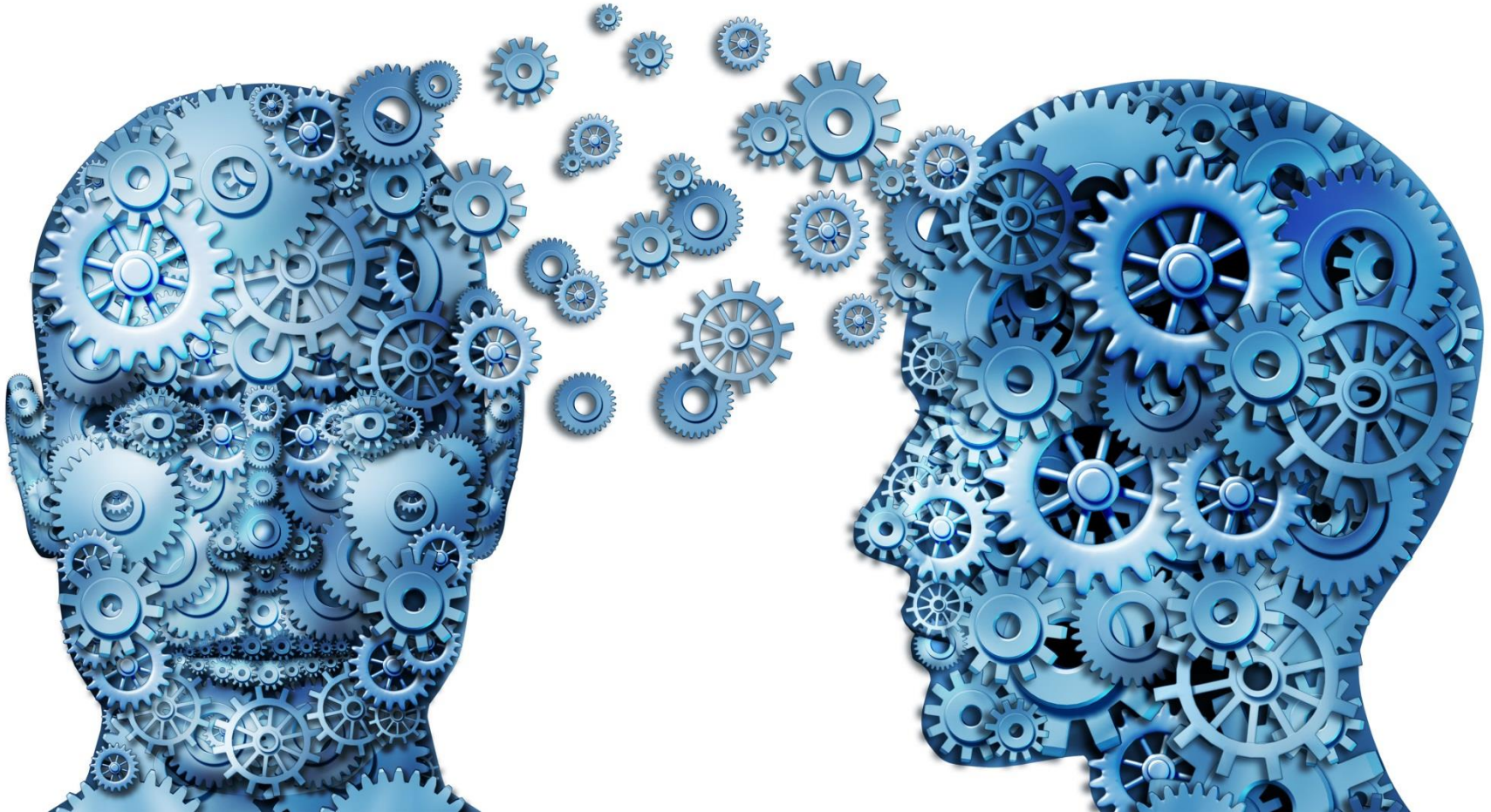
Concept Based Teaching



Concept Based Teaching

Introduction

Enduring Understandings

- Concepts help students to organise, understand and remember information.
- Concepts transcend disciplines and can allow students to make links between topics and disciplines.

Essential Questions

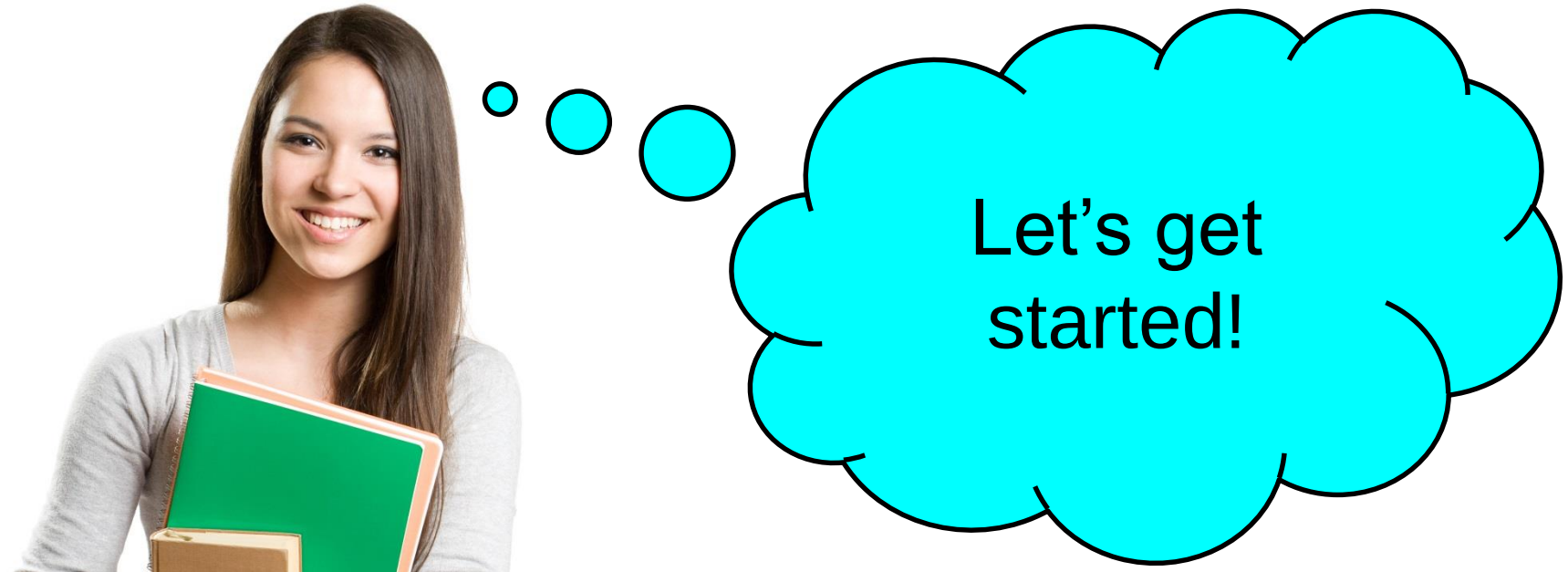
- What is a concept?
- Why use concept based teaching?
- How can I use concept based teaching in the classroom?

Concept Based Teaching

Introduction

John Dewey (1859 – 1952) argued that curriculum should be relevant to students' lives [authentic]. He saw learning by doing [applied learning] and development of practical life skills [21st century skills and 10Cs] as crucial to children's education.

Concept Based Teaching



Concept Based Teaching

- You have 30 seconds to study this list of objects before you are then asked to recall as many of them as possible.

Car	Rabbit	Japan
Horse	Piano	Dog
Plane	Chicken	Saxophone
Guitar	Singapore	Bus
Sheep	Helicopter	Drums
England	Australia	Cat
Violin	Train	Brazil
Thailand	Trumpet	Boat

Concept Based Teaching

What can you remember?

Concept Based Teaching

- The objects fall into four different categories; animals, countries, musical instruments and forms of transport.

Car	Rabbit	Japan
Horse	Piano	Dog
Plane	Chicken	Saxophone
Guitar	Singapore	Bus
Sheep	Helicopter	Drums
England	Australia	Cat
Violin	Train	Brazil
Thailand	Trumpet	Boat

Concept Based Teaching

- Establishing what the objects have in common, and organising them into categories, helps to remember them.

Car	Rabbit	Japan
Horse	Piano	Dog
Plane	Chicken	Saxophone
Guitar	Singapore	Bus
Sheep	Helicopter	Drums
England	Australia	Cat
Violin	Train	Brazil
Thailand	Trumpet	Boat

Concept Based Teaching

- Establishing what the objects have in common, and organising them into categories, helps to remember them.

Cat	Chicken	Dog
Horse	Rabbit	Sheep
Australia	Brazil	England
Japan	Singapore	Thailand
Drums	Guitar	Piano
Saxophone	Trumpet	Violin
Boat	Bus	Car
Helicopter	Plane	Train

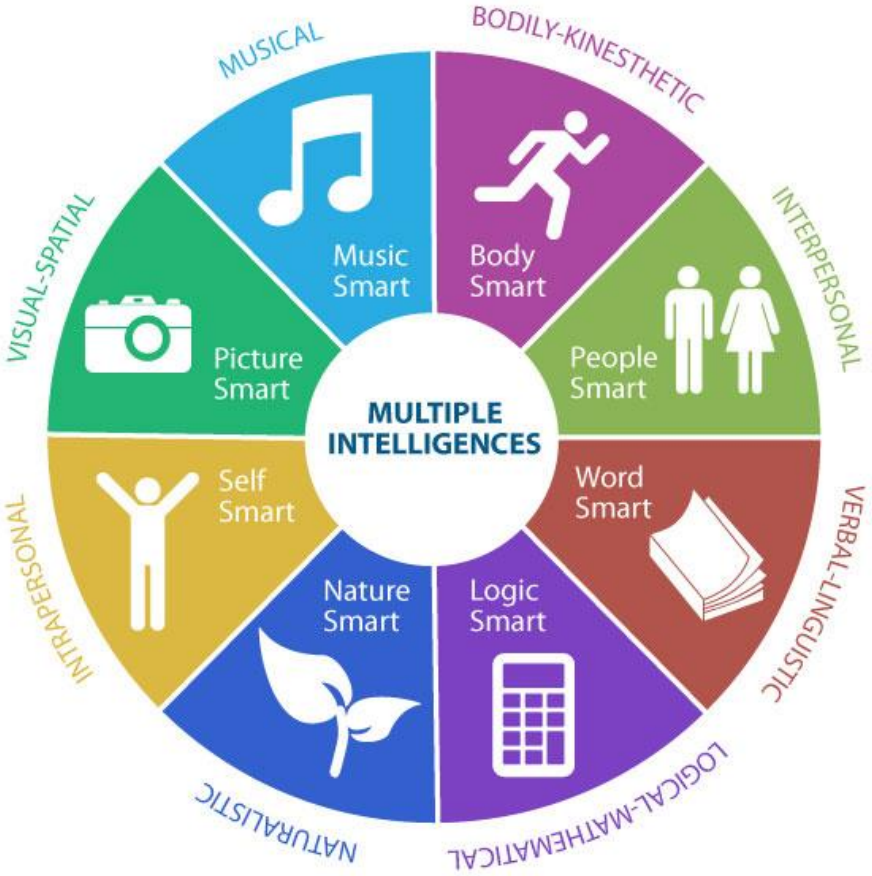
Concept Based Teaching

Isn't it human nature to classify, group and organise things?

Concept Based Teaching

Howard Gardner (Harvard Graduate School of Education) has proposed that humans have different kinds of intellectual strengths. This is known as the *theory of multiple intelligences*.

Concept Based Teaching



- Howard Gardner's theory of multiple intelligences.

Concept Based Teaching

What is a *concept* ?

Concept Based Teaching

What is a Concept?

- A concept is:

→ A general idea.

→ Which represents a class of people, items, actions or relationships.

→ Having certain defined characteristics.

Concept Based Teaching

Examples of Concepts

- Biology: Cell.
- Chemistry: Acid.
- Geography: Lake.
- Mathematics: Probability.
- Physics: Energy.
- Social Studies: Family.

Concept Based Teaching

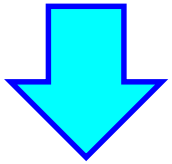
Elements of a Concept

- Name.
- Critical attributes (essential characteristics of the concept).
- Value range of the critical attributes (acceptable variation of the characteristics).
- Examples.
- Non-examples.

