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EFFECTIVE STRATEGIES FOR TEACHING CHEMISTRY IN HIGH SCHOOL

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Abstract: Recently, many teaching skills have been considered as teaching strategies. Chemistry is the natural science associated with substances and their metabolites and their applications. The formation of chemical concepts as well as the classification of chemical substances and reactions is a fundamental feature of chemical research and teaching. Students at different levels can access this kind of knowledge differently, so teachers are required to have effective and basic teaching skills that can promote the student's competence in studying chemistry.

Keywords: teaching chemistry, concept map, power note, K/W/L strategy, L.I.N.K strategy.

1. INTRODUCTION

In the past, many chemistry educators chose a traditional lecturing style as it allowed maximum content coverage and it was the mode with which they were most familiar with. In the recent years, the effectiveness of the traditional lecture method has come under the scrutiny of science educators for its inability to teach students a wide range of abilities and learning styles, and the passive atmosphere it creates in a classroom. When an instructor chooses to use an alternative pedagogy, there is often a concern about whether portions of the course content are satisfactory. This is a common concern, though it is our impression that many faculties involved in the curriculum reform feel that the benefits provided by alternative instruction (for example, active learning methods) outweigh the loss of course content, and we support this view [1].

Some of the strategies we have used are as effective as the design and construction of types of exercises for teaching inorganic chemistry [2] and organic chemistry [3] in high schools and universities. The use of contemporary teaching strategies in teaching chemistry can be incorporated in new developments in science education [4]. Case method teaching can increase students' interests in studying chemistry, concept mapping [5], [6] and deepens their understanding, Predict-Observe-Explain (POE) strategy increases the level of classroom interaction, workshops and problem-based learning provide students with an opportunity to acquire effective problem-solving techniques [7].

Instructional strategies can be divided into four specific teacher tasks [8]: i) Make input comprehensible; ii) Provide opportunities for language output; iii) Enhance the comprehensibility of readings; iv) Develop a system for providing constructive feedback.

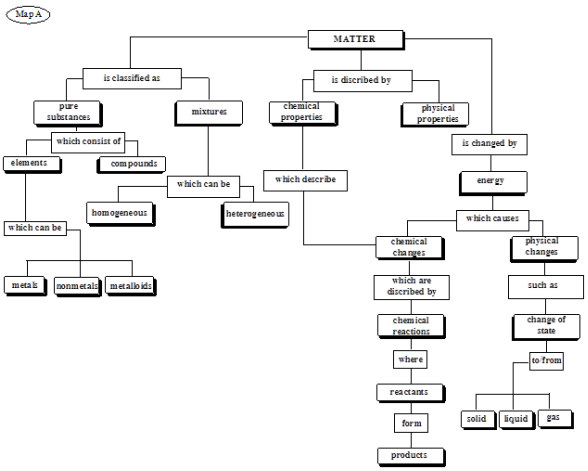
In fact, many strategies have been used by teachers effectively. We will introduce some of the strategies used successfully in the teaching of chemistry that many countries around the world have applied [7], [5], [9].

2. CONTENT

2.1. Making Concept Maps

Making concept maps can help you decide what material in a unit/chapter is important and how to efficiently learn that material. A concept map presents key ideas, meanings, and relationships for the concepts being studied. It can be thought as a visual road map of the unit/chapter. Learning happens efficiently when you use concept maps because you work with only the key ideas and how they fit together [10].

The concept map shown as **Map A** was made from vocabulary terms in a topic of "Classification of Matter". Vocabulary terms are generally labels for concepts, and concepts are generally nouns. In a concept map, linking words are used to form propositions that connect concepts and give them meaning in context. For



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example, on the map below, "matter is described by physical properties" so it is a proposition.

Studies show that people are better able to remember materials presented visually. A concept map is better than an outline because you can see the relationships among many ideas. Because the outlines are linear, there is no way of linking the ideas from various sections of the outline. Reading through the map helps people become familiar with the information presented. After looking at the map in relation to all of the text pages in this topic; what do you think gives a better picture of the important concepts - the map or the full lesson?

To Make a Concept Map:

- *List all the important concepts.* We'll use some of the boldfaced and italicized terms from the topic of "Classification of Matter": matter; mixture; compound; pure substance; element; homogeneous mixture; heterogeneous mixture.

