Effective Skills for Learning in Chemistry 108 & Elsewhere

This page contains ideas from Effective Learning Skills which was the final chapter of a physics textbook I wrote in 1989. This page is condensed (by cutting parts that seem less useful for Chemistry 108) and rearranged, with a little bit of re-writing; sometimes, but not always, I've removed references to "physics" or have substituted "chemistry" instead.

An easy-to-print pdf file contains this page (in pages 1-3 of the file) and (in pages 4-6) an APPENDIX for Learning Skills that includes Learning & Problem Solving, Summary Notes & Flash Cards, and Active Reading.

Another page you may find useful and fun is Motivation for Personal Education — I recommend reading the first half, about how my friend became an expert welder, and how I didn't learn to ski, and how you can learn in *Steps and Leaps*. Also, there is a "scanned image" pdf file you can print, with these ideas (on the first page) and (second page) tips for improving your memory for problem solving.

20.4 — Concentration

According to the Random House Dictionary, *concentration* is "exclusive attention to one object" and *to concentrate* is "to bring all efforts, faculties, etc, to bear on one thing or activity." Good concentration is an extremely valuable thinking tool.

Ignoring Distractions

The human mind responds to sensory input (sight, sound,...) and also constantly generates its own ideas. These mental activities are the focus of **external distraction** or **internal distraction,** respectively, and each can interfere with other.

The best way to cope with either kind of distraction is to provide competition, with **interest** and **activity**. During an interesting conversation it is easy to totally ignore distractions (or tell them to "go away, don't bother me now, I'm busy") and keep good concentration. When you develop an interest in what you're studying, distractions won't have a chance. And if you are extremely ative (reading, listening, thinking, reviewing, note-taking, ...) your mind is so filled with thoughts about the lecture-ideas that there is "no room" left for a distraction to squeeze into.

During lecture, if you have a valuable thought about a non-chemistry topic, quickly write it down. The thought is on paper as a reminder, so you don't have to worry about forgetting it and you can return to studying with full concentration. Later, look at the paper and give the thought your undivided attention.

Taking notes during a lecture requires a combination of skills: Mainly you want **externally directed concentration**, but with some internally directed concentration. You must **receive information** (listen) but if you want to learn you must also process it (by thinking) and preserve it (in your memory). Below you'll find useful ways to improve your note-making skill: prepare before the lecture, be alert during it, and review afterward.

Active Listening during Lecture

Active Listening is similar to *Active Reading* but there are two major differences:

During a lecture you can learn from the content and also **how** it is said, in the voice pitch, loudness, inflection & rhythm, facial expressions, hand-waving,...

You control the pace of your reading, but a speaker talks as fast as she (or he) wants. Unless a lecture is recorded, stop-and-go is not practical. Instead, you must do several things almost-simultaneously: listen, mentally process, and make notes. Here are three ways to improve your skill at listening-and-processing.

PREPARE BEFORE THE LECTURE: How? Quickly review your notes from previous lectures, and read the appropriate textbook sections. If the teacher's lecture notes from a previous quarter are available, read them for a "preview".

Why? If you know something about a subject already, it's easier to understand the lecture. By comparing the treatment of material by the textbook and teacher, you will learn something about the teacher's "emphasis". You can probably take less notes, so you can do more thinking-while-listening, and it will be easier to make quick decisions about what is important enough to put in your notes.

CONCENTRATE DURING THE LECTURE: With quality practice (relaxed yet alert, motivated, confident) your listening-and-processing skill will improve.

Practice writing as fast as you can; push the limits! Develop your own system of abbreviations, especially for words that you use often: w = with, fex = for example, and so on. Try leaving out vowels, as in "rdng, wrtng, rthmtc."

If the speaker is dull, use willpower to motivate yourself. With a skilled speaker, don't think that you will automatically remember the lecture just because it is presented clearly; take good notes anyway.

REVIEW SOON AFTER THE LECTURE: You won't be able to capture the whole content of a lecture in your notes, but part of what's missing is preserved in your memory — temporarily. If you review the notes soon after the lecture while your memory is fresh, you can use the notes to remind you of weakly remembered ideas that will fade and vanish unless they are solidified during after-the-lecture review; you can add these ideas to the notes. And it is easier to interpret your abbreviations and condensations at this time than it will be later. Don't rewrite your notes; just fill the gaps, make comments in the margins (leave some space), and do whatever it takes to give them a "summary structure". Do you see why a quick but well-timed review can improve your memory AND your notes?

Interest and Activity

Do you have to "try to concentrate" when you watch the climax of an exciting movie, or when you're in the middle of a fascinating conversation? No; if you are truly interested in an activity, good concentration is natural and effortless.

