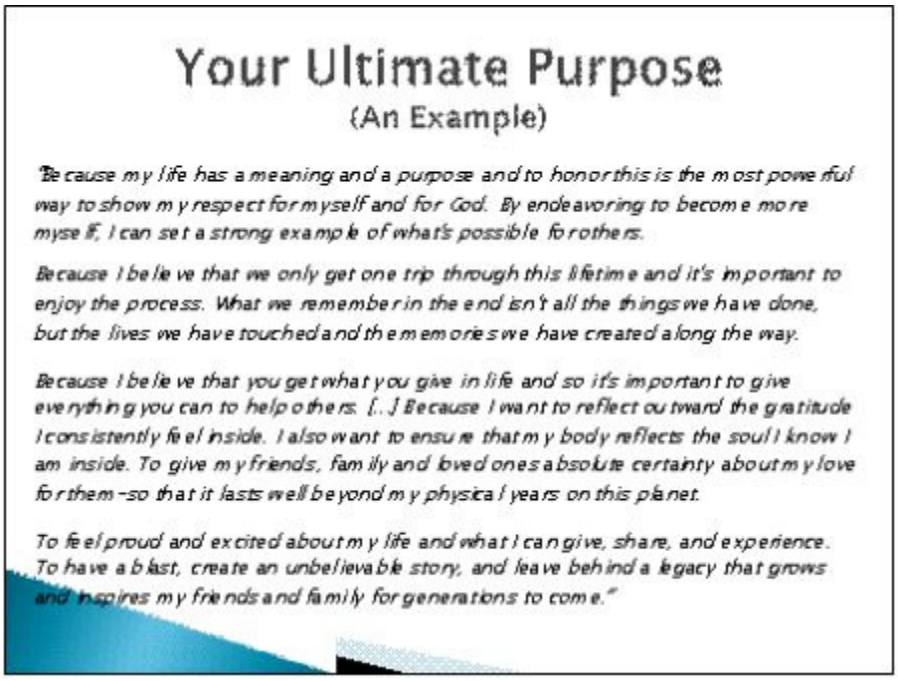

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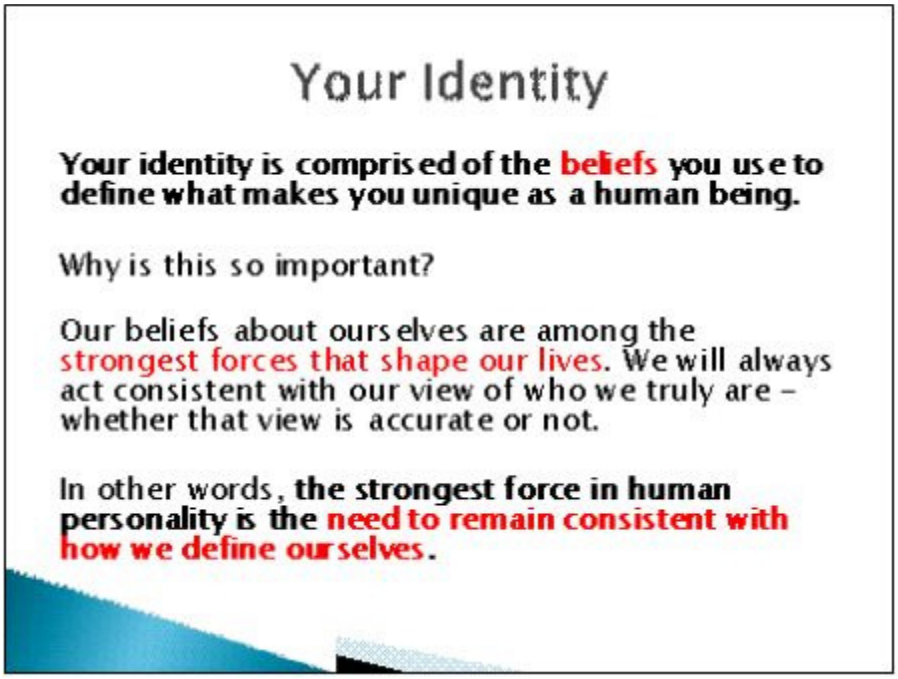

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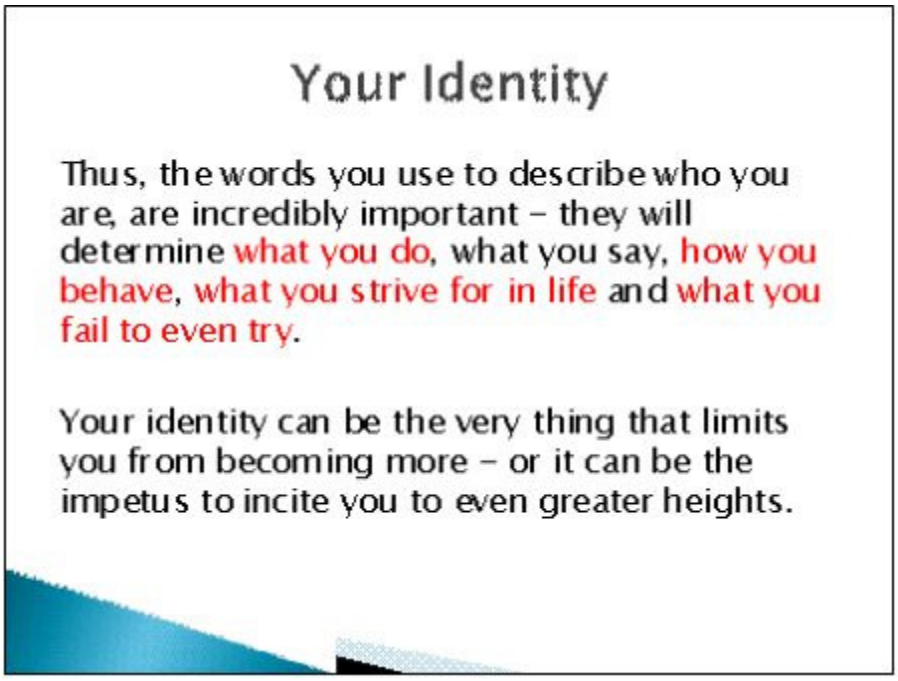

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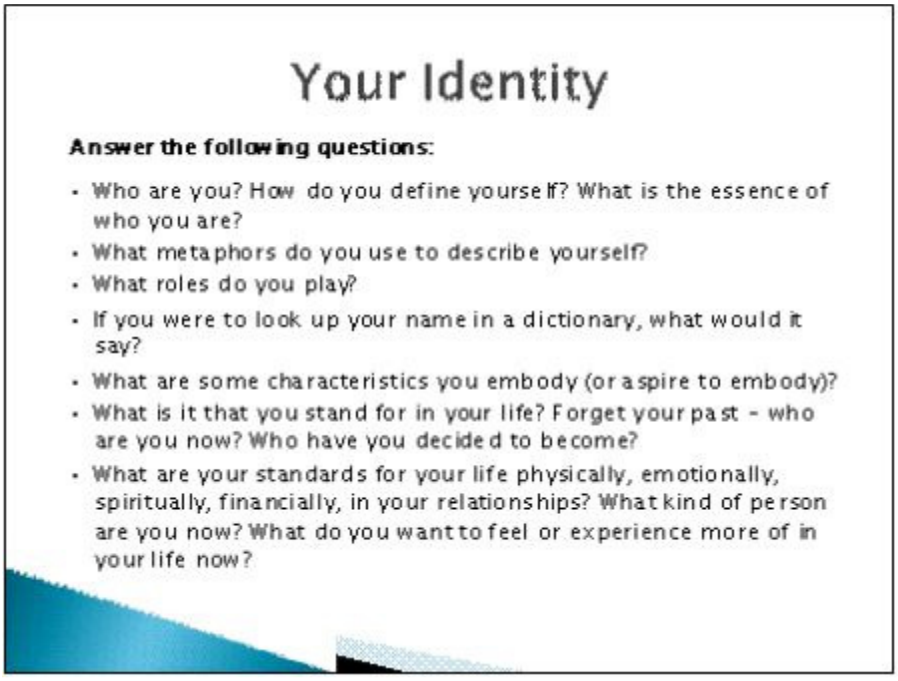