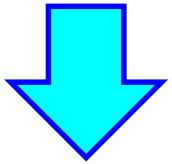
Concept Based Teaching

Concepts in the Building Blocks of Knowledge

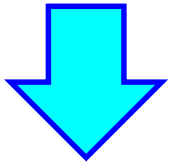
- Facts



- Concepts



- Principles / Rules / Generalisations



- Theories

Concept Based Teaching

Why place emphasis on *concept based teaching* ?

Concept Based Teaching

For Learners:

- Research has shown that the human brain seeks to structure information.
- Concept based learning allows the brain to:

→ Organise information.

→ Accommodate new information.

→ Retain key information better in the long-term.

Concept Based Teaching

For High-ability Learners:

- Research shows that high-ability learners have intellectual sophistication.
- Concept based learning allows them to:

→ Handle in-depth learning.

→ Manipulate conceptual schemata.

Concept Based Teaching

For Teachers:

- Compact the curriculum:

→ Focus on key concepts.

- Promote higher-order thinking:

→ Critical, creative and reflective thinking.

Concept Based Teaching

For Schools with High Ability Learners:

- Integrate the curriculum:

→ Use of unifying concepts for inter-disciplinary studies.

Concept Based Teaching

For Life:

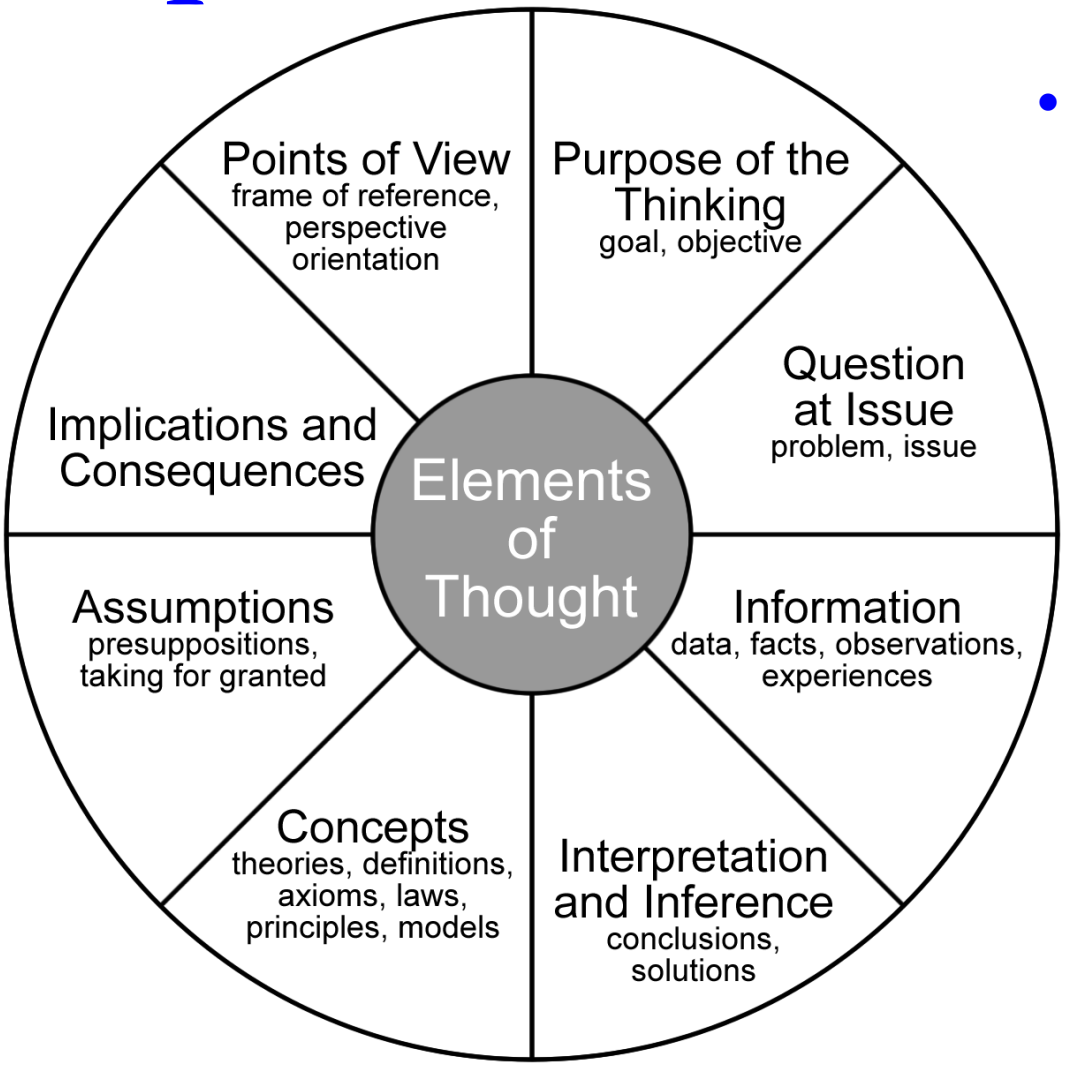
- Manage the information explosion in the rapidly changing and globalising world of the 21st Century.

Concept Based Teaching

Please remind me, what is *critical thinking*?

- Thinking about your thinking while you are thinking.

Concept Based Teaching



- Richard Paul's Wheel of Reason.

- www.chemist.sg/critical_thinking/index.html

Concept Based Teaching

How do I teach *concepts* in the classroom?

Concept Based Teaching

How to Carry Out Concept Based Teaching?

Deductive (Rule-to-Example) Approach

- Consists of teacher *first naming* and *defining* the concept, and then providing students with examples and non-examples to reinforce their understanding of the concept. Focus is on labeling and defining the concept.

Concept Based Teaching

How to Carry Out Concept Based Teaching?

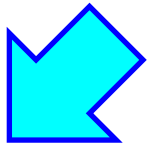
Inductive (Example-to-Rule) Approach

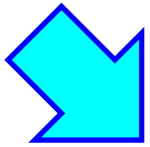
- *Examples* and *non-examples* of a particular concept are given *first*, and students discover or attain the concept themselves through the process of inductive reasoning. Labeling and defining the concept comes at the end rather than at the beginning of the lesson.

Concept Based Teaching

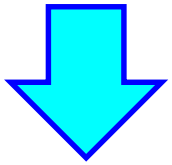
How to Carry Out Concept Based Teaching?

- Concept Teaching





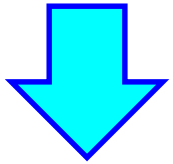
- Deductive Teaching



- From Definition

→ Apply to Examples

- Inductive Teaching



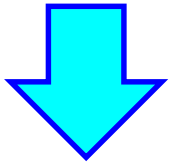
- From Examples and Non-examples

→ Formulate Definition

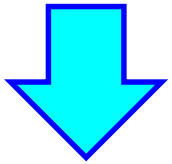
Concept Based Teaching

How to Carry Out Concept Based Teaching?

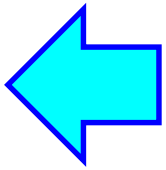
- Concept Teaching



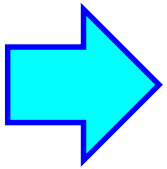
- Inductive Teaching



- From Examples and Non-examples
→ Formulate Definition



- Concept Attainment Model (Jerome Bruner). Concept NOT given.



- Concept Development Model (Hilda Taba). Concept IS given.

Concept Based Teaching

Teaching Concepts – One Possible Approach

- **Step 0:** Prepare the classroom and the materials / resources for the lesson. Students need to be seated in groups, arranged so that they can all see each other. Materials / resources include mah-jong paper, marker pens, Blu-tac, Post-It Notes, www.wallwisher.com or www.linoit.com class page.

- **Step 1:** Inform the students about the concept that is going to be discussed, developed and defined.

Concept Based Teaching

Teaching Concepts – One Possible Approach

- **Step 2 a:** Students brainstorm and list words and terms that are associated with the concept. This can be discussed and written on a common piece of paper, or done individually and written on Post-It Notes.
- **Step 2 b:** Alternatively, students can be given examples and non-examples of the concept by the teacher in order to stimulate their thinking.

- **Step 3:** Students group together words / terms with common characteristics (classification).

- **Step 4:** Students label each group with a title that accurately describes its content.

Concept Based Teaching

Teaching Concepts – One Possible Approach

- **Step 5:** Students examine the groups that they have created and consider:

a) Do all items truly belong in that group? Do any items need to be moved to another group or deleted (*e.g.* non-examples)?

b) Are any of the groups so similar that they can be merged into one?

c) Are any items in one group so diverse that the group should be split?

d) Are there any groups that now appear to be out-of-place and should be deleted?

Concept Based Teaching

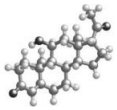
Teaching Concepts – One Possible Approach

- **Step 6:** Students repeat **Step 5** until the process has been exhausted.

- **Step 7:** Using the titles that label / define each one of the groups, students develop generalisations about the concept.

- **Step 8:** Students write a statement that defines the concept. The statement should be an accurate, brief and concise definition of the concept.

Concept Based Teaching



Chem!stry

Name: ..... ( )
Class: .....
Date: ..... / ..... / .....

Hilda Taba's Model of Concept Development

- **Step 0:** Prepare the classroom and the materials / resources for the lesson. Students need to be seated in groups, arranged so that they can all see each other. Materials / resources include mah-jong paper, marker pens, Blu-tac, Post-It Notes, www.wallwisher.com or www.linoit.com class page.

- **Step 1:** Identify the concept that is going to be discussed and developed by the students.

- **Step 2:** Students brainstorm and list words and terms that are associated with the concept. This can be discussed and written on a common piece of paper, or done individually and written on Post-It Notes.

- **Step 3:** Students group together words / terms with common characteristics.

- **Step 4:** Students label each group with a title that accurately describes its content.

- **Step 5:** Students examine the groups that they have created and consider:
a) Do all items truly belong in that group? Do any items need to be moved to another group or deleted (*e.g.* non-examples)?
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- **Step 6:** Students repeat **Step 5** until the process has been exhausted.

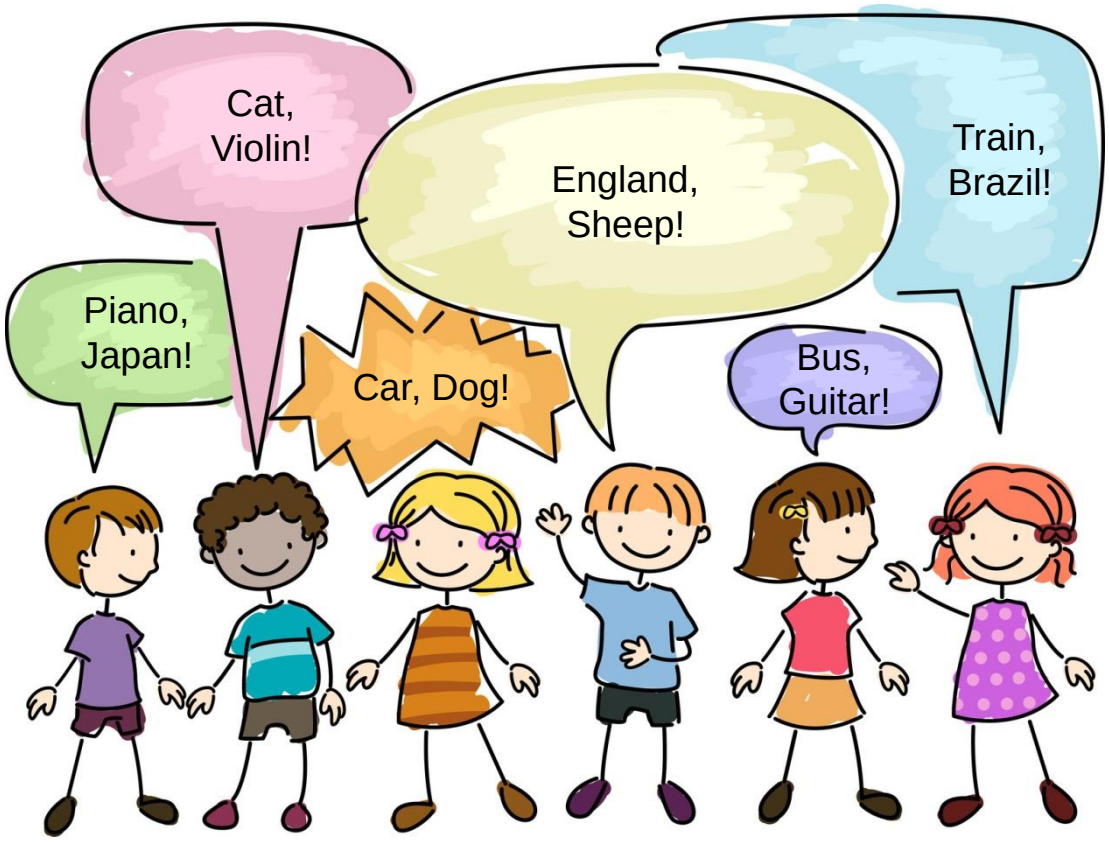
- **Step 7:** Using the titles that label / define each one of the groups, students develop generalisations about the concept.