In her excellent book *On Becoming an Educated Person,* Virginia Voeks describes how interest-and-activity helps you learn more — and have more fun — when you read: "Start with an intent to make the very most you can from whatever you read. Treat the author as you do your friends. When talking with a friend, you listen attentively and eagerly. You watch for contributions of value and are sensitive to them. You actively respond to his ideas with ones of your own. Together you build new syntheses."

You can read with similar expectations and results. Expect the author to present facts you had not known before, to offer new ideas, to give new slants on old problems and to formulate new problems. When you are alert to these things, you will see them. Reading becomes refreshingly stimulating fun. Of course, you can use this positive attitude for all of your studying. *Listening to a lecture becomes an exciting adventure in learning,* reviewing flashcards is a self-testing game, making a summary is a chance to be logical-and-creative with no grading pressure, and solving problems is a fun, idea-stimulating challenge. <snip .....; Here, and later throughout this page, I've cut parts that are in the original chapter; if you want to read more, click the *top-of-page* link for the full-length chapter about Effective Learning Skills.>

Be fully alive! Wherever you are, be all there. Whatever you're doing, do it fully.

Do you ever think "when I'm not studying I feel like I should be, and when I am studying I wish I wasn't"? If there is conflict between your perceptions of what you "should do" and what you want to do, it will cause a waste of mental and emotional effort, like two tug-of-war teams pulling in opposite directions.

The key to resolving this conflict is balance. All work and no play (or vice versa) does not lead to a happy, productive, full life. Don't make yourself choose between work and play. Do both with enthusiasm!

Studying is a two-step, two-level process: 1) just do it, 2) do it with gusto!

You can *make yourself study* with willpower and the procrastination-avoiding techniques of *Section 20.7*. To reach the gusto level, which is more efficient and more fun, generate interest with the "positive attitude" discussed earlier, and generate motivation with a "piecework incentive" expectation.

When you are paid by the hour, you earn the same amount of money no matter how slow or fast you work. But with a piecework salary the more you produce the more you earn, so you get to harvest the rewards of your own efficiency.

Studying is a piecework activity. If you are efficient, you automatically receive a higher "learning per hour" salary -- you'll learn a lot quickly, and will feel a real satisfaction about studying. Later, when you "play" you can relax and enjoy it because you won't be nagged by worries about unfinished schoolwork.

Motivation is important, but just **wanting** something doesn't make it happen. <snip .....>

It is usually good to study enthusiastically with **high intensity**, trying to learn a lot in a short time. Use piecework incentive!

If possible, study in a quiet place. But when noise occurs, ignore it and remember that your own response (of interest or irritation) is usually the main distraction, not the noise itself. If you learn to concentrate despite noise, you increase your own freedom; you can study in a wider variety of situations, independent of other people's actions. This will also increase the freedom of others, since you can let them do what they want. <snip .....>

physical fitness and mental fitness: There is an intimate connection between mind and body. Each affects the other. If you take better care of your body with "whole-person living" that includes good nutrition, adequate exercise, and getting enough rest, your concentration and thinking quality will improve. <snip .....>

As with most skills, a good way to develop concentration is to **search for insights**. [as in the story about "*my first morning on the slopes*" explaining how I didn't learn to ski] Notice what works best for you in different situations, and practice until fast, clever, reliable thinking becomes a natural and easy habit.

20.7 — Using Your Time Effectively

Dost thou love life? Then do not squander time, for that's the stuff life is made of. { Benjamin Franklin, 1746 }

Three ways to use your time more effectively are wise **planning**, good **timing**, and increased **efficiency**. <snip.....>

To get more done, you can 1) waste less time, and 2) work more efficiently. <snip.....>

20.6 — Exam Preparation and Performance

You probably have two learning goals for every college course: 1) to learn things that will be useful in your future courses, in a career and in life, and 2) to do well on exams so you'll get a good grade and "GPA credit" for what you know.

This section will focus on the more **urgent** second goal, but the principles are just as useful for reaching the more **important** first goal.

1) Gather Information

Read the instructor's course syllabus carefully. If you miss the start of a lecture, when exam announcements are often made, check with other students to find out what you missed. During lectures, listen for subtle clues (or obvious statements) about what the teacher thinks is interesting and important. Try to "get oriented" and find out, as soon as possible:

What are you expected to KNOW and be able to DO? Will you be asked to solve problems, analyze statements about theory, or remember specific details? If there are problems, will

they be like those in the assigned homework? Will the exam emphasize material from the text or lectures?