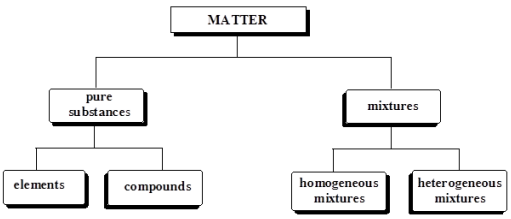
From this list, we group similar concepts together. For example, one way to group these concepts is dividing these into two groups, one is related to mixture and the other is related to pure substances.

mixture	*pure substance*
heterogeneous mixture	compound
homogeneous mixture	element

- *Select a main concept for the map.* We will use *matter* as the main concept for this map.

- *Build the map by placing the concepts according to their importance under the main concept and matter.* One way of arranging the concepts is shown in **Map B**.

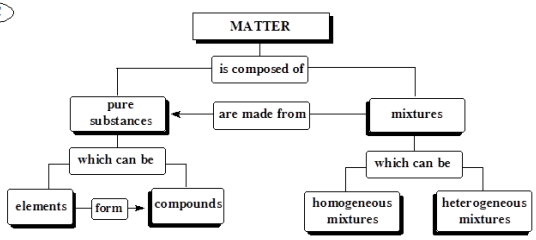
Map B



- *Add linking words to give meaning to the arrangement of concepts.* When adding the links, make sure that each proposition makes sense. To distinguish concepts from links, place your concepts in circles, ovals, or rectangles, as shown in the maps. Then make cross-links. Cross-links are made of propositions and lines connecting concepts across the map. Links that apply in only one direction are indicated with an arrowhead. **Map C** is a finished map covering the main ideas listed in Step 1.

Making maps might seem difficult at first, but the process forces you to think about the meanings and

Map C



relationships among the concepts. If you do not understand those relationships, you can get help. Practice mapping by making concept maps about topics you know. For example, if you know a lot about a particular sport such as basketball, or if you have a particular hobby such as playing a musical instrument, you can use that topic to make a practice map. By perfecting your skills with information that you know very well, you can feel more confident about making maps from the information in a chapter.

2.2. Making Power Notes

Power notes help us organize the chemical concepts you are studying by distinguishing main ideas from details. Similar to the outlines, power notes are linear in form and provide you with a framework of important concepts. In addition, power notes are easier to use than outlines because their structure is simpler. Using the power notes numbering system you assign a *1* to each main idea and a *2*, *3*, or *4* to each detail.

Moreover, power notes are an invaluable asset to the learning process, and they can be used frequently throughout your chemistry course. You can use power notes to organize ideas while reading your text or to restructure your class notes for studying purposes.

To learn to make power notes, firstly practice by using single-word concepts and a subject you are especially interested in, such as animals, sports, or movies. As you become comfortable with structuring power notes, integrate their use into your study of chemistry. For an easier transition, you should start with a few boldfaced or italicized terms. Later you can strengthen your notes by expanding these single-word concepts into more-detailed phrases and sentences. You can use the following general format to help you structure your power notes.

Power 1: Main idea

Power 2: Detail or support for power 1

Power 3: Detail or support for power 2

Power 4: Detail or support for power 3

- *Pick a Power 1 word from the text.* The text you choose does not have to be taken from your chemistry textbook. You can make power notes based on your

lecture notes or from an outside source. We'll use the term *atom* found in the topic of "The Structure of Atom".

Power 1: Atom

- Using the text, select some Power 2 words to support your Power 1 word. We'll use the terms *nucleus* and *electrons*, which are two parts of an atom.

Power 1: Atom
Power 2: Nucleus
Power 2: Electrons

- Select some Power 3 words to support your Power 2 words. We'll use the terms *positively charged* and *negatively charged*, two terms that describe the Power 2 words.

Power 1: Atom
Power 2: Nucleus
Power 3: Positively charged
Power 2: Electrons
Power 3: Negatively charged

- Continue to add powers to support the main idea as necessary. There are no restrictions on how many power numbers you can use in your notes. If you have a main idea that requires a lot of support, add more powers to help you extend and organize your ideas. Make sure that words having the same power number have a similar relationship to the power above. Power 1 terms should not be related to each other. You can use power notes to organize the material in an entire section or chapter of your text. Doing this will provide you with an invaluable study guide for your classroom quizzes and tests.