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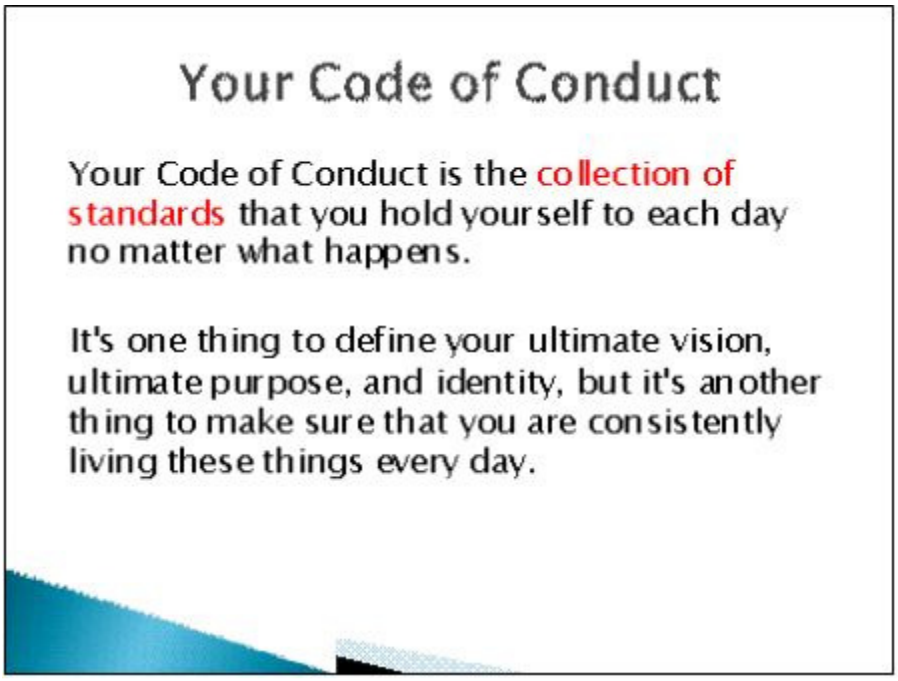

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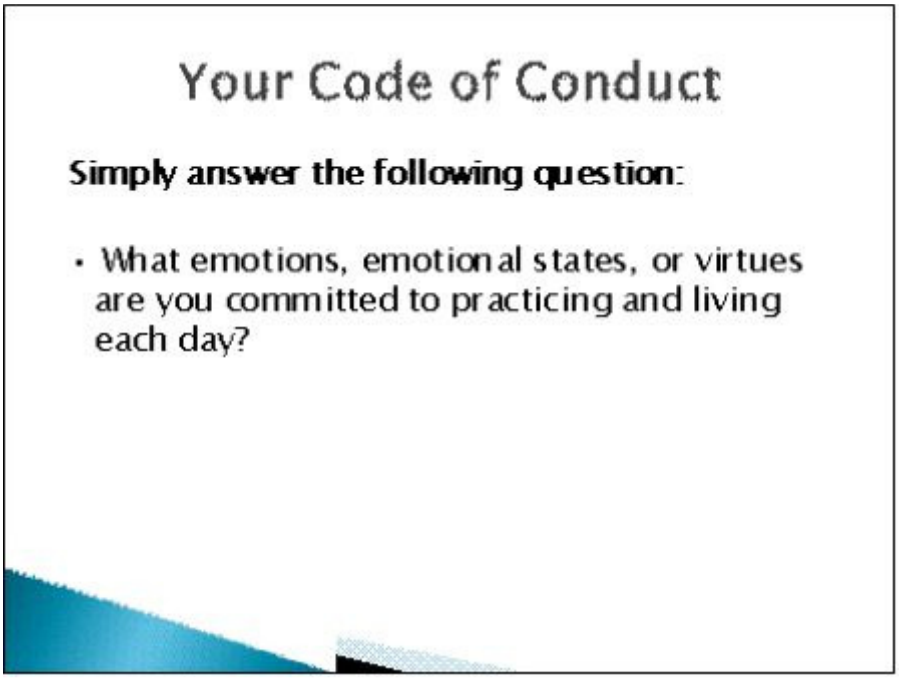

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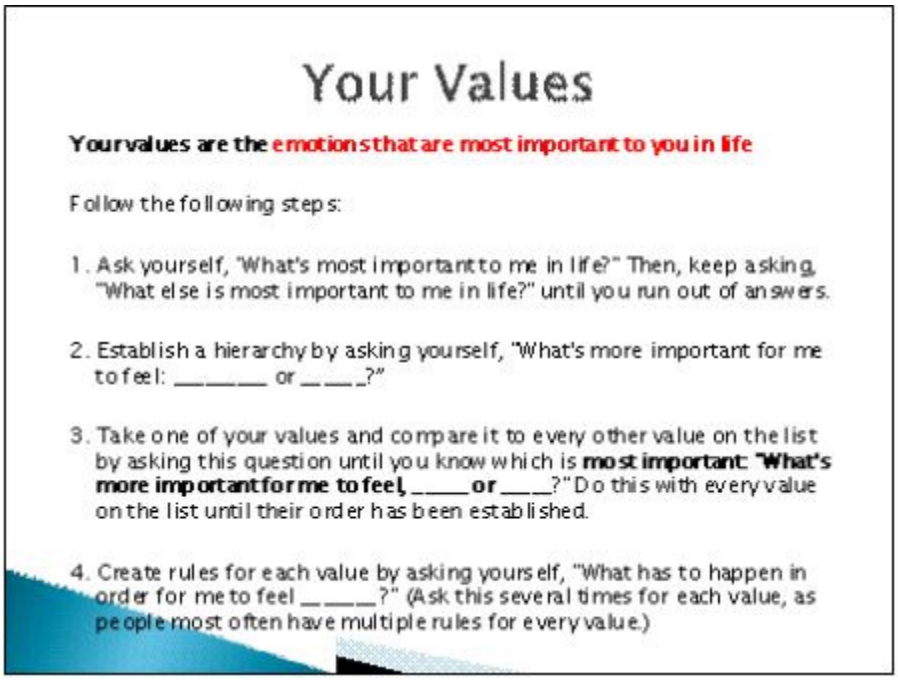

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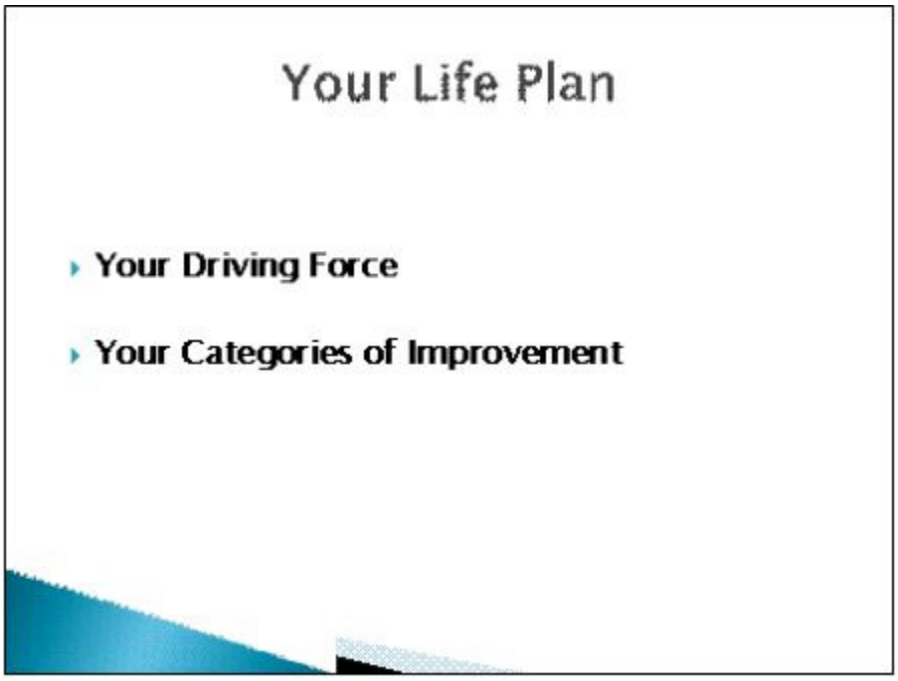

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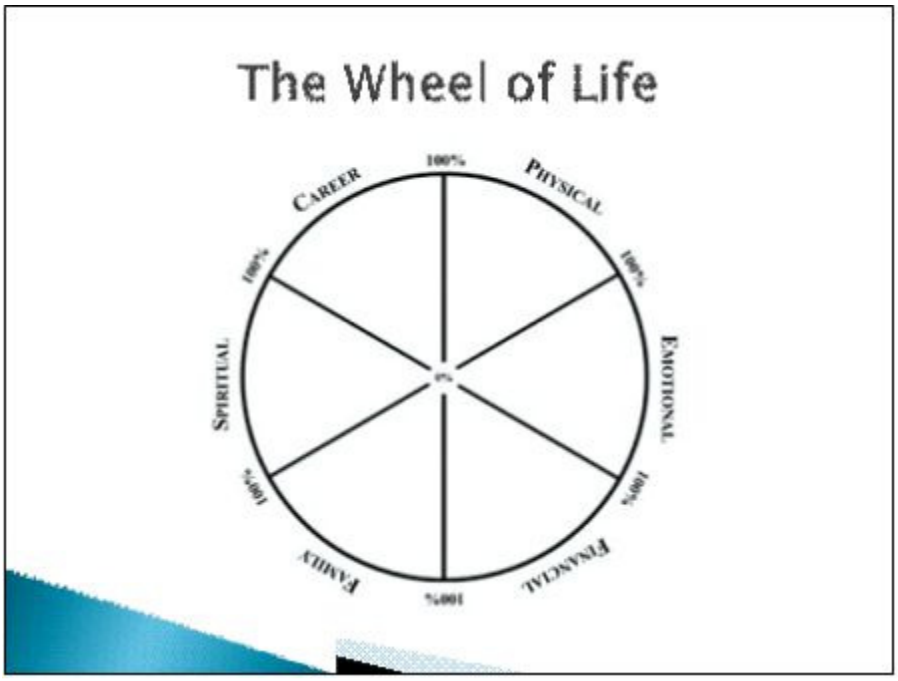