What is the grading policy? How much of the course grade is determined by midterms? by the final exam? by extras like quizzes, homework, labs, projects, papers, class discussion,...? Will students be graded "on a curve"?

What is the exam format? Open book or closed book? Will you do problems and show your work? do machine graded multiple choice? true-false? fill in the blanks? Will there be "qualitative" questions? Will the exam reward speed in doing many easy problems, or in figuring out a few difficult ones? If possible, try to get one of the teacher's old exams; this will give you a better idea of what to expect.

Selectivity is important. You have a limited amount of time to invest in each class. You'll want to use this time wisely, and this requires making choices.

note: The following sections (2-3-4-5) have been condensed from the full chapter-section, keeping only a few central ideas.

2) Early Exam Preparation

Use the study suggestions from Sections 20.1, 20.3 & 20.5: learn from problem-solving practice, make summary notes, read and listen actively. Do most of your studying early, so you can "cram" effectively later.

3) Late Exam Preparation

Cramming will help you get better grades. When you practice fact-recalling and problem-solving in the days before an exam, very little "fading" occurs between studying and the exam, so your memory and skill levels remain high. But if you use the time before an exam for "original learning" that could have been done earlier, you're wasting time that is extremely valuable for memory and skill practice. To be effective, **CRAMMING** should be a **supplement** to earlier study, not a replacement. It should be mainly **consolidation** (review & practice) of knowledge and skill that have been built on a solid foundation over a long period of time. [because "chemistry is cumulative"]

4) Exam Performance

The most reliable way to do well on exams is **good preparation**, as described above in 1-3. But the quality of your thinking during the exam is also important.

5) After the Exam

Think about what happened so you can learn from it, for each phase discussed above. {use the Oregon Strategy by asking "Why did I miss it, and how can I fix it?"}

20.3 — Memory as a Problem-Solving Tool

Good problem solving requires an "active memory" that gives you quick, reliable access to essential thinking tools. A good memory isn't sufficient to make you an expert problem solver (you also need creativity and logic) but it is necessary.

To improve your memory, take advantage of **original awareness** with **intention to remember**, **organization**, and **review**.

a Section Summary: The best way to insure good recall is good preparation, to achieve storage. The final step of "retrieval" is usually easy if you've done a good job with the earlier stages: 1) **learn with intention-to-remember**, 2) **organize** the information (with intrinsic logic or an external system), 3) **review actively** and often, using appropriate cues.

INTENTION TO REMEMBER — When you find something worth remembering (in your listening, reading, or problem-solving practice), stop for a few seconds and **review it before you lose it**! <snip.....>

ORGANIZATION IS IMPORTANT

It's easy to find page 86 of a book, or the word "grace" in a dictionary, due to organization; book pages are in numerical order, and dictionary words are alphabetical. Logical organization also makes it easy to retrieve information from your memory so you can "use what you know" for problem solving.

Quiz #1: For a few seconds, look at these 22 letters:

t s e k h a u o e n d y g c a l h t e y n m

Then close your eyes and try to remember all of them; don't leave any letters out and don't put any extras in.

If you were given enough time and incentive, you could memorize these letters. But there is a better way to do it — by using organization!

Quiz #2: Does it help if you combine the letters into these combinations of letters? temuy acnh gnte ysol aek dh

Quiz #3: After a few seconds of study, can you remember these combinations? sneaky the lunch dog my ate

Each quiz contains the same 22 letters. So why is Quiz #3 easier to remember?

To make it even easier to remember, you can organize the words of Quiz #3 into a sentence. What does the dog do?

RETRIEVAL: the importance of REVIEW

If you want to remember something (concepts, equations, problem-solving strategies,...), review it. A balanced combination of review **distributed** throughout the course and a **massed** cramming session before the exam is better than either one alone.

As explained in the *appendix* for this page, *summary notes* can provide **organization**, *flash cards* require **activity**, and both let you make **quick reviews** of **the entire chapter**. Each type of review offers advantages. Generally, review is more effective when *you are active*. <snip.....>

APPENDIX

Three Ways to Learn, and Problem Solving in Design & Science

Learning by Exploring

One way to learn about nature is to explore it yourself. You can do this in many ways, using all of your senses. You can explore near and far, by studying plants in your yard, birds in the park, and clouds in the sky, by looking out your car window and letting what you see inspire questions about the geology and biology, about the land and what's growing on it. Exploring is fun at any age. It is interesting and motivating for children, and also for adults who (as non-scientists, amateur scientists, or professional scientists) are continuing their explorations of nature.

Learning from Others

When you explore, you learn from your own experience. But you can also learn from the experience of others, by letting them help you learn. This happens when you read, listen, or watch what they have written, spoken, or filmed. Learning from others is an easy way to learn a lot in a little time.