Power 1: Atom
Power 2: Nucleus
Power 3: Positively charged
Power 3: Protons
Power 4: Positively charged
Power 3: Neutrons
Power 4: No charge
Power 2: Electrons
Power 3: Negatively charged

2.3. Making Two-Column Notes

Two-column notes can be used to learn and review definitions of vocabulary terms, examples of multiple-step processes, or details of specific concepts. The two-column-note strategy is simple: write the term, main idea, step-by-step process, or concept in the left-hand column, and the definition, for example, or detail on the right.

One strategy for using two-column notes is to organize main ideas and their details. The main ideas from your reading are written in the left-hand column of your paper and can be written as questions, key words, or a combination of both. Details describing these main ideas are then written in the right-hand column of your paper.

- Identify the main ideas. The main ideas for a chapter are listed in the objective section. However, you should decide which ideas to include in your notes. For example, the table below shows some main ideas for the objectives in Unit 18: Describe the locations in the periodic table and the general properties of the alkali metals, alkaline-earth metals, the halogens and the noble gages.

- Divide a blank sheet of paper into two columns and write the main ideas in the left-hand column. You summarize your ideas using quick phrases that are easy for you to understand and remember, and then decide how many details you need for each main idea, and write that number in parentheses under the main idea.

Main idea	Detail Notes
Alkali metals (4 details)	• Group 1 • highly reactive • ns^1 electron configuration • soft, silvery
Alkaline-earth metals (4 details)	• Group 2 • reactive • ns^2 electron configuration • harder than alkali metals
Halogen (3 details)	• Group 17 • reactive • nonmetallic
Noble gases (3 details)	• Group 18 • low reactivity • stable ns^2np^6 configuration

- Write the detail notes in the right-hand column. Make sure you list as many details as you designated in the main idea column. The table above shows some details that correspond to the main ideas in the topic "Main-Group Elements"

The two-column method of review is perfect whether you use it to study for a short quiz or for a test on the material in an entire unit/chapter. Just cover the information in the right-hand column with a sheet of paper, and after reciting what you know, uncover the notes to check your answers. Then ask yourself what else you know about that topic. Linking ideas in this way will help you to gain a more complete picture of chemistry.

2.4. Using the K/W/L Strategy

The K/W/L strategy stands for "what I **K**now - what I **W**ant to know - what I **L**earned". You should start by brainstorming about the subject matter before reading the assigned material. Relating new ideas and concepts to those you have learned previously will help you better understand and apply the new knowledge you obtain.

The section objectives throughout your textbook are ideal for using the K/W/L strategy.

- *Read the section objectives.* You may also want to scan headings, boldfaced terms, and illustrations before reading. Here are two of the objectives from the topic of "States of Matter" to use as an example: (1) Explain the gas, liquid, and solid states in terms of particles, and (2) Distinguish between a mixture and a pure substance.

- *Divide a sheet of paper into three columns, and label the columns "What I **K**now", "What I **W**ant to Know", and "What I **L**earned"*

- *Brainstorm what you know about the information in the objectives, and write these ideas in the first column.* Because this chart is designed primarily to help you integrate your own knowledge with new information, it is not necessary to write complete sentences.

- *Think about what you want to know about the information in the objectives, and write these ideas in the second column.* Include information from both the section objectives and any other objectives your teacher has given you.

- *While reading the section or afterwards, use the third column to write down the information you learned.* While reading, pay close attention to any information about the topics you wrote in the "What I Want to Know" column. If you cannot find all of the answers you are looking for, you may need to reread the section or reference a second source. Make sure to ask your teacher if you still cannot find the information after reading the section for a second time.

It is also important to review your brain stormed ideas when you have completed reading the section. Compare your ideas in the first column with the information you write down in the third column. If you find that some of your brainstormed ideas are incorrect, cross them out. It is extremely important to identify and correct any misconceptions you had prior to reading before you begin studying for your test.

What I Know	What I Want to Know	What I Learned
gas has no definite shape or volume liquid has no definite shape, but has definite volume solid has definite shape and volume mixture is combination of substances pure substances has only one component	how gas, liquid, and solid states are related to particles how mixture and pure substances are different	molecules in solid and liquid states are close together, but are far apart in gas state molecules in solid state have fixed positions, but molecules in liquid and gas state can flow mixtures are combinations of pure substances pure substances have fixed compositions and definite properties

2.5. Using L.I.N.K Strategy

The L.I.N.K. strategy stands for **L**ist, **I**nquire, **N**otes, **K**now. It is similar to the K/W/L strategy, but you should work with a class or in groups.