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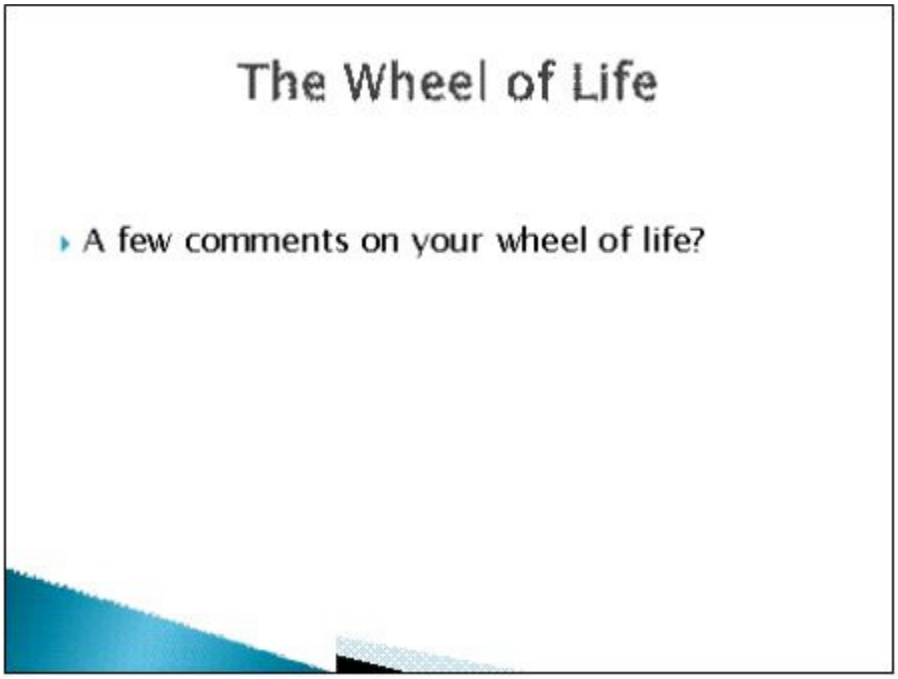

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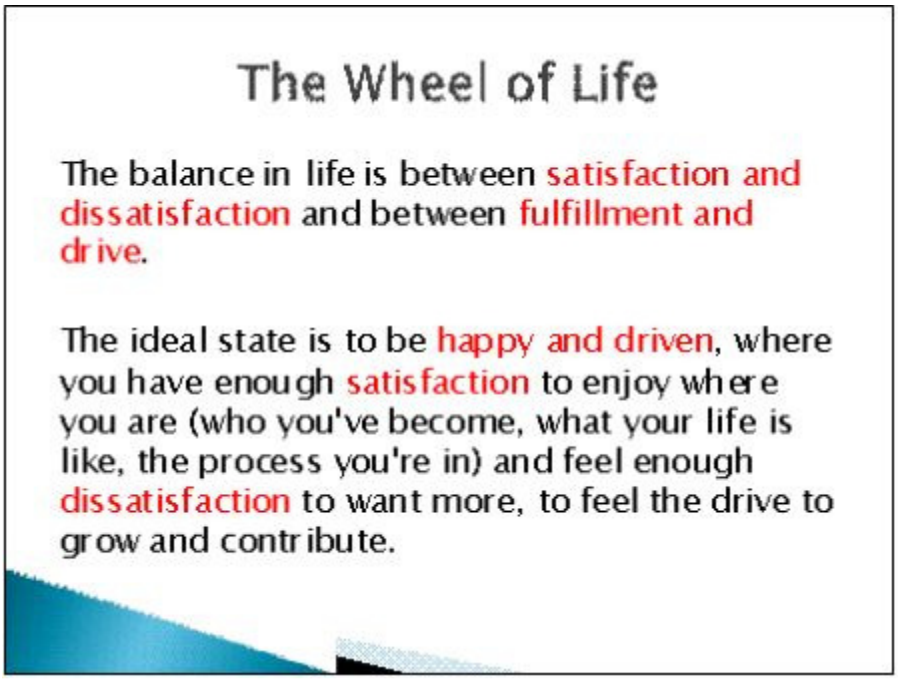

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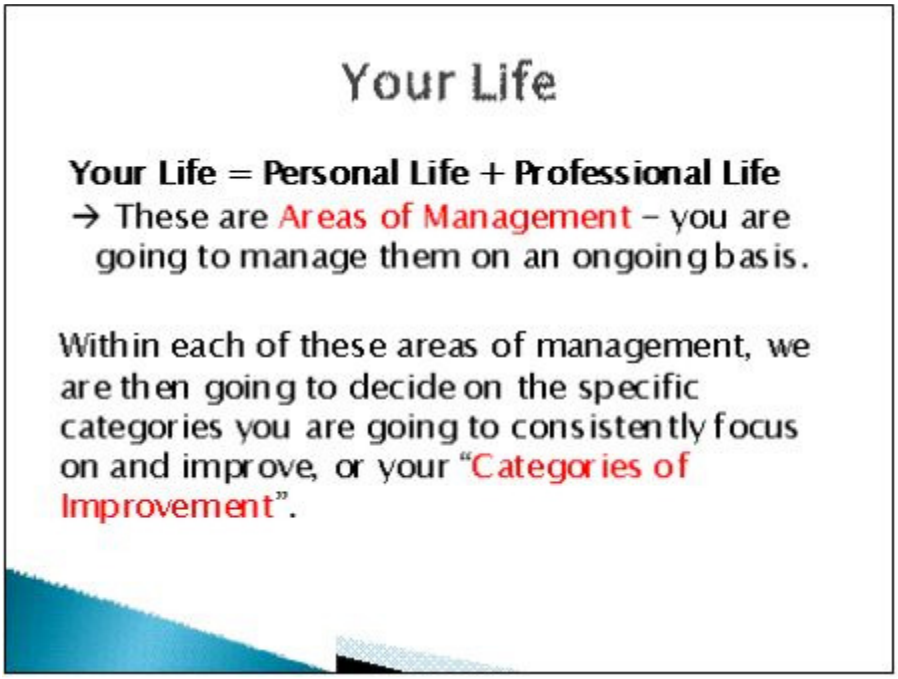

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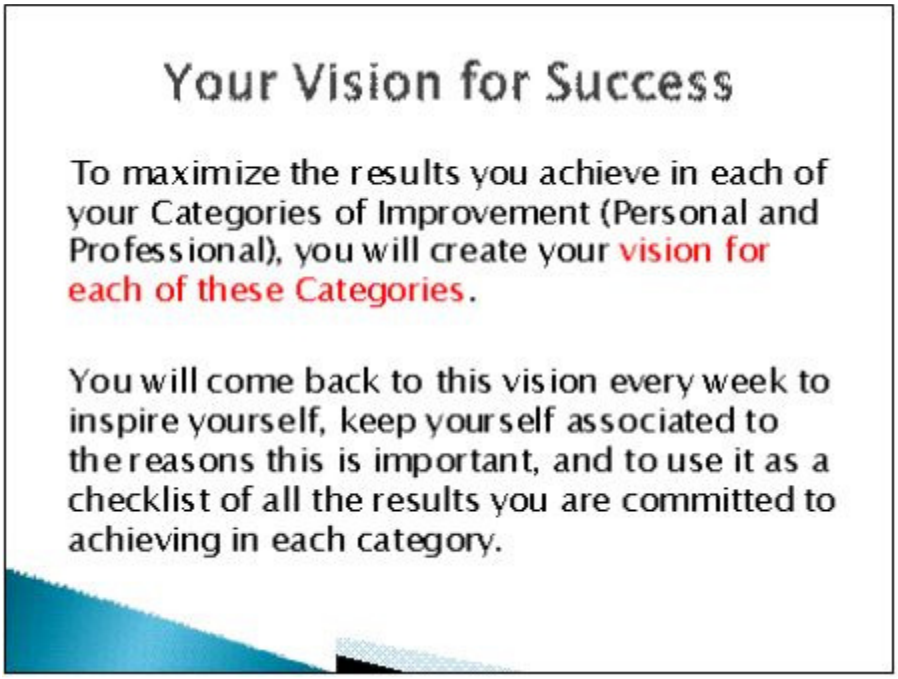

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SLIDE 57

SLIDE 58

Chunking!

Chunking: Grouping together information into ideally sized pieces so that they can be used effectively to produce the results you want without stress or overwhelm.

How do I slice my pizza?