Learning is an Active Process

Learning is an active process that requires *thinking*. When you learn by reading, for example, your thinking converts symbols on the page into ideas in your mind. Every time you learn a new idea, you are actively constructing your own mental representations of the idea in a personally meaningful form. And your new idea interacts with your old ideas, as you try to combine the new and old into a coherent system of ideas.

The process of active reading is the theme when Virginia Voeks, in her book *On Becoming an Educated Person,* explains how to learn more and enjoy more while reading: "Start with an intent to make the very most you can from whatever you read. Treat the author as you do your friends. When talking with a friend, you listen attentively and eagerly. You watch for contributions of value and are sensitive to them. You actively respond to his ideas with ones of your own. Together you build new syntheses." When you're an active reader, eagerly searching for new ideas, you will find them, and reading becomes a stimulating adventure.

You can read passively or you can make it an active adventure. Some of the most effective teaching methods are designed to stimulate thinking, to replace boring passivity with exciting activity. For example, members of a class can have a pro-and-con debate about the ideas in a book they are reading. This activity encourages the mentally active reading that is recommended by Voeks. But if you "internalize the action" you can always read with an active mind, whether or not your reading will be followed by an external debate. You control the quality of your learning.

We hope you'll read the rest of our website actively. If you're eager to learn and you "listen attentively and eagerly" it can be a stimulating adventure for you, and you will be richly rewarded with understanding and enjoyment.

Problem Solving in Life

We're made for *thinking,* and it's exciting to use our minds skillfully. We'll explore two ways to think: in design and science.

Design is a way to solve problems. In common language, a "problem" is usually bad. But in design, a problem is an opportunity to make a difference, to make things better. Whenever you are thinking about ways to increase the quality of life (or avoid a decrease in quality), you are actively involved in problem solving.

In every area of life, creative thinking (to generate ideas) and critical thinking (to evaluate ideas) are essential. These mutually supportive skills are combined in the problem-solving methods used in a wide range of design fields — such as engineering, architecture, medicine, music, art, literature, philosophy, history, law, business, athletics, and science — where the goal is to design a product, strategy, or theory. In fact, design includes almost everything in life.

If we define design as the process of designing products or strategies, and science as the designing of theories about nature, the main objective of design is to *improve* what humans *construct* in our societies, while the main objective of science is to *understand* what humans *observe* in nature.

Design includes almost everything in life, so you can find many ways to enjoy the excitement of design thinking, to experience the satisfaction of solving a problem and achieving a practical goal. Since the beginning of human history, people have been designing strategies for better living, and designing products to carry out these strategies more effectively. For example, strategies for getting food (by hunting and farming) were more effective when using products (spears and plows). Design continues to be useful in the modern world.

Science is also useful, in two ways. First, the understanding gained by science is often used by designers when they develop new products or strategies. The technological results of "applied science" are familiar. Second, science can help us fulfill a deep human need, because it is one way to search for answers when, inspired by our curiosity, we ask questions about what, how, and why. Most of us want to know the truth, so an intrinsically appealing goal is the design of scientific theories that are true, that correctly describe what is happening now and what has happened in the past.

Creativity and Logic: How do scientists combine these thinking skills in their efforts to understand? The simplicity of using "reality checks" in scientific method is summarized in an introduction to **the logic of science**.

Curiosity and Delight: In our search for truth in nature, we are motivated by curiosity and a desire to solve mysteries. Two scientists who played key roles in solving an important scientific mystery, in 25 years of shared work, exchange letters to express their shared delight: One writes, "I am reading your paper in the way a curious child eagerly listens to the solution of a riddle with which he has struggled for a long time, and I rejoice over the beauties that my eye discovers." The other responds by agreeing that "everything resolves itself with unbelievable

simplicity and unbelievable beauty, everything turns out exactly as one would wish, in a perfectly straightforward manner, all by itself and without forcing." They struggled with a problem, solved it, and were thrilled. It's fun to think and learn!

Why would a scientist — while reading about a new idea (*) — "rejoice over the beauties that his eye discovers"? Find out in **the joy of science**.

* Scientists enjoy the fascinating world of ideas, and they also enjoy the magnificent beauty of our world in the sky and sea, rivers and mountains, forests and meadows, plants and animals.

You can also learn about **the joy of design** — WHY it includes almost everything you do (because when you make a decision in any area of life, you're designing a strategy to help you achieve your goals for life), HOW you can find a variety of ways to enjoy the excitement of design thinking, WHAT are the similarities and differences between design and science, and WHY we should teach design before science (because design makes a connection with the past and future of students) — in other pages, beginning with An Introduction to Design.