- **Step 8:** Students write a statement that defines the concept. The statement should be an accurate, brief and concise definition of the concept.

Concept Based Teaching

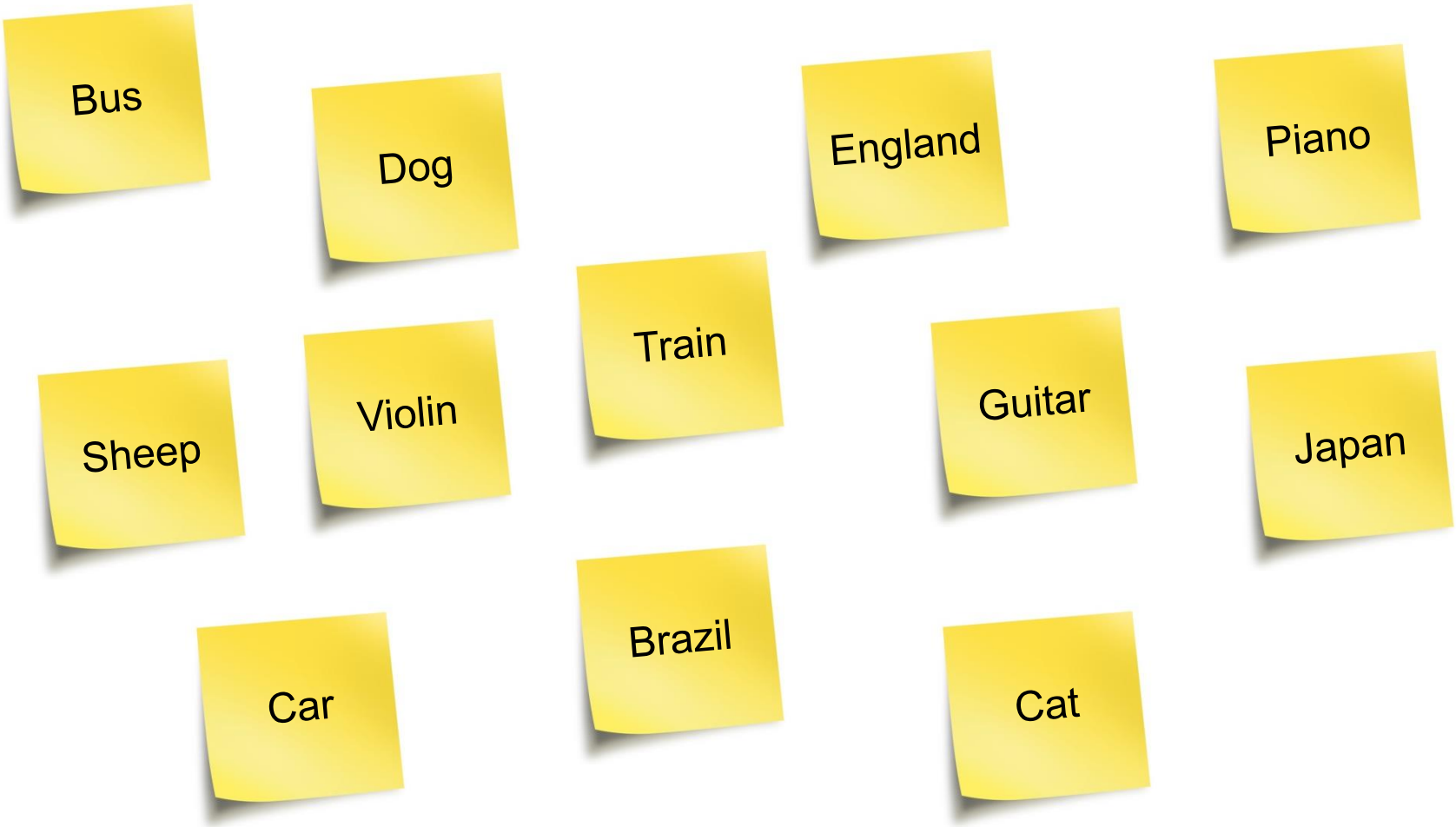
Teaching Concepts – Another Approach

- At the end of a class discussion, group students' ideas to develop concepts.



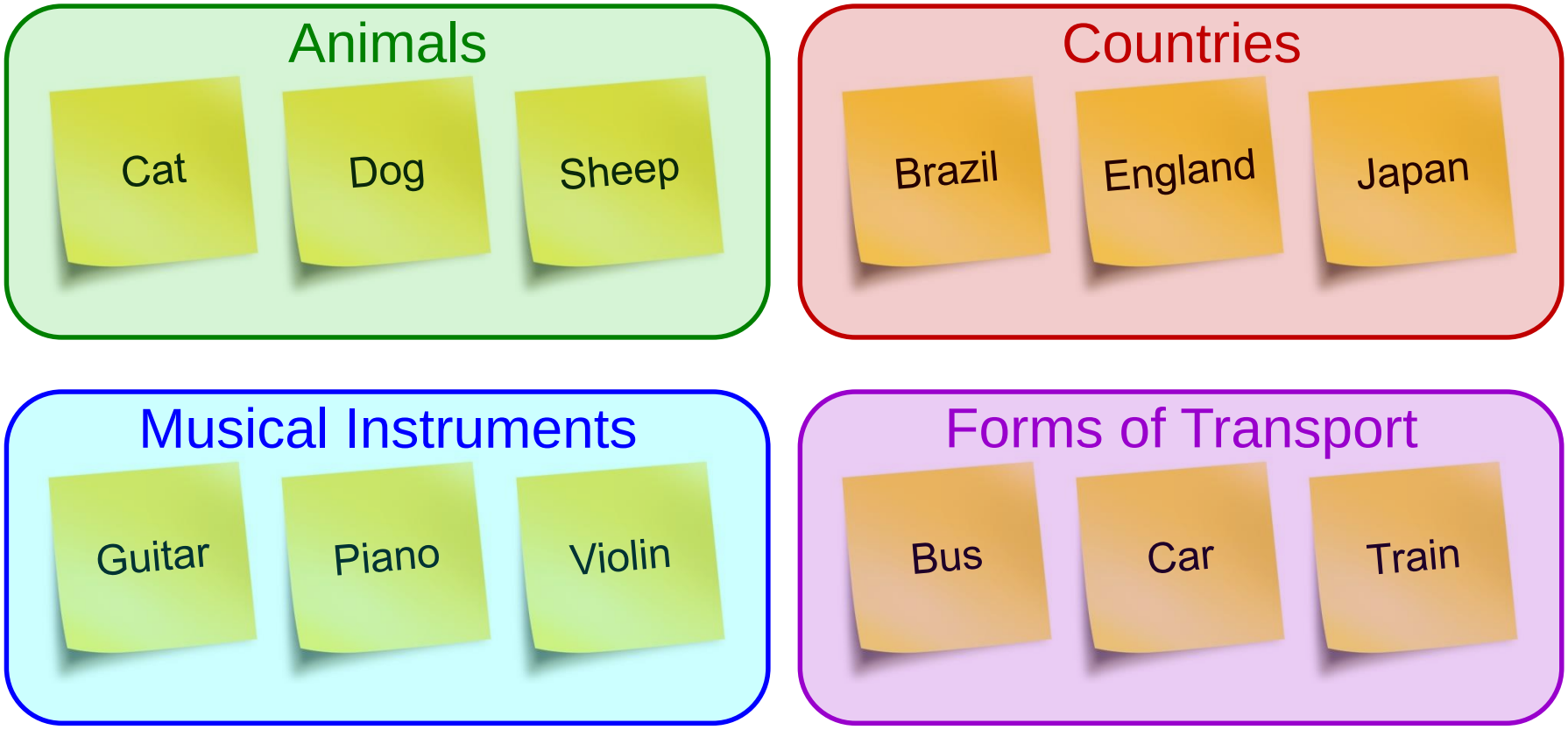
Concept Based Teaching

Teaching Concepts – Another Approach



Concept Based Teaching

Teaching Concepts – Another Approach



www.padlet.com and www.linoit.com

Concept Based Teaching

Could I please have a *simple* example?

- This example follows the *Concept Development Model* (proposed by Hilda Taba) which is an *inductive* approach. The concept is named and – by using examples and non-examples – a definition of the concept is developed.

Concept Based Teaching

1) The following pictures represent *examples* of the concept of "*maison*". Examine them carefully to identify the *critical attributes* of a "*maison*".

- All images taken, with permission, from Shutter Stock – http://www.shutterstock.com

Concept Based Teaching

Concept Based Teaching

Concept Based Teaching

Concept Based Teaching

Concept Based Teaching

Concept Based Teaching

Concept Based Teaching

2) Discuss with your group members to identify the critical attributes of a "*maison*".

3) Discuss with your group members to derive a commonly agreed definition statement for the concept of "*maison*".

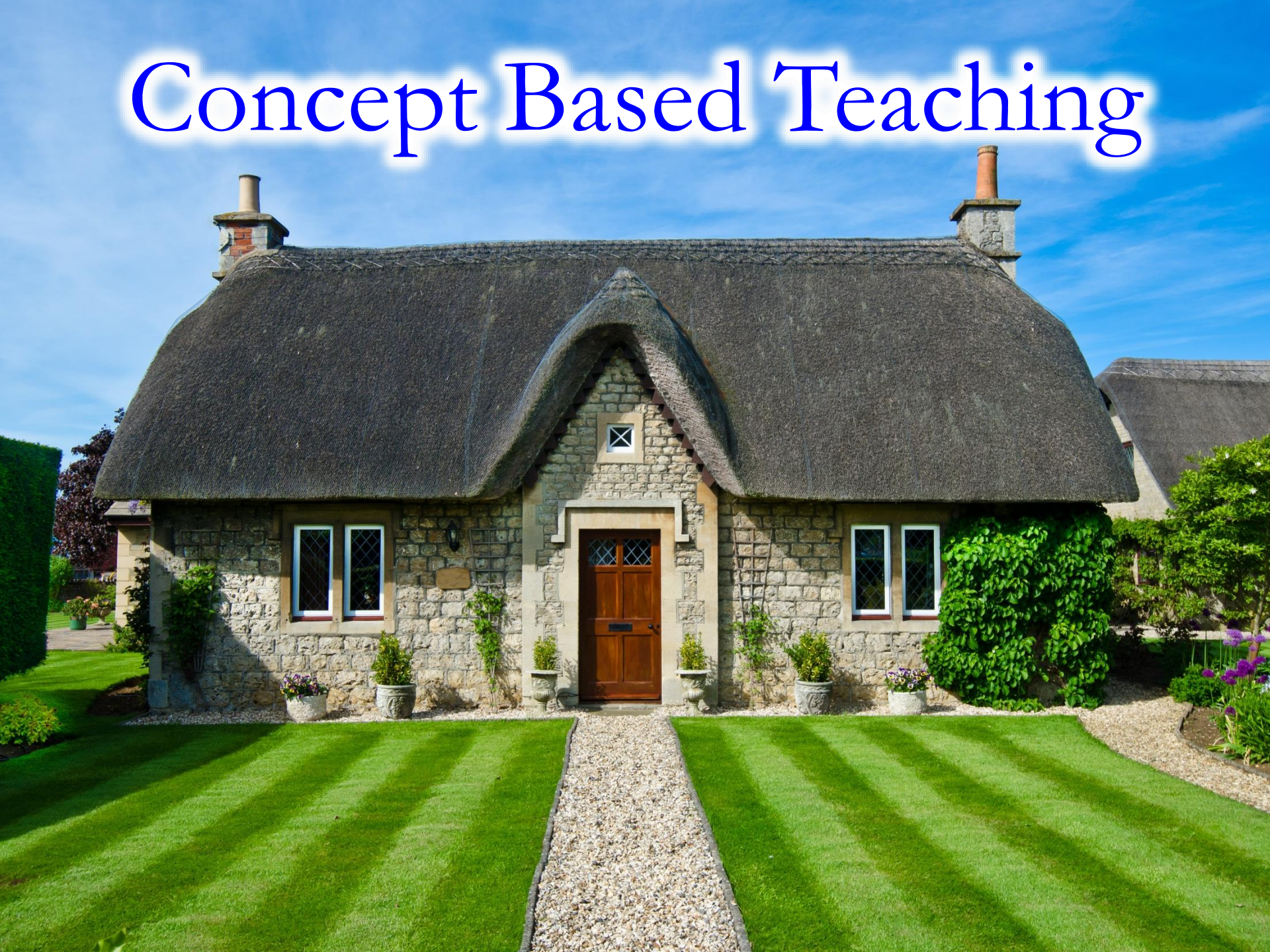
Concept Based Teaching

Concept Based Teaching

4) The following pictures represent *non-examples* of the concept of "*maison*".