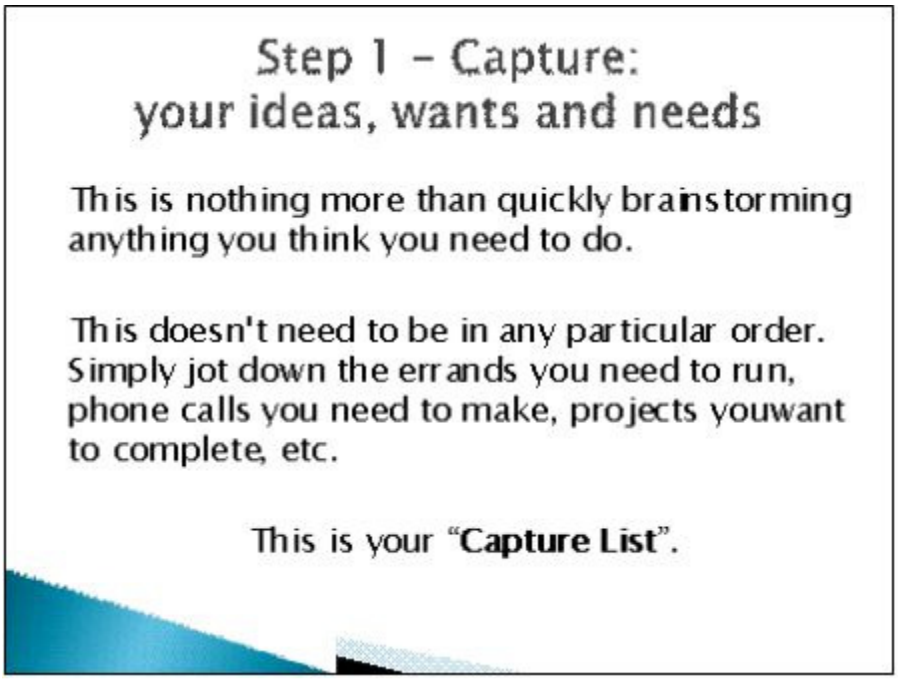
SLIDE 59

The 5 Master Steps of Planning

Whether you are planning a day, a week, or a project, the Five Master Steps of Planning are the same.

Step 1: Capture Ideas, Wants, & Needs
Step 2: Create Your RPM Master Plan
Step 3: Commit to Block Time & Resolve Your Musts
Step 4: Schedule Specific Time to Work on Your Results
Step 5: Complete, Measure & Celebrate Your Results

SLIDE 60



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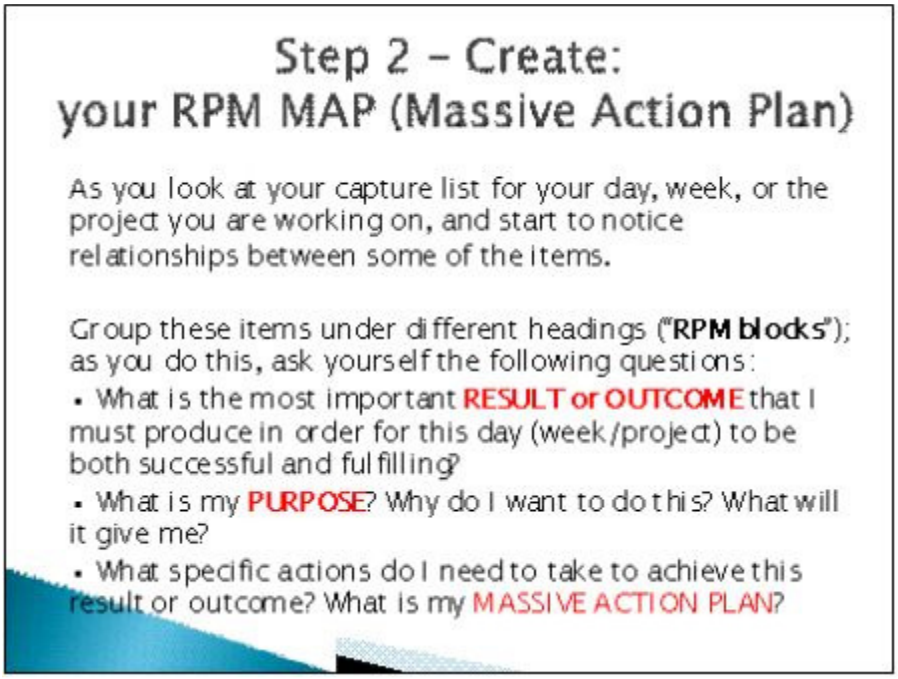

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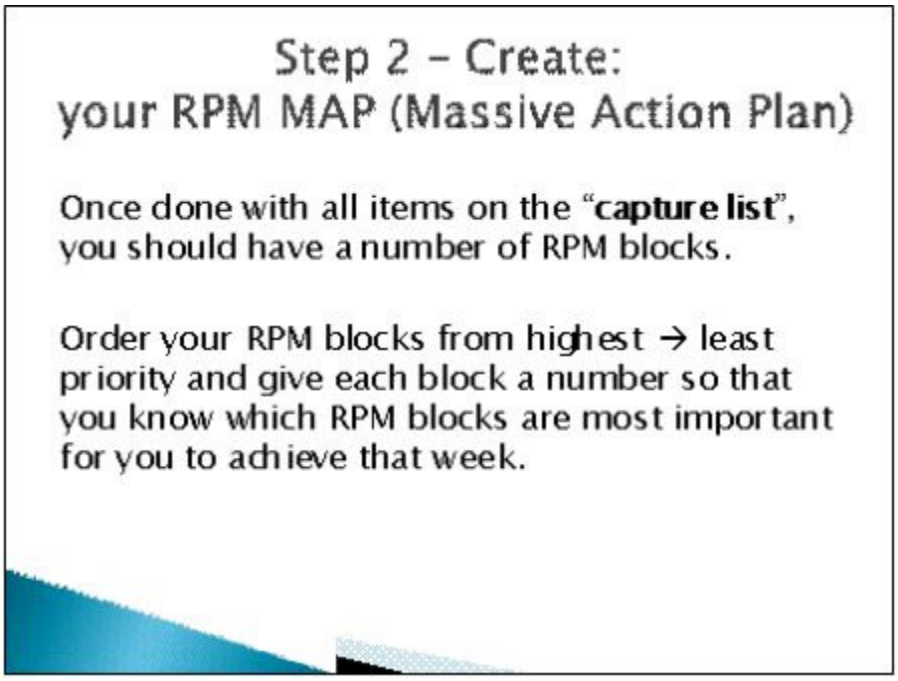

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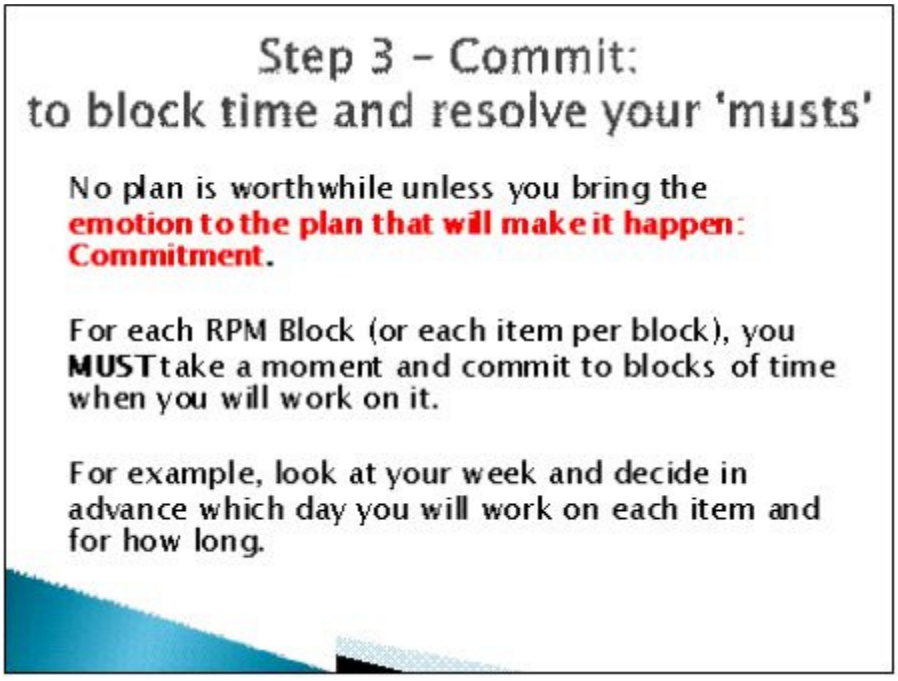

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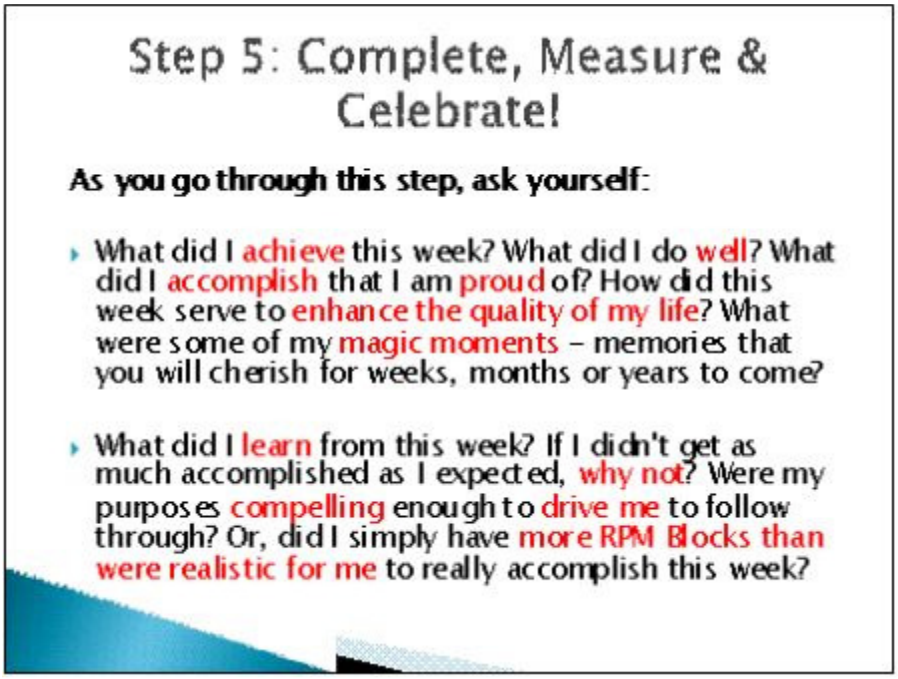