- *Brainstorm all the words, phrases, and ideas associated with the term your teacher provides.* Volunteers can keep track of contributions on the board or on a separate sheet of paper.

- *Your teacher will direct you in a class or group discussion about the words and ideas listed.* Now is the time to inquire, or ask your teacher and other students for clarification of the listed ideas.

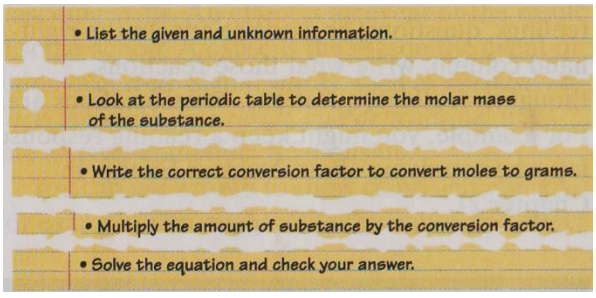
- *At the end of the discussion, make notes about everything you can remember.* Look over your notes to see if you have left anything out.

- *See what you now know about the given concept based on your own experience and the discussion.*

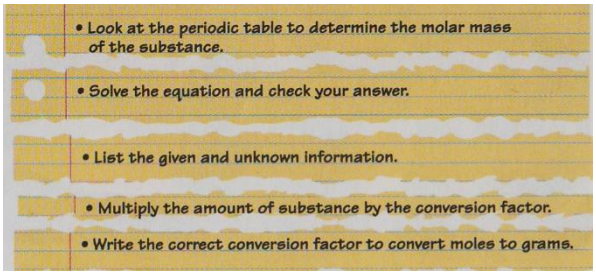
2.6. Using Sequencing/Pattern Puzzles

You can use pattern puzzles to help you remember sequential information. Pattern puzzles are not just a tool for memorization. They also promote a greater understanding of variety of chemical processes, from the steps in solving a mass-mass stoichiometry problem to the procedure for making a solution of specified molarity.

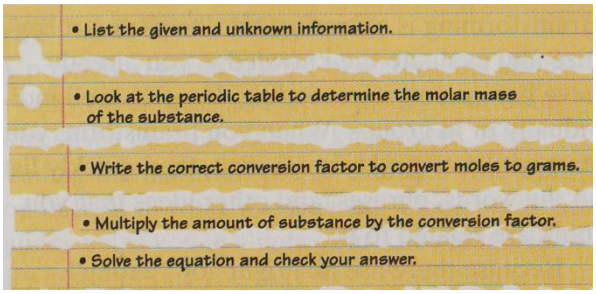
2.6.1. Write down the steps of a process in your own words. For an example, we will use the process for converting the amount of a substance in moles to mass in grams. On a sheet of notebook paper, you should write down one step per line, without numbering the steps. Also, you should not copy the process straight from your textbook. Writing the steps in your own words promotes a more thorough understanding of the process. You may want to divide longer steps into two or three shorter steps.



2.6.2. Cut the sheet of paper into strips with only one step per strip of paper. Shuffle the strips of paper so that they are not in the right order.



2.6.3. Place the strips in their proper sequence. Confirm the order of the process by checking your text or your class notes.



Pattern puzzles are especially helpful when you are studying for your chemistry tests. Before tests, use your puzzles to practice sequencing and to review the steps of chemistry processes. You and a classmate can also take turns creating your own pattern puzzles of different chemical processes and putting each other's puzzles in the correct sequence. Studying with a classmate in this manner will help make studying fun and will enable you to help each other.

3. CONCLUSIONS

Studying chemistry can be difficult, but you can make it easier using simple strategies for dealing with the concepts and problems. Becoming skillful in using these strategies will be your keys to success in teaching chemistry. Using these strategies in appropriate content in chemical programs at all levels will enhance teaching effectiveness in all aspects: i) develop the ability to take notes of the students in mind map; ii) practice sustainable memory of student for data of the knowledge of chemistry; and iii) create excitement and save time in teaching chemistry.

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