- How adequate is your definition and understanding of "*maison*" as described in **3)** in helping you to discriminate the following items as *non-examples*?

Concept Based Teaching



Concept Based Teaching

Concept Based Teaching

Concept Based Teaching

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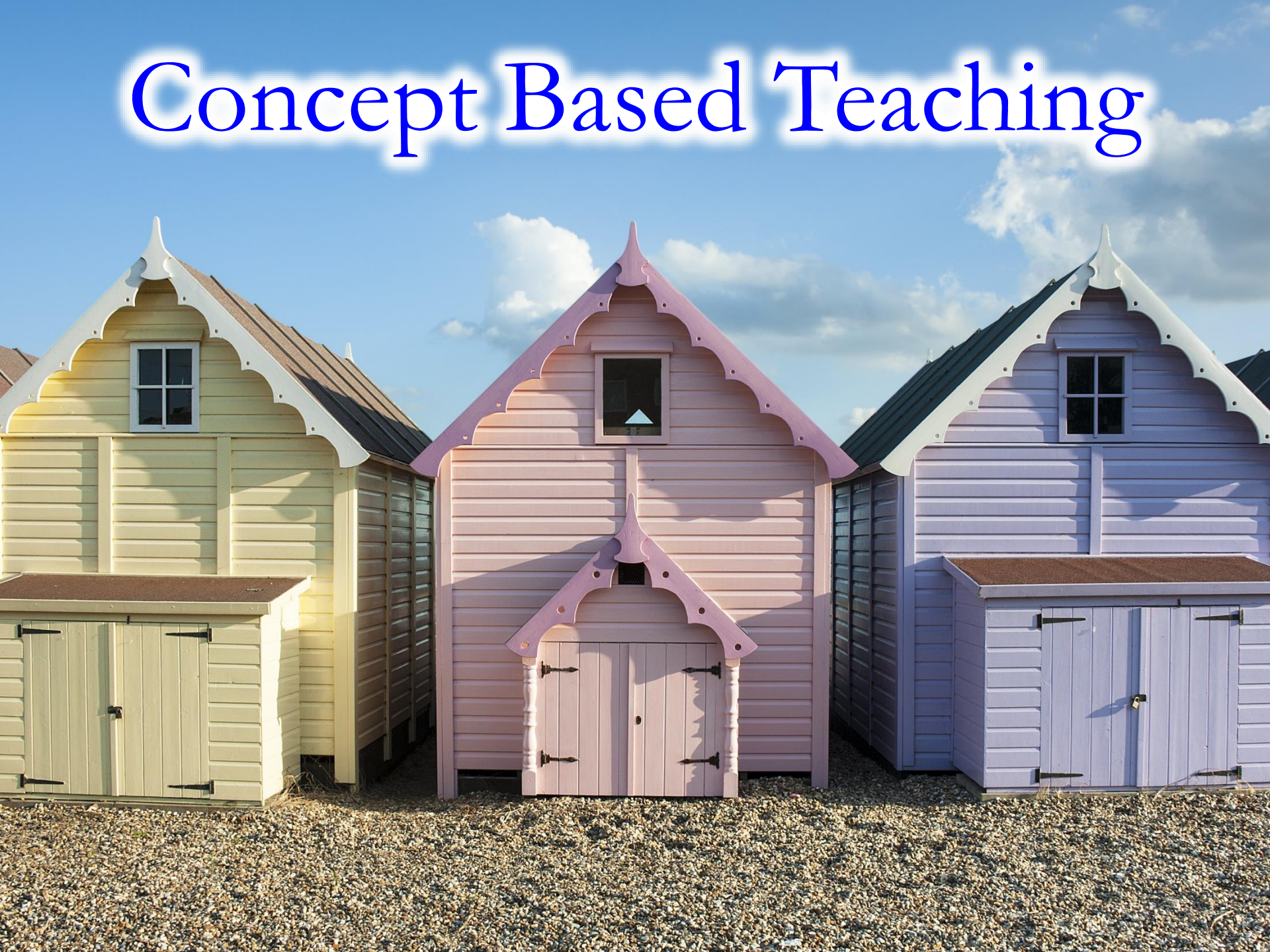

Concept Based Teaching

5) What revisions would you make to clarify your understanding of the concept of "*maison*".

Concept Based Teaching

Concept Based Teaching

6) Now put your development of the concept of "*maison*" into practice.

- Which of the following would you confidently classify as a "*maison*"?

Concept Based Teaching

Concept Based Teaching

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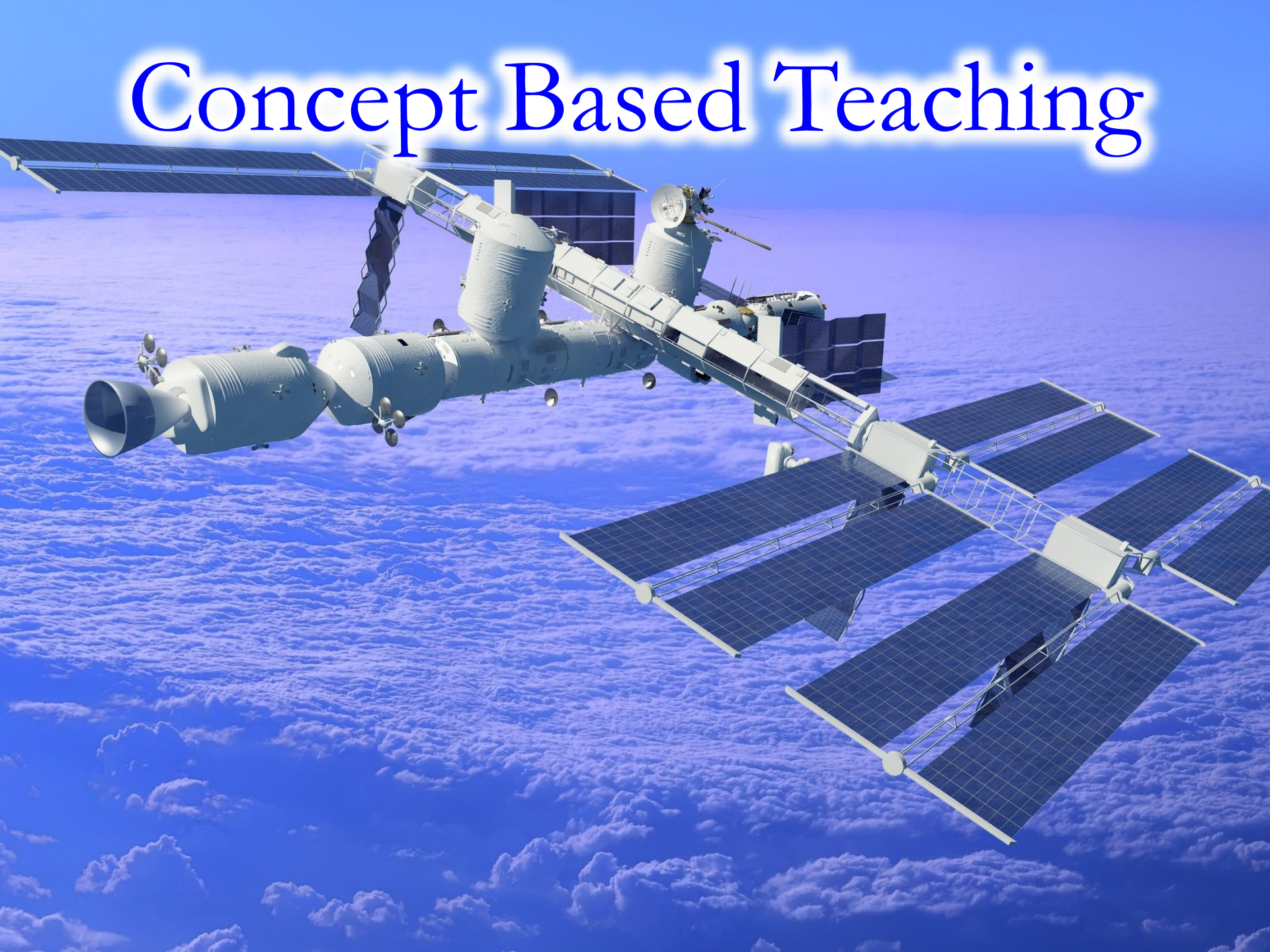

Concept Based Teaching

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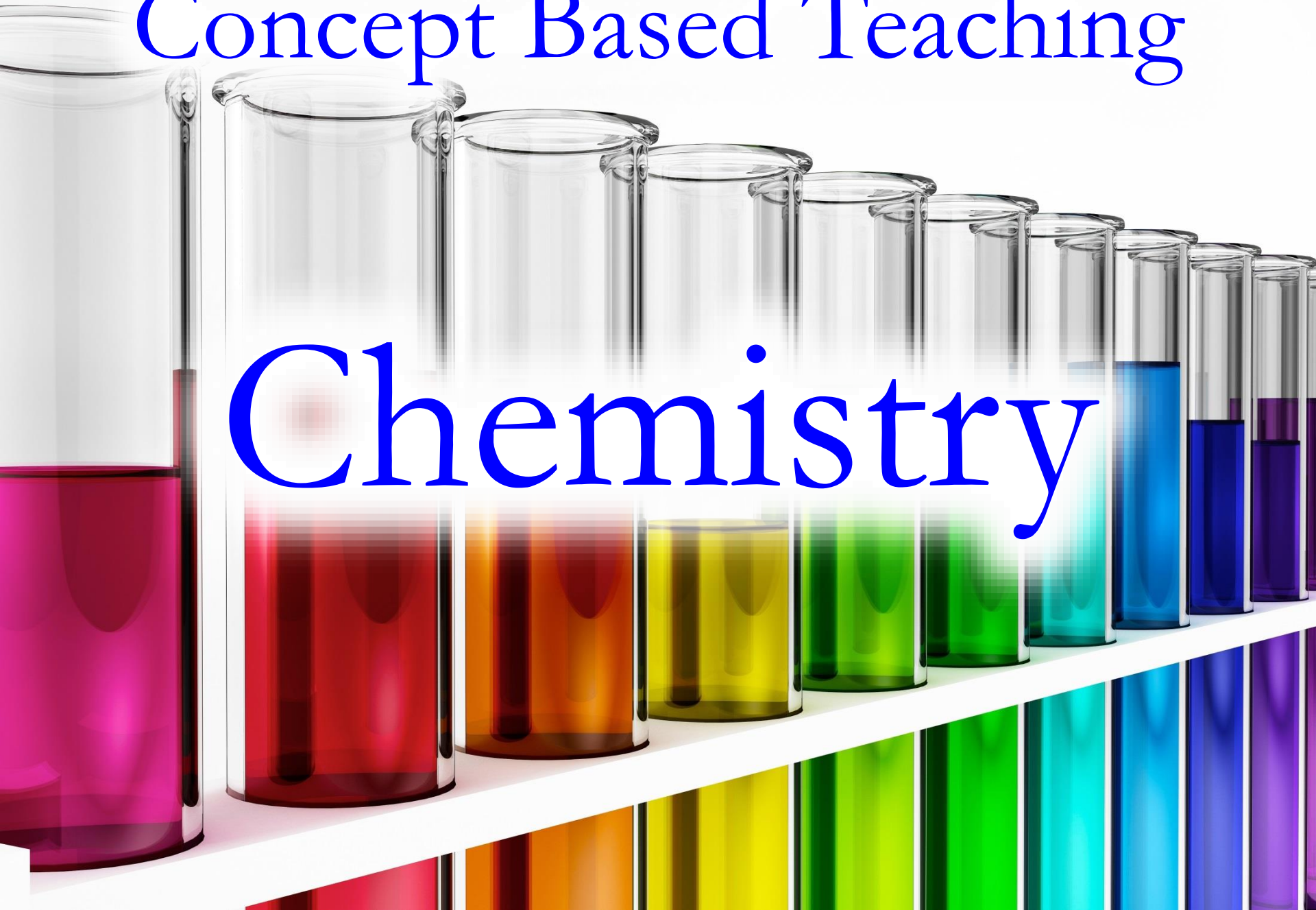