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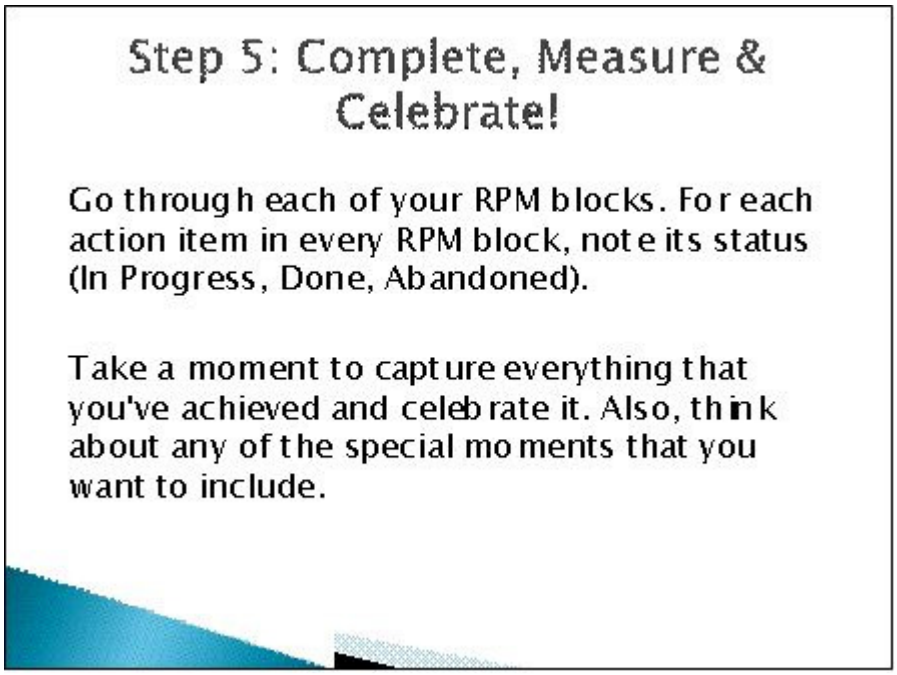

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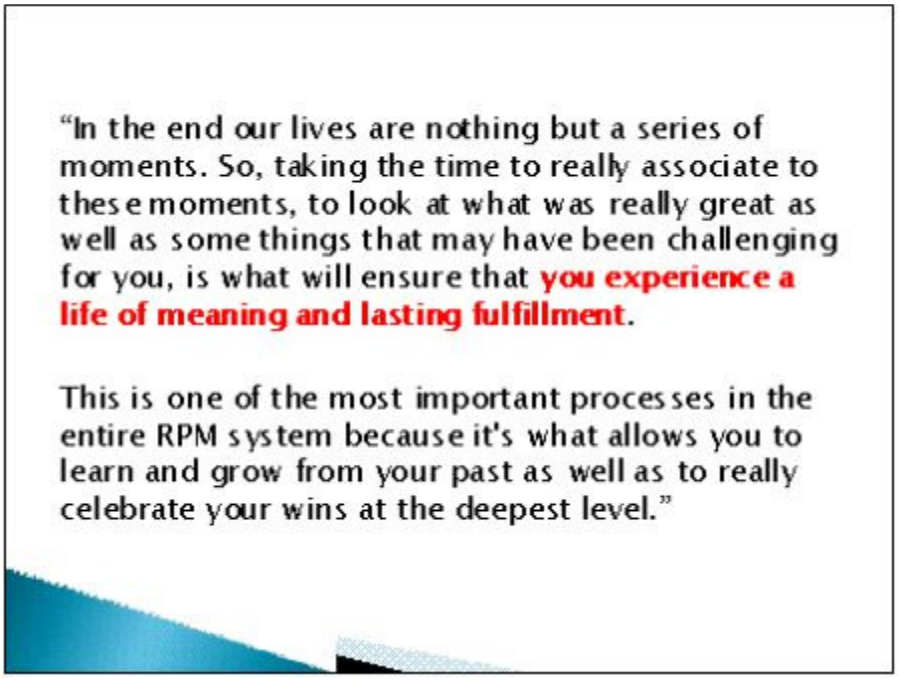

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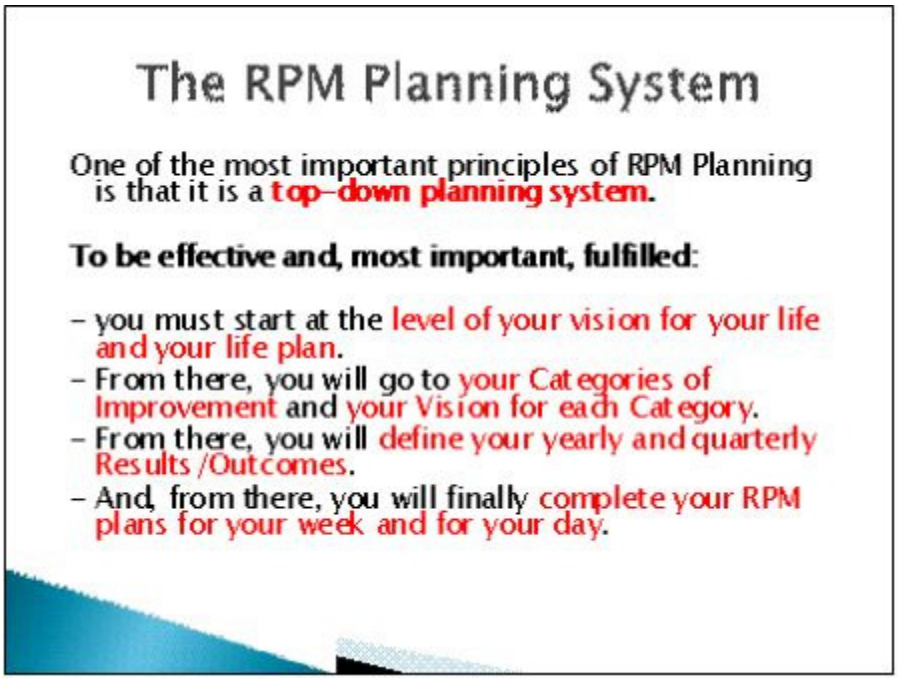

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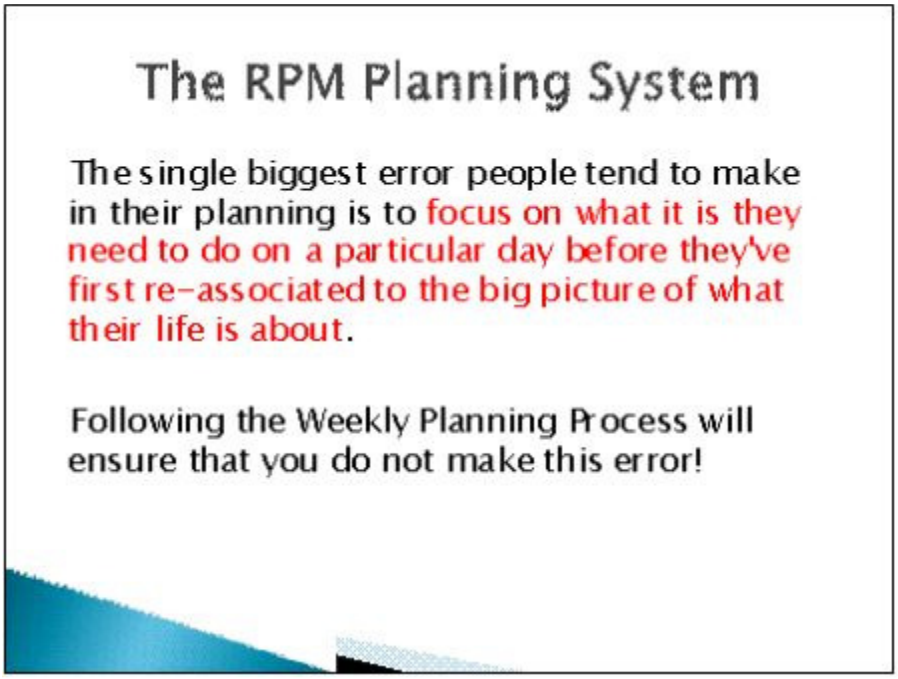

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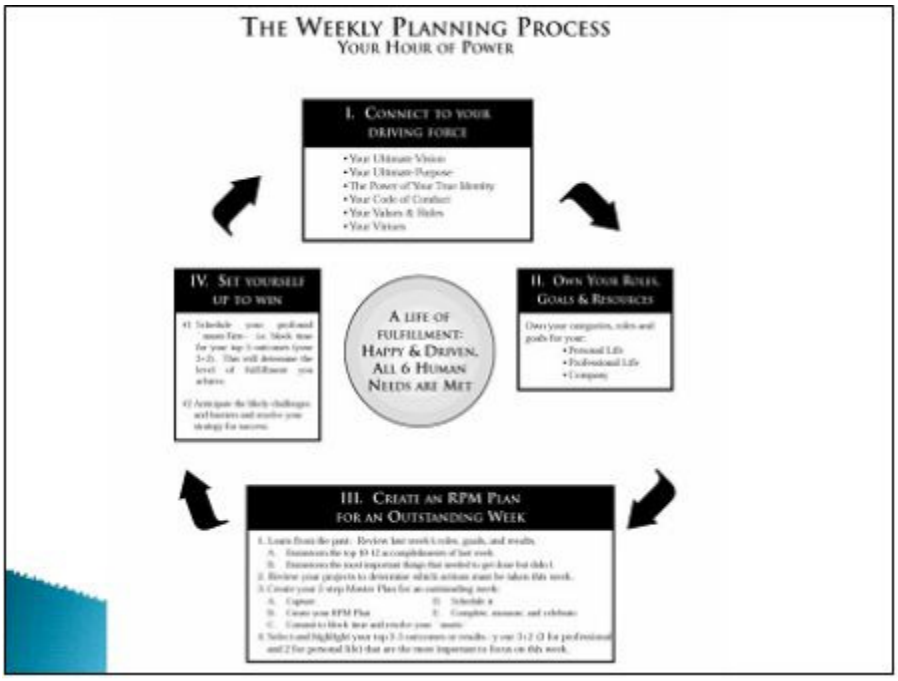

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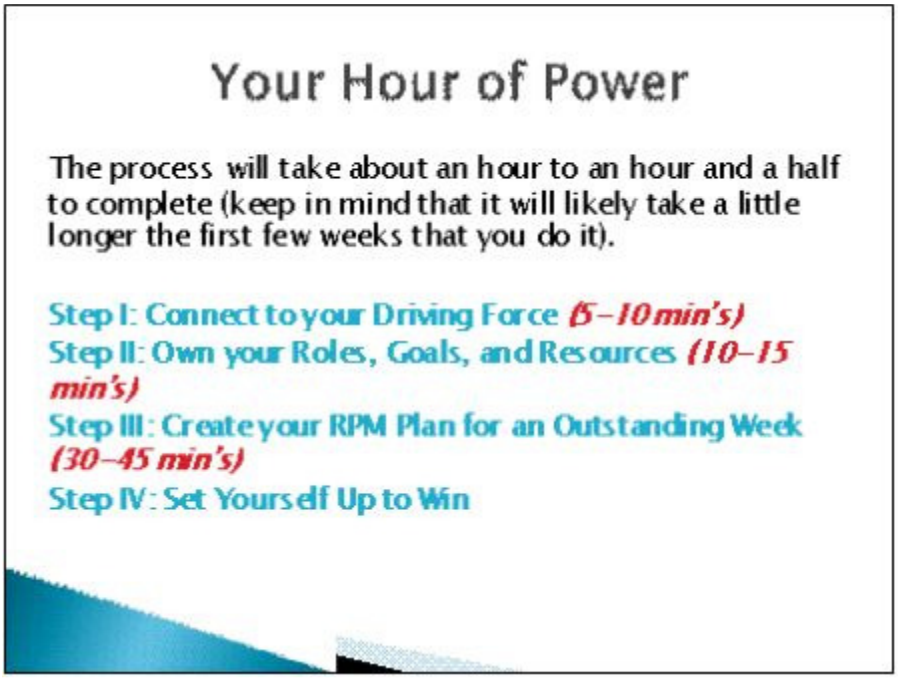

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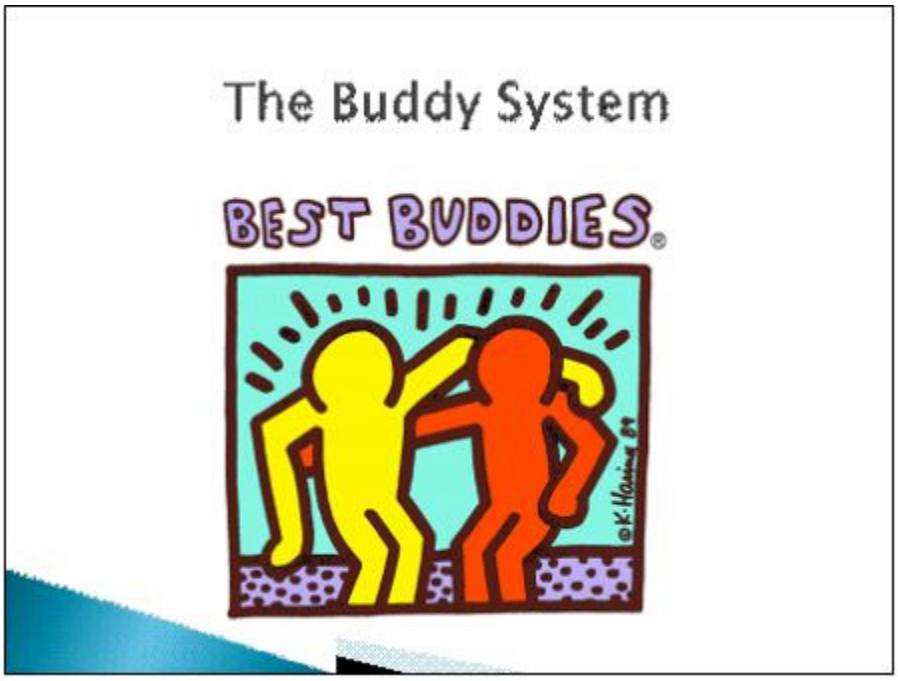

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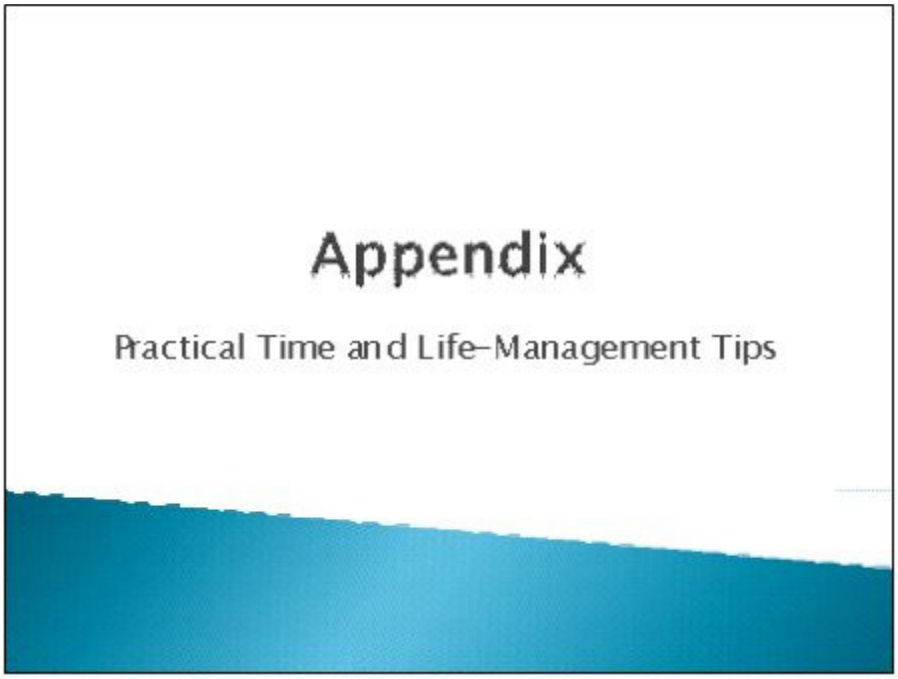


SLIDE 74

How to Formulate SMART Goals

SMART is a convenient acronym for the set of criteria that a goal must have in order for it to be realized by the goal achiever.

- SPECIFIC
- MEASURABLE
- ACHIEVABLE
- RELEVANT
- TIMED

SLIDE 75

And Don't Forget: The 3 P's

- POSITIVE
- PERSONAL
- POSSIBLE

SLIDE 76

Back to Elvis...

RESULT OR OUTCOME: To lose 20 pounds and enjoy the process of reaching my ideal weight and vitality.