Chemistry

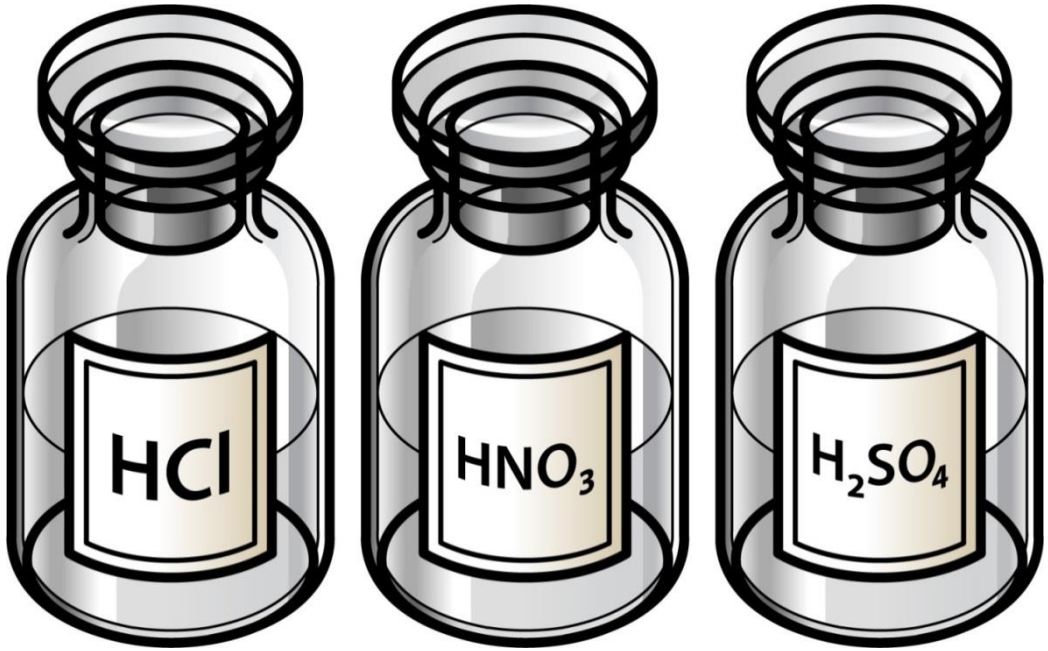
Concept Based Teaching

Developing the Concept of “Acid”

What are some common examples of *acids*?

Concept Based Teaching

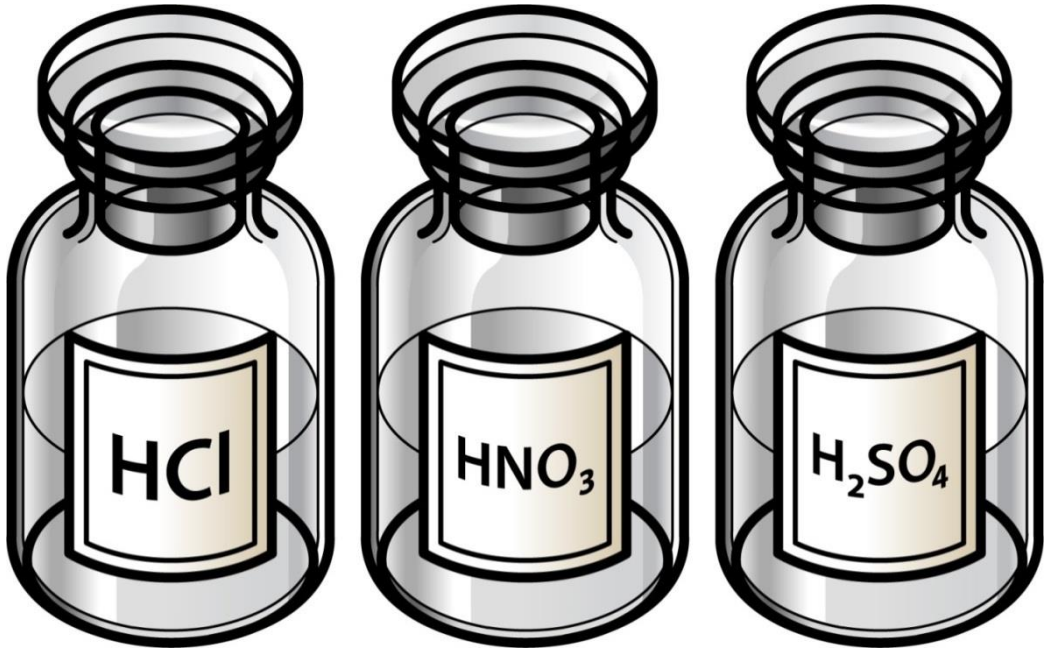
Developing the Concept of "Acid"



- Hydrochloric Acid, $HCl_{(aq)}$
- Nitric Acid, $HNO_{3(aq)}$
- Sulfuric Acid, $H_2SO_{4(aq)}$

Concept Based Teaching

Developing the Concept of "Acid"



Other examples include: • Phosphoric acid, $H_3PO_{4(aq)}$
• Ethanoic acid, $CH_3COOH_{(aq)}$ • Citric acid, $C_6H_8O_7$

Concept Based Teaching

Developing the Concept of “Acid”

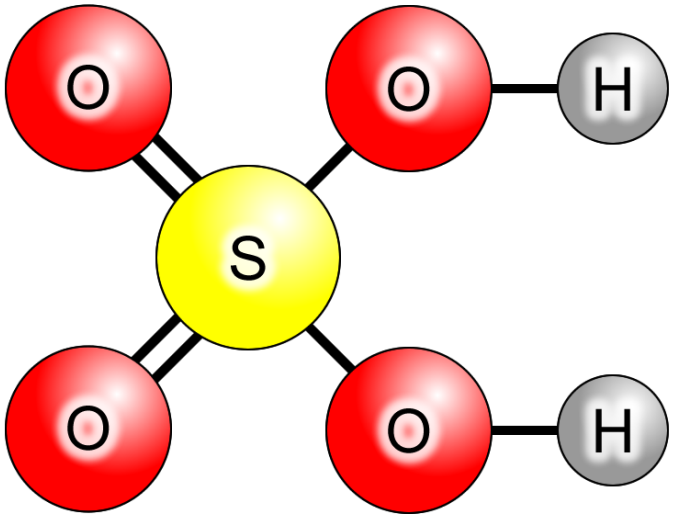
What property must a chemical have in order to be classified as an *acid*?

- Consider the following examples. Think about what they all have in common.

Concept Based Teaching

Developing the Concept of “Acid”

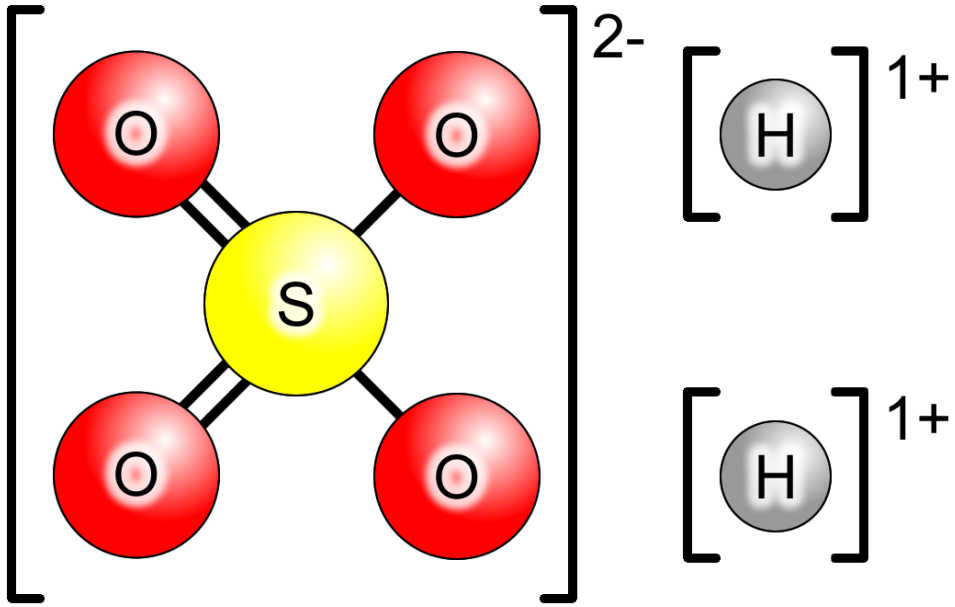
- Pure sulfuric acid:



Concept Based Teaching

Developing the Concept of “Acid”

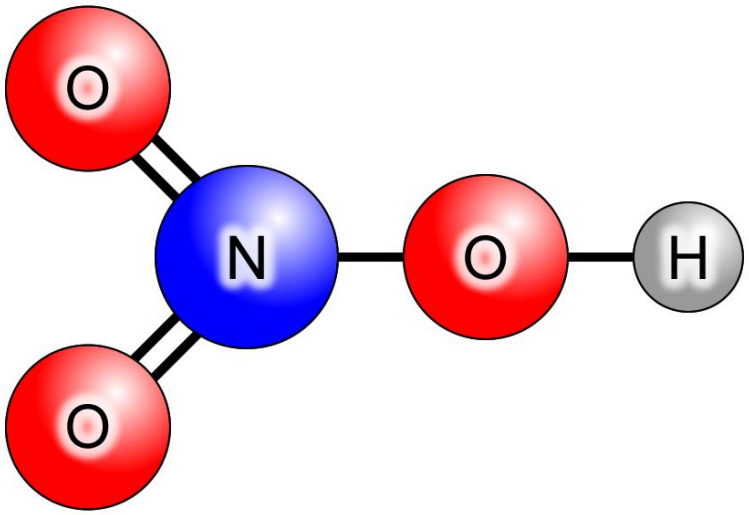
- Sulfuric acid dissolved in water:



Concept Based Teaching

Developing the Concept of “Acid”

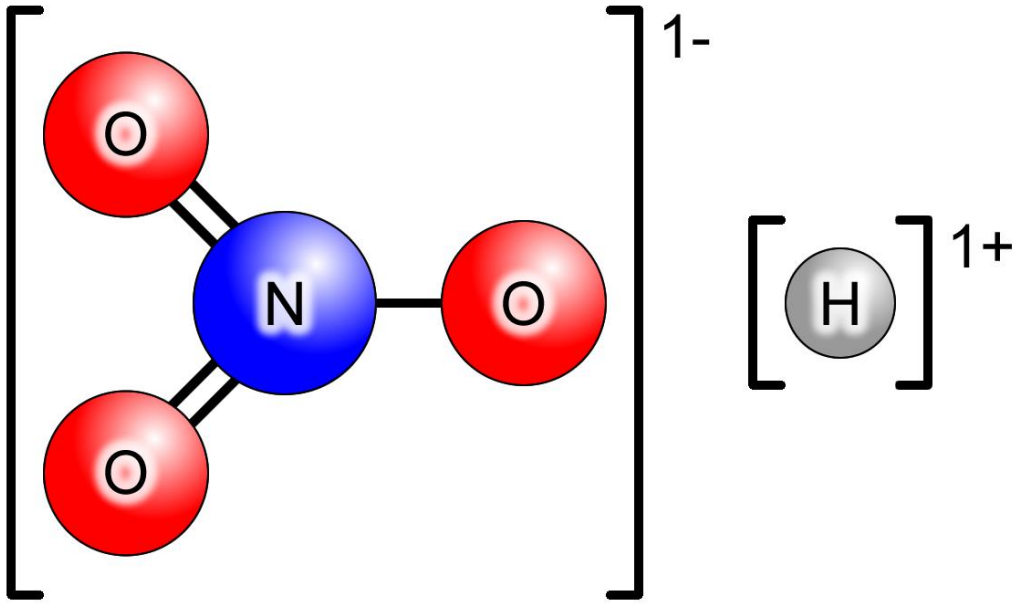
- Pure nitric acid:



Concept Based Teaching

Developing the Concept of “Acid”

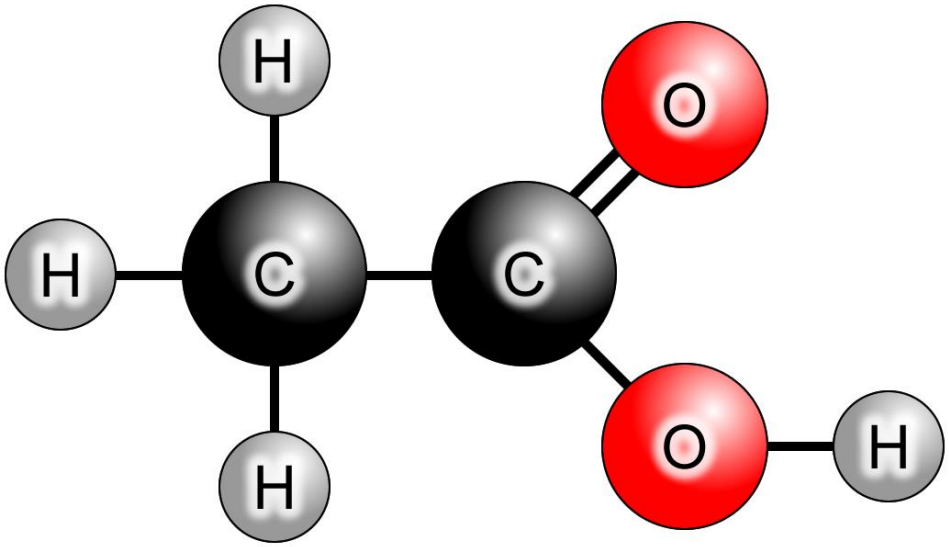
- Nitric acid dissolved in water:



Concept Based Teaching

Developing the Concept of “Acid”

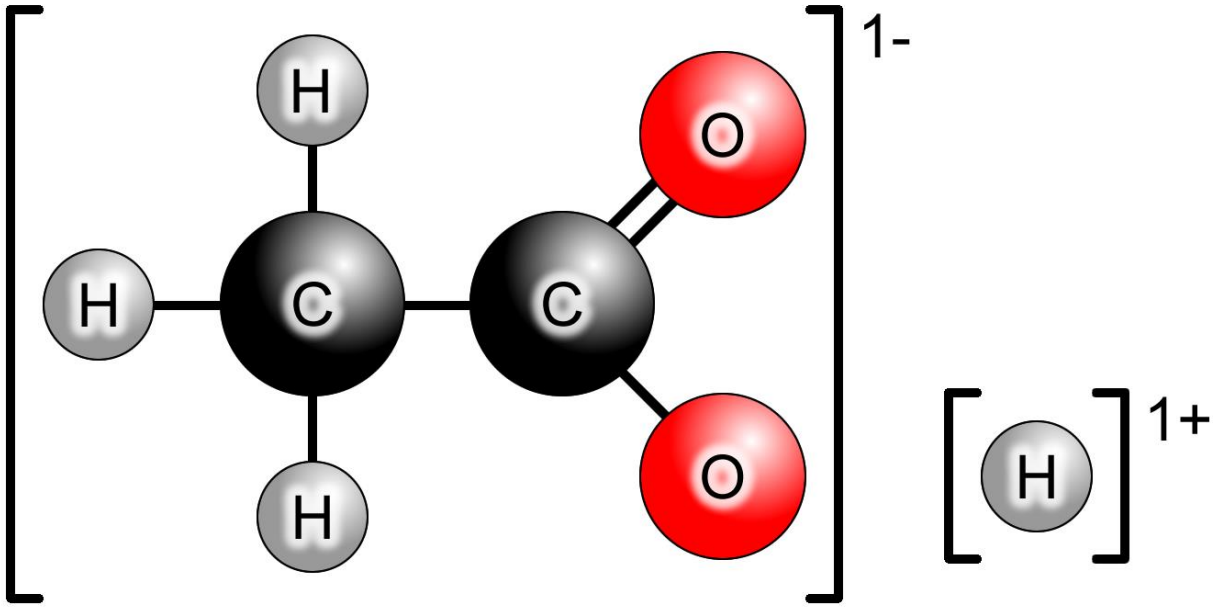
- Pure ethanoic acid:



Concept Based Teaching

Developing the Concept of “Acid”

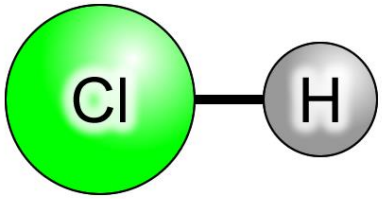
- Ethanoic acid dissolved in water:



Concept Based Teaching

Developing the Concept of “Acid”

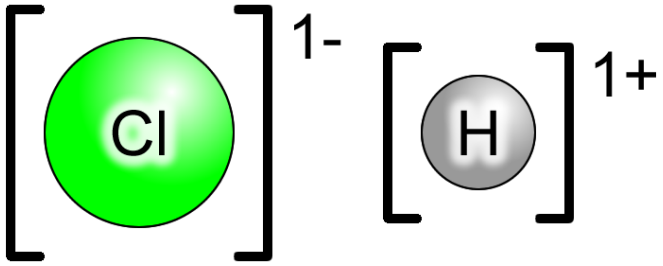
- Pure hydrogen chloride:



Concept Based Teaching

Developing the Concept of “Acid”

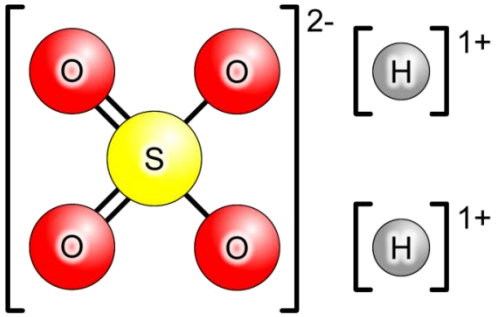
- Hydrogen chloride dissolved in water (hydrochloric acid):

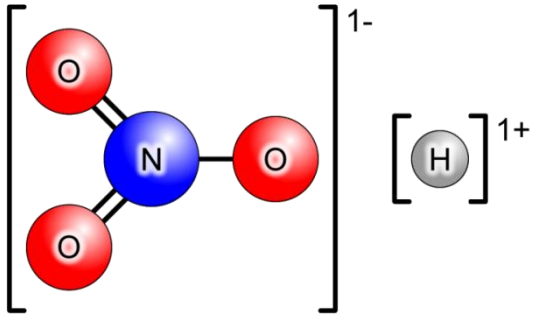


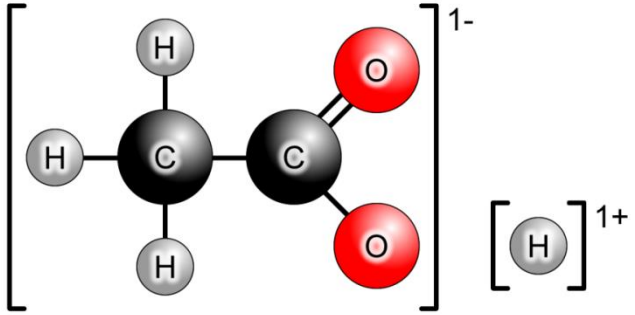
Concept Based Teaching

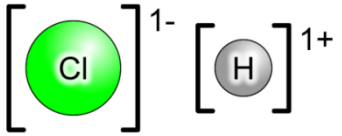
Developing the Concept of “Acid”

- In summary, all four chemicals dissolved in water.









- In what way(s) are they similar?

Concept Based Teaching

Developing the Concept of “Acid”

Now define the concept of *acid*.

Concept Based Teaching

Developing the Concept of "Acid"

- An acid is a chemical that will ionize when dissolved in water to produce *hydrogen ions* ($H^+_{(aq)}$) as the *only positive ion*.

- For example, nitric acid:

nitric acid $\rightarrow$ nitrate ions + hydrogen ions

$HNO_{3(l)} \rightarrow NO_3^-{}_{(aq)} + H^+_{(aq)}$

- For example, sulfuric acid:

sulfuric acid $\rightarrow$ sulfate ions + hydrogen ions

$H_2SO_{4(l)} \rightarrow SO_4^{2-}{}_{(aq)} + 2H^+_{(aq)}$

Concept Based Teaching

Developing the Concept of "Acid"

- Test your understanding. Which of the following chemicals would you classify as an acid?

- NaCl:

$$NaCl_{(s)} \rightarrow Na^{+}_{(aq)} + Cl^{-}_{(aq)}$$

- CH_3COOH

$$CH_3COOH_{(l)} \rightarrow CH_3COO^{-}_{(aq)} + H^{+}_{(aq)}$$

- $NaHSO_4$:

$$NaHSO_{4(s)} \rightarrow Na^{+}_{(aq)} + H^{+}_{(aq)} + SO_4^{2-}{}_{(aq)}$$

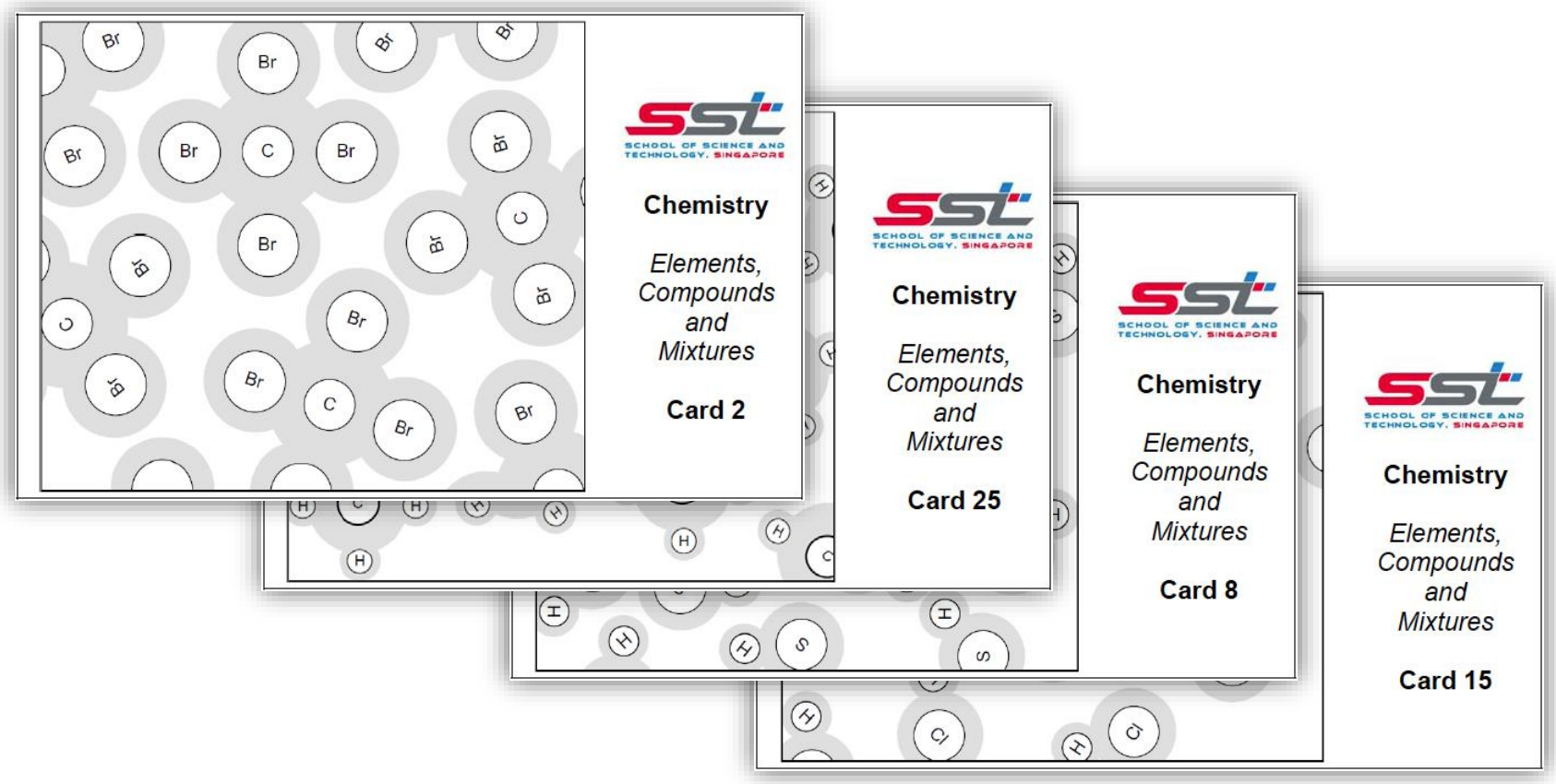
Concept Based Teaching

Elements, Mixtures and Compounds

What are some examples of *elements*, *compounds* and *mixtures*?