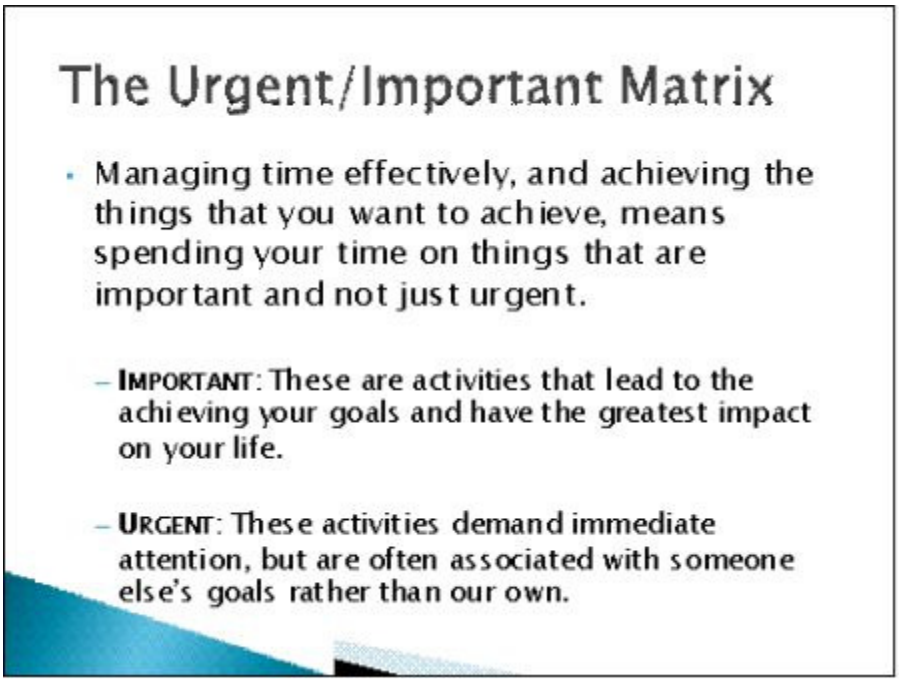
SMART GOAL: To lose 20 pounds in 3 months through eating more healthy foods and exercising regularly, and enjoy the process of reaching my ideal weight and vitality.

SLIDE 77

The Glass Jar: Rocks, Pebbles, Sand, and Water

- **ROCKS**: These represent your highest priority projects and deadlines with the greatest value, often *important, but not urgent* tasks that move you toward your goals.
- **PEBBLES**: These represent tasks that are *urgent, and important*.
- **SAND**: Now add sand to fill your jar. In other words, schedule *urgent, but not important* tasks, only after important tasks.
- **WATER**: Finally, pour water into your jar. These trivial time-wasters are neither important nor urgent.

SLIDE 78



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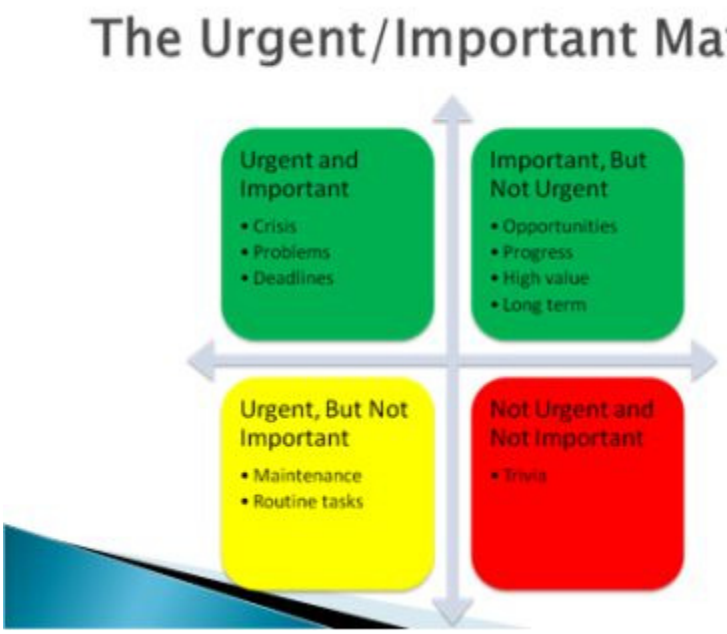


SLIDE 80

Why We Procrastinate

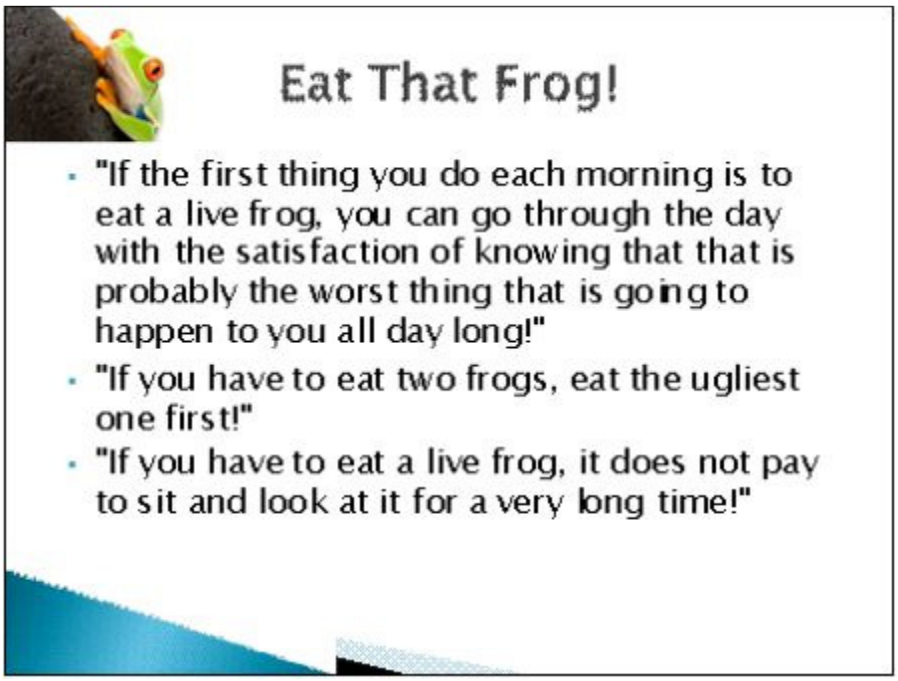
- No clear deadline
- Inadequate resources available
- Don't know where to begin
- Task feels overwhelming
- No passion for doing the work
- Fear of failure or success

SLIDE 81

Eight Ways to Overcome Procrastination

1. DELETE IT.
2. DELEGATE.
3. DO IT NOW.
4. ASK FOR ADVICE.
5. CHOP IT UP.
6. HAVE CLEAR DEADLINES.
7. GIVE YOURSELF A REWARD.
8. REMOVE DISTRACTIONS.

SLIDE 82



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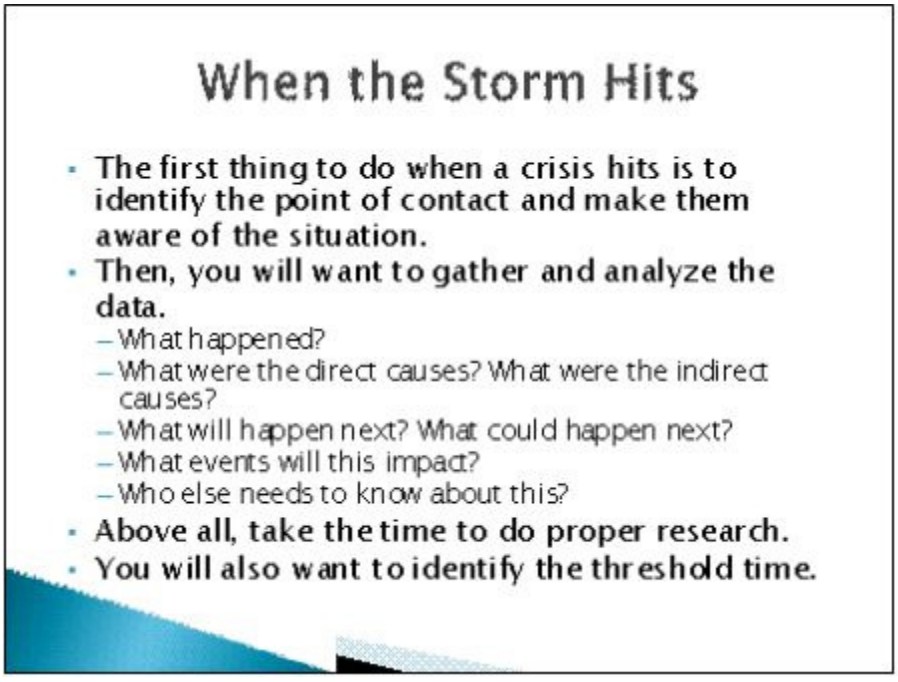