Concept Based Teaching

Elements, Mixtures and Compounds



Concept Based Teaching

Elements, Mixtures and Compounds

- Look at the chemicals presented on the 25 different cards that you have been given.

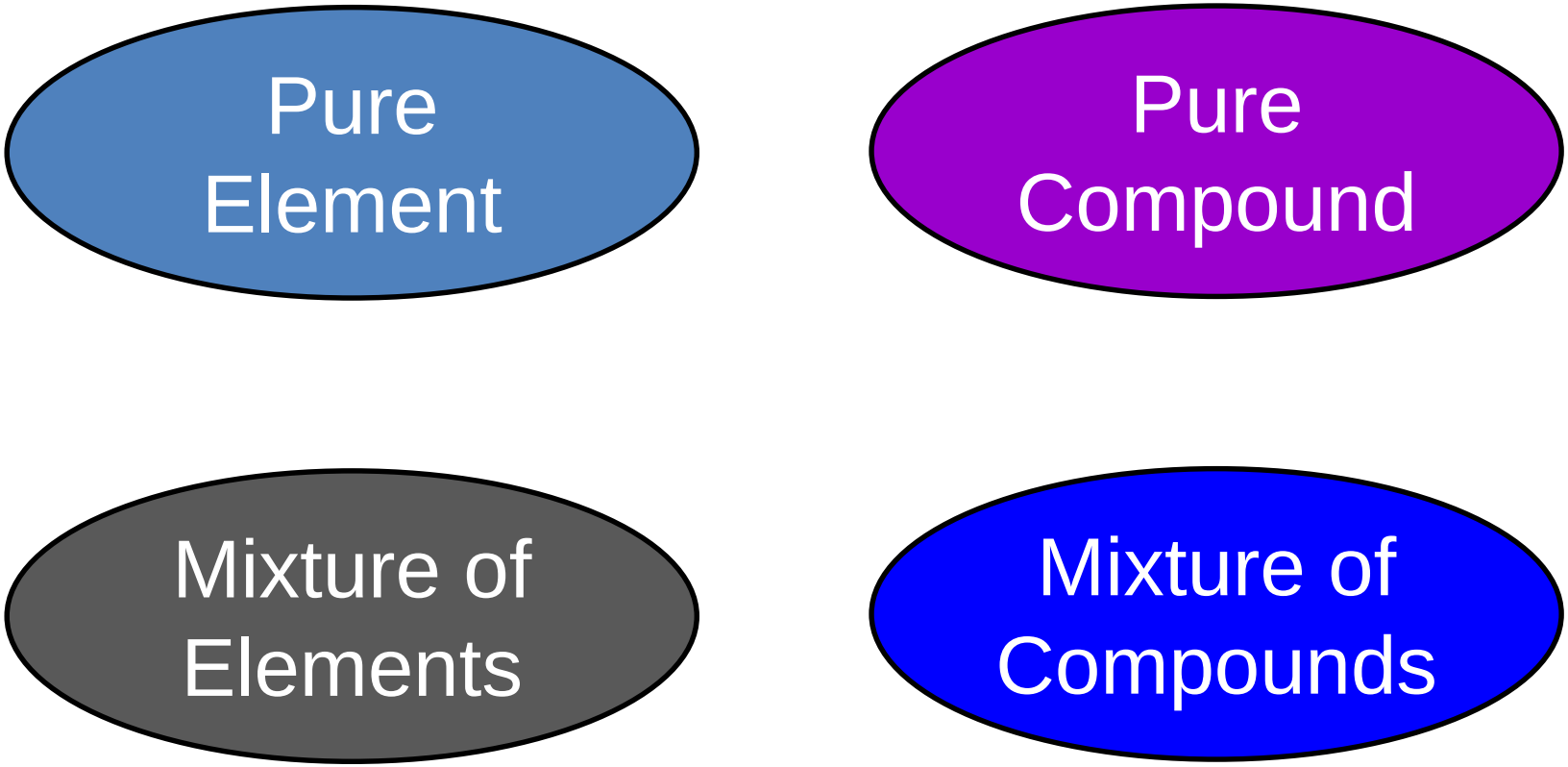
- What patterns can you see? In what ways are they *similar* and in what ways are they *different*?

- Put chemicals that appear *similar* together in the *same group*. Justify why they belong together. Give that group of chemicals an *appropriate name* or *label*.

- Identify why chemicals *do not* belong together in the same group. In what ways are the chemicals in *different* groups *different* from each other?

Concept Based Teaching

Elements, Mixtures and Compounds



Concept Based Teaching

Elements, Mixtures and Compounds

Summary of the properties of *elements*:

- A chemical element is a *pure* substance.
- It is composed of only *one* type of atom.
- It cannot be converted into anything more simple by a chemical reaction or *electrolysis*.
- All known chemical elements are listed in the *Periodic Table*.

Concept Based Teaching

Elements, Mixtures and Compounds

Summary of the properties of *compounds*:

- A compound is a *pure* substance.
- It is composed of *two or more* different chemical elements that react and *bond* together in a fixed ratio.
- It can only be converted into more simple substances by a *chemical reaction*.
- The compound has unique chemical and physical properties that are *different* from those of the chemical elements that it is composed of.

Concept Based Teaching

Elements, Mixtures and Compounds

Summary of the properties of *mixtures*:

- A mixture is *not* a pure substance.
- Two or more different chemicals (elements or compounds) are added together, but do *not* react and chemically bond together.
- The components of a mixture can be easily separated by a *physical process*, *e.g.* distillation or filtration.
- The ratio of chemicals in a mixture can vary.
- The mixture has the same chemical and physical properties as the individual chemicals that it is composed of.

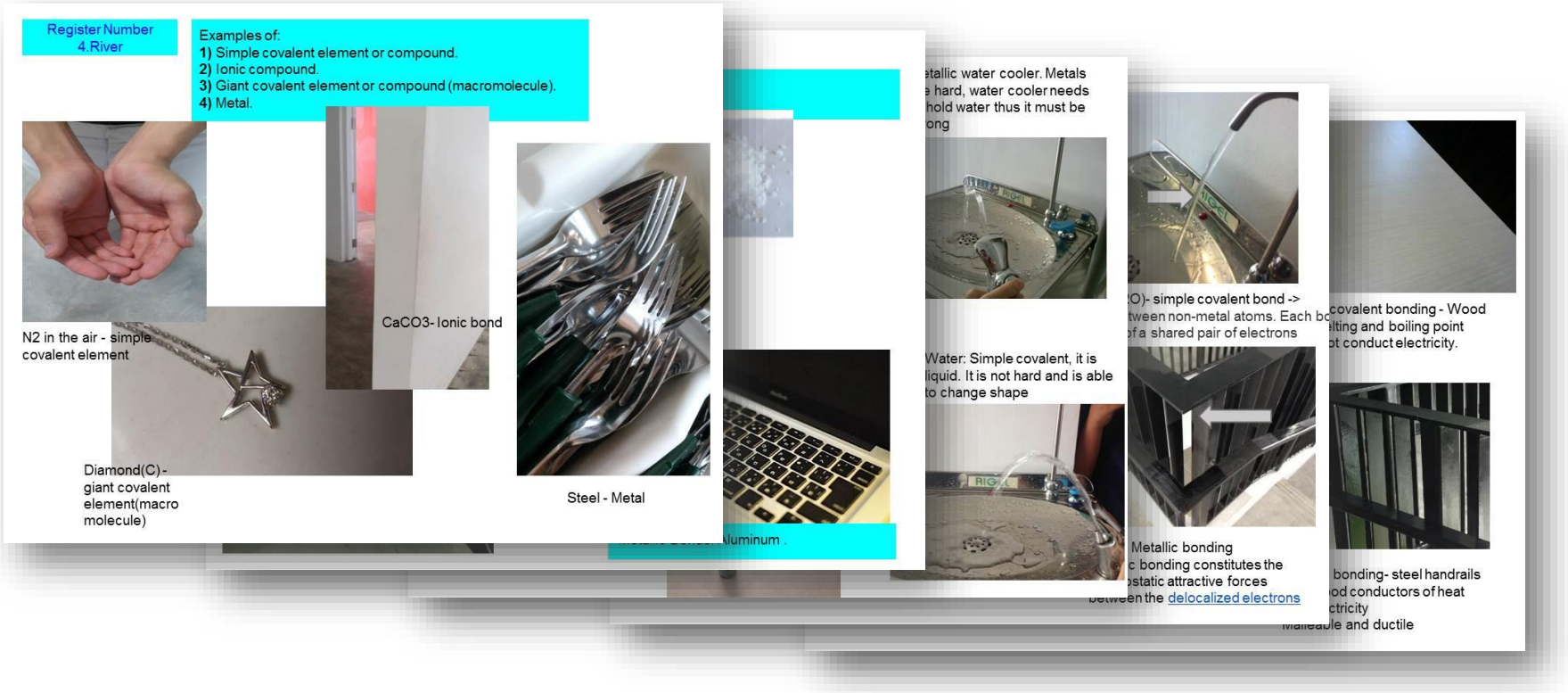
Concept Based Teaching

Developing the Concept of “Bonding”

What are some examples of *ionic compounds*, *covalent compounds* and *metallic elements*?

Concept Based Teaching

Developing the Concept of “Bonding”



Concept Based Teaching

Developing the Concept of "Bonding"

Ionic	Covalent	Metallic
$NaCl$	H_2O	Al
Fe_2O_3	$C_6H_{12}O_6$	Au
$CaCO_3$	CO_2	Cu
	C (diamond)	Fe
	C (graphite)	

Concept Based Teaching

The Concept of “Organic Compound”

What are some examples of *organic compounds* and *inorganic compounds*?

Concept Based Teaching

The Concept of “Organic Compound”

Concept Based Teaching

The Concept of “Organic Compound”

Organic	Inorganic
$C_6H_{12}O_6$	H_2O
CH_3COOH	H_2SO_4
CH_3CH_2OH	CO_2
$-(CH_2CHCl)_n-$	NH_3
CH_4	NaCl

Concept Based Teaching

What are *macroconcepts*?

Concept Based Teaching

Macroconcepts

- Macroconcepts are enduring ideas that are common to many different disciplines.
- Macroconcepts allow different disciplines to be linked together.
- Macroconcepts allow students to see beyond the boundaries of discrete subject areas.
- Macroconcepts reinforce student knowledge and understanding by exposing them to the same ideas in different subject areas.
- Macroconcepts can help students solve authentic inter-disciplinary real-world problems.

Concept Based Teaching

Macroconcepts

Examples of Macroconcepts

- Change

→ Change is inevitable.

→ Change can be positive or negative.

→ Change can be steady or erratic.

- Model

→ Models simulate real world processes.

→ Models facilitate testing and prediction.

→ Models can be physical, conceptual or mathematical.

Concept Based Teaching

Macroconcepts

Examples of Macroconcepts

- Scale

→ Scale involves measurable properties.

→ Scale is a ratio and involves a range of magnitudes.

→ Scale allows data of extreme magnitude to be Managed with relative ease.

- System

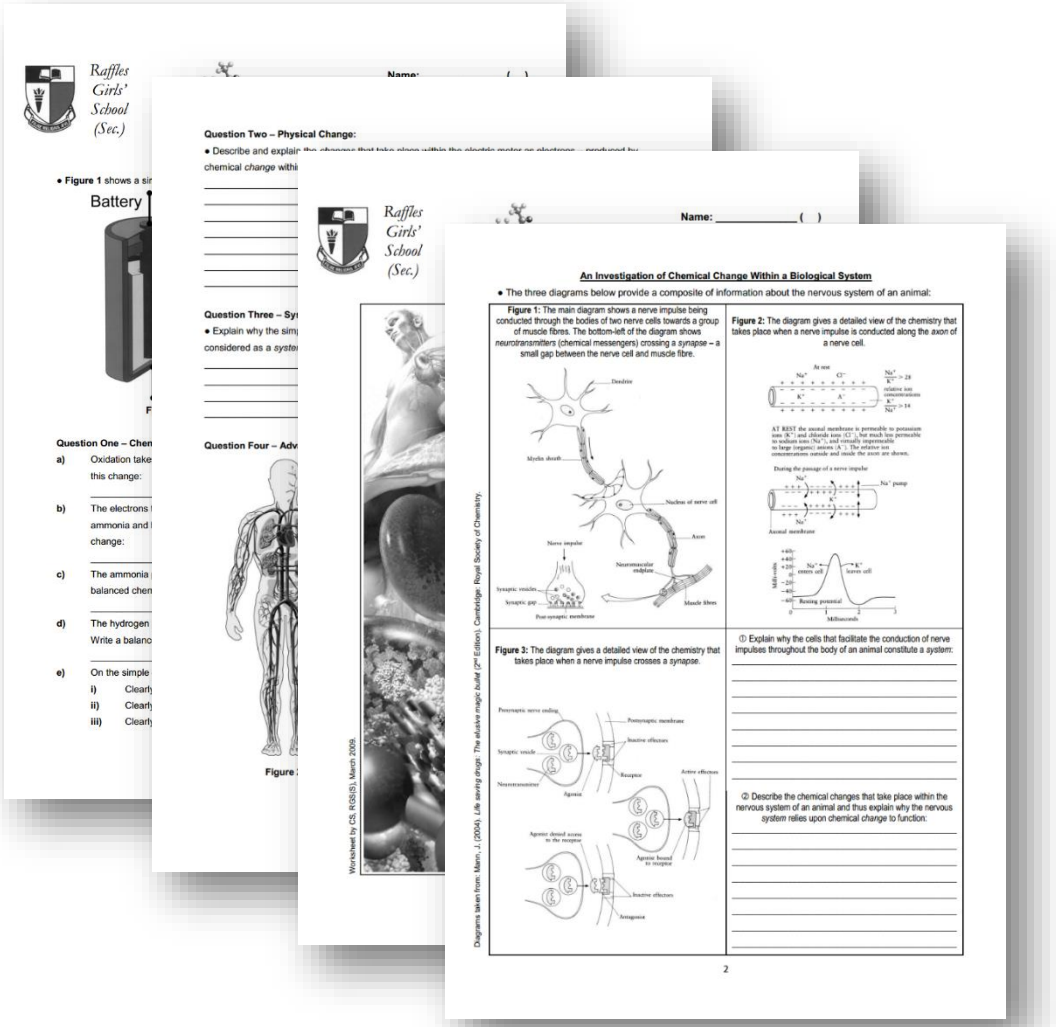
→ Systems follow rules.

→ Systems are made-up of sub-systems.

→ Systems are composed of elements that interact with each other.

Concept Based Teaching

Macroconcepts



Concept Based Teaching

Macroconcepts

Models

- Enduring Understanding

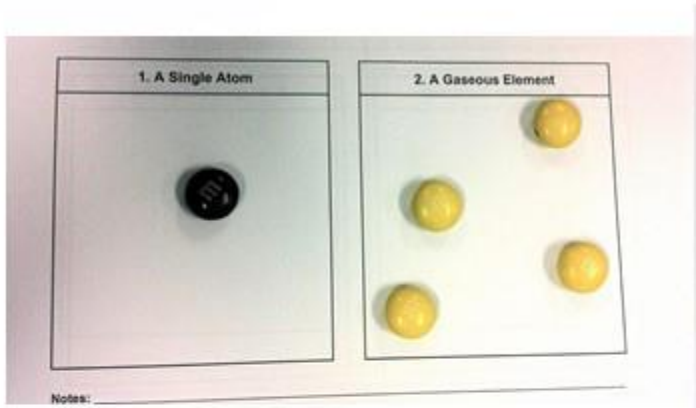
Models help scientists understand the nature of matter, whether on a very small scale or a very large scale.

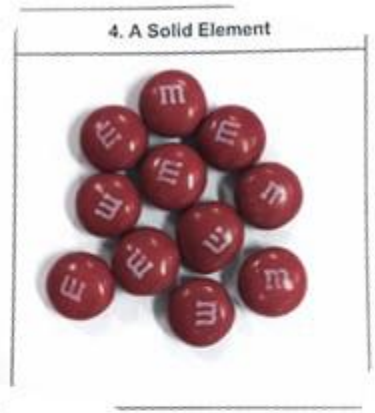
- Essential Question

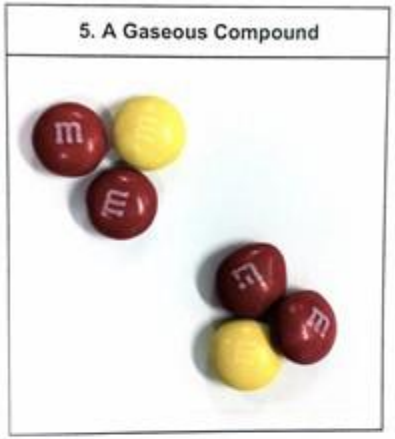
To what extent can scientists (humanity) ever fully understand the nature of the universe?

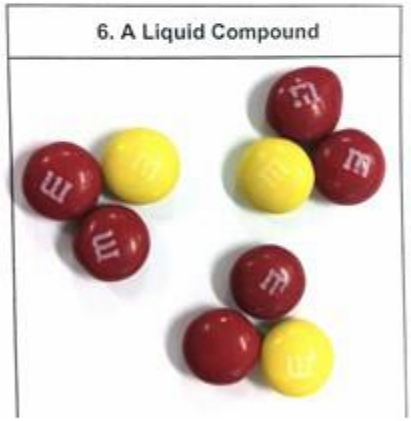
Concept Based Teaching

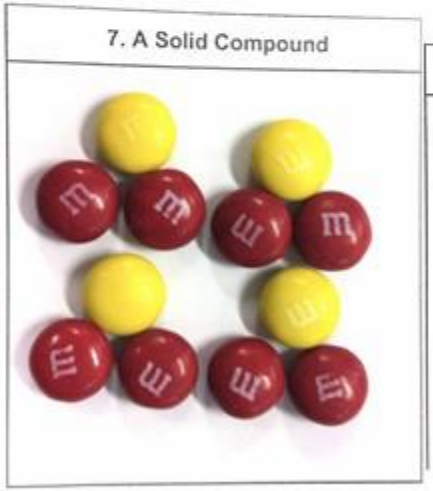
Modelling element, mixture, compound, solid, liquid and gas using M&M's

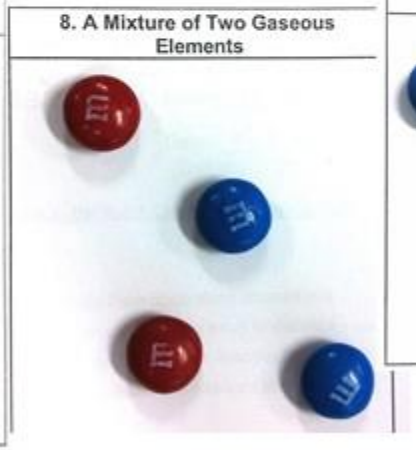


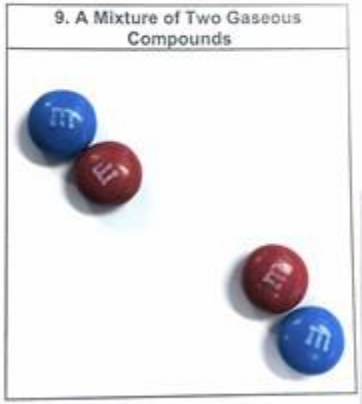


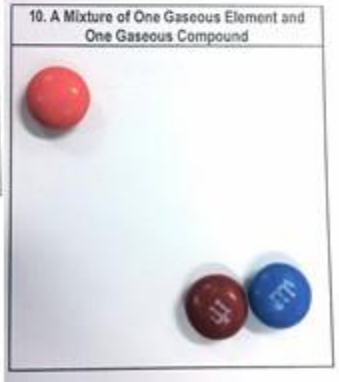






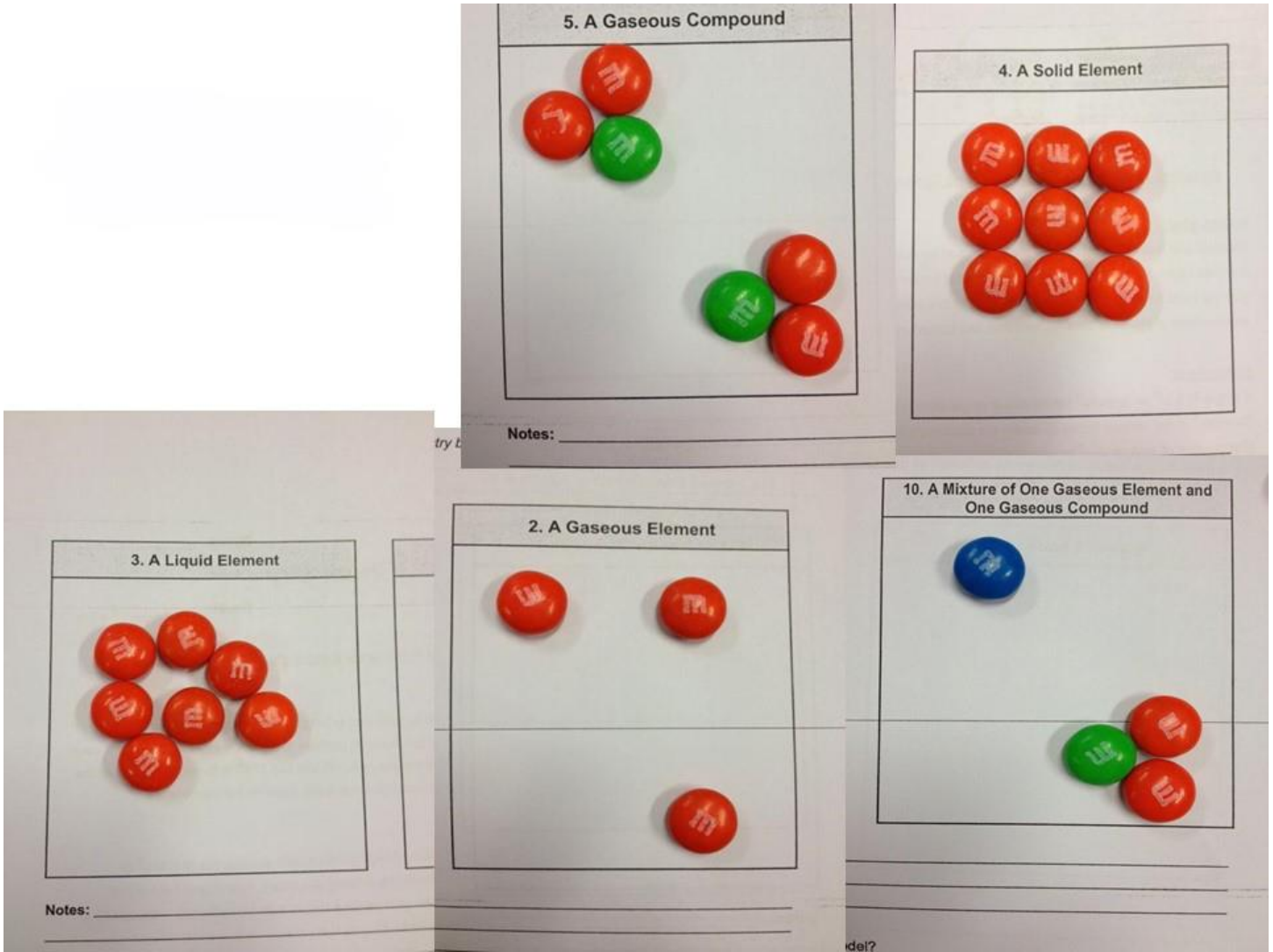






Concept Based Teaching

Modelling element, mixture, compound, solid, liquid and gas using M&M's



Concept Based Teaching

Phew! Can I please leave now?

Concept Based Teaching

Exit Pass

- What is a concept?
- Why is concept based teaching important?
- How can concept based teaching be done?
- What concept will you teach within the next two weeks?

Concept Based Teaching

Presentation on
Concept Based Teaching
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28th September 2015