SLIDE 84

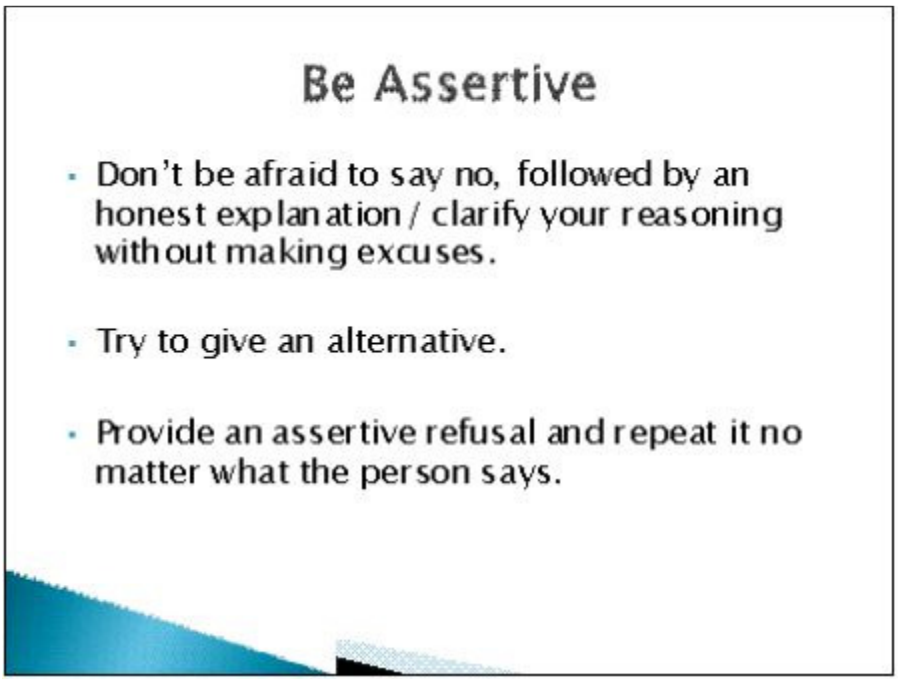
Lessons Learned

- After the crisis is over, take a moment to look at why it happened and how to prevent it in the future.
- You will likely find that you're always adjusting and perfecting your approach, so it is important to learn from the times where those tools don't work.
- You can even be prepared for other disasters and adjust accordingly.

SLIDE 85

De-Clutter!!!

SLIDE 86



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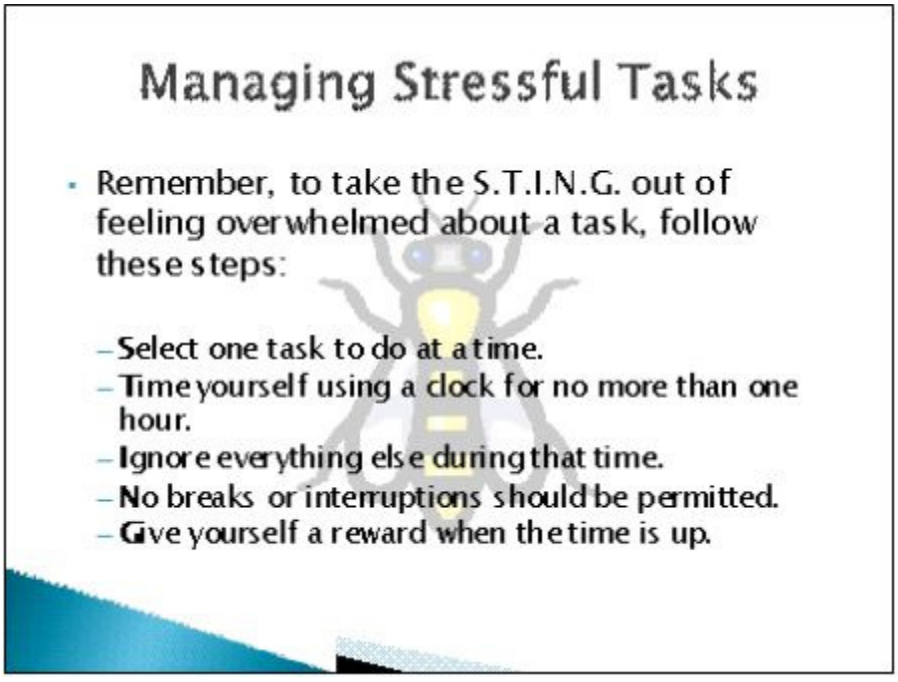

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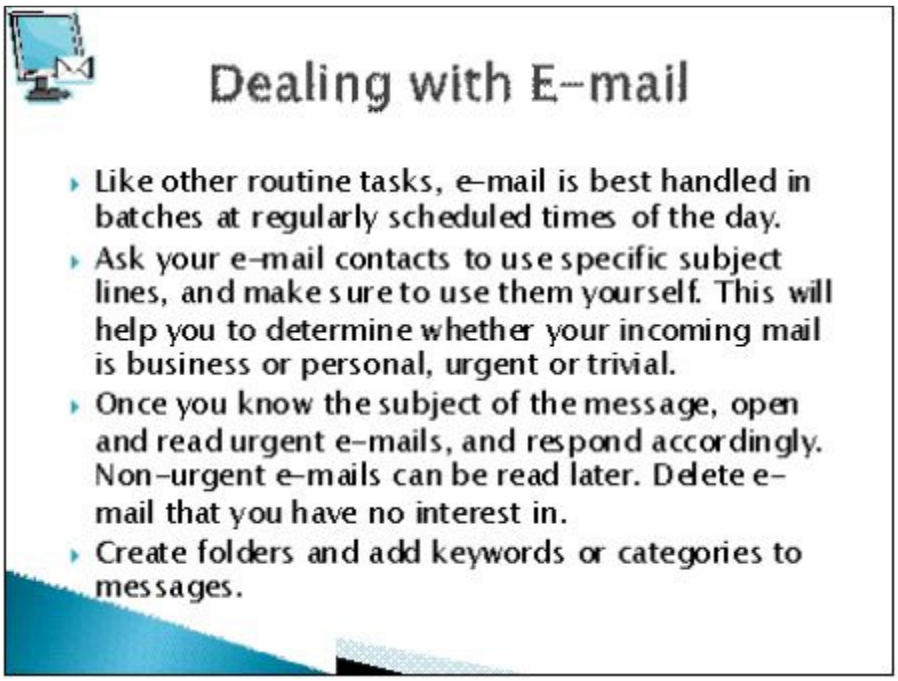

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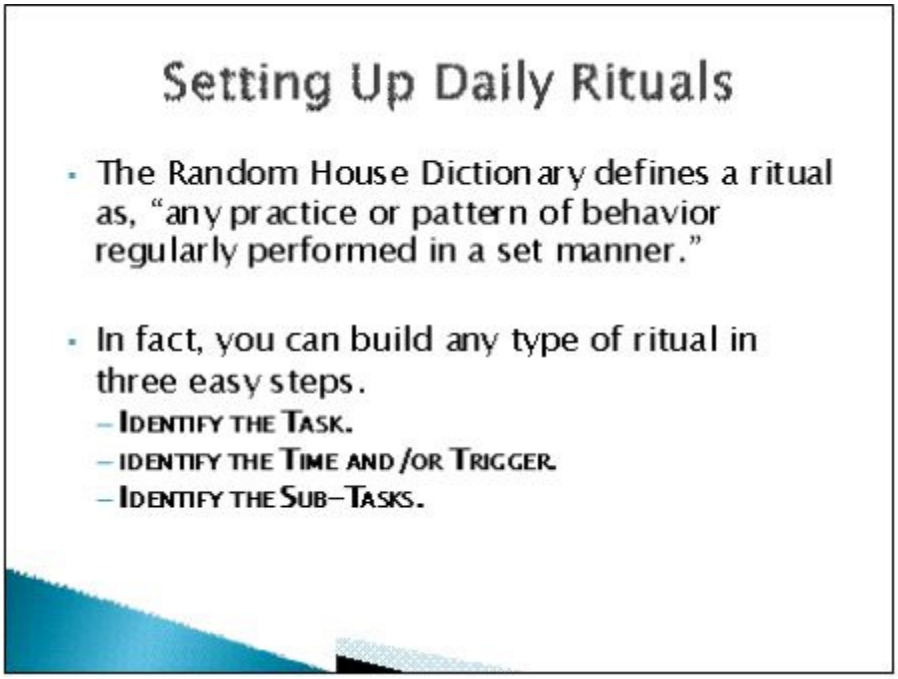

SLIDE 90

Setting Up Daily Rituals

- **SLEEP:**
  - Establish a ritual for half an hour before you sleep.
  - This might include praying, filling out your productivity journal for the next day, enjoying a cup of tea, taking a warm bath, performing some stretches...
  - All of these activities will help you wind down and sleep better.
  - It is best to try to go to bed at around the same time every night, too.
  - If you can have an hour of an afternoon nap, go for it!

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Setting Up Daily Rituals

- **MEALS:**
  - Take a half hour each weekend to plan meals for the next week, including lunches and suppers.
  - Make sure you always have a healthy, nutritious breakfast in the morning.
  - Spread apart your meals' and snacks' times through the day.
  - Healthy foods!
  - It's OK to sneak a "guilty-pleasure" meal once or twice a month, provided you maintain a balanced diet.

SLIDE 92

Setting Up Daily Rituals

- **EXERCISE:**
  - Try to exercise for one hour three times a week, or half an hour each day.
  - One easy way is to go for a brisk walk at lunch/evening, or do some stretching exercises before leaving in the morning.
  - The buddy system works well here! ;)

SLIDE 93

A Few General Tips

- Carry reading material wherever you go for waiting situations.
- Always include family/personal time in your week/day.
- Limit TV as much as possible.
- Work on your hobbies and develop your talents.
- Limit pointless chatter as much as possible.

SLIDE 94