Memory Activities

This section continues the "strategies for remembering" that began in Effective Learning Skills for Chemistry 108.

SUMMARY NOTES

One powerful organizing technique is **SUMMARY NOTES.** To make them, **choose** the most important ideas from your textbook, lecture notes and problem-solving practice, then **organize** these ideas into a unified summary. Be creative. Divide information into idea-clusters, spread these all over the page, and use spatial cues to show their relationships. Use flowcharts, hierarchy structure, outlines, tables, or free-form chaos. Experiment with different kinds of organization. Personalize your summary. For example, an author may use several pages to explain a new concept, but you can use a small phrase (that wouldn't make sense to anyone else) to bring the concept's whole meaning back to your memory.

Invent and use your own system of symbols (+ - vs ! ? / * x arrows linklines ...), underlining and circling (of various types), brackets { [(, differing print size, and (one of my favorites) colors.

You can make your summary "from scratch." Or use a chapter summary in this book as your starting point, and then change it in any way you want. Make photocopies of my summary and you'll feel more free to experiment creatively; if you don't like the changes you've made, just try it again on another copy.

Make a "rough draft summary" early. Then as you use these notes for problem-solving, think about how you can change them to make a new improved version. You may find it freeing to use a pencil for the rough draft. This encourages creativity because you'll feel more spontaneous if you know it will be easy to revise the summary later.

In your early summary, include everything you think might be useful. Then notice which tools are used most often when you solve problems, and edit the summary accordingly. Eventually, you'll want to **travel lightly** so your summary includes only the tools you really need: no more and no less. When you eliminate "excess clutter" the important ideas stand out more clearly.

You'll learn a lot during the "choose and organize" process of making summary notes. And when you study it, a summary is useful in many ways. It will help you to:

1) **memorize**. When information is condensed in a small area you can literally **see** the visual and logical interconnections, and it is easier to understand relationships. Because the information is organized on paper, it is easier to organize in your mind, which makes it easier to remember! And summary notes are short, so you can do many quick yet thorough reviews.

2) **develop problem-solving strategies**. Most of the tools you need are available in clear view, so you can focus your attention on how to use them.

3) **acquire more knowledge**. New information is easier to understand when it is related to what you already know, if it is a variation on a familiar theme, or is a logical consequence of a principle you understand. Summary notes organize the essential ideas into a framework, providing a structure where you can insert details and new ideas.

FLASH CARDS

If you mix problem-solving practice with reviews of the **flashcards** and **summary** at the end of each chapter in this [physics] book, it will do wonders for your "tool memory" and problem solving skill.

MAKING AND USING FLASH CARDS: Put a CUE on one side of a 3x5 index card, and its corresponding "ANSWER" on the other side. Then use the card for self-testing: look at the cue, predict the answer, turn the card over to see if it's correct. / Use cards for anything you want to memorize. { For example, information from summary notes,... Every chapter of *Physics: Tools for Problem Solving* has suggestions for specific cue-answer pairs. }

The CUE is important; choose it carefully. Try to use the same kind of cue that real problems will provide. And "minimize" it; the less cue you need during flash card practice, the more likely it is that information within a problem will be enough to trigger the correct response. Here is a minimum-cue example. [note: For the following example, ignore the technical "physics-math details" that aren't important for Chem 108, so you can focus on the "minimal cue" principle that will be useful no matter what subject you're studying.] The 4 basic right-triangle relationships {definitions of sine, cosine & tangent, plus the formula "aa + bb = cc"} are often used in physics to split a diagonal line, / , into its horizontal and vertical components. For review, should you use a cue like "What are the 4 right-triangle formulas?" or "How can I split a diagonal into components?" or " / " ? The last cue is best. Why? Because a problem won't jab you in the ribs and shout in your ear "Hey Sam! Why don't you use one of the 4 trigonometry formulas?" Instead, there will be a diagonal vector, / , that needs to be split, and the sight of this must be enough to trigger your recall of the trig-formula tools. Do you see why memorizing with a minimal

"/" cue (instead of a long "give-away" cue) is better preparation for real problem-solving situations? Almost always, the less cue you need for retrieval, the better.

MULTIPLE CUES: One fact may have several cues. This makes it more likely that the cues within a problem will let you retrieve the fact from memory. [similar to *funneling*]

The ANSWER can be practiced in different ways. You can WRITE it (and also SEE), or SAY it (and also HEAR), or REHEARSE it mentally (along with "VISUALIZING" of sight, sound, meaning,...). Try each method and choose your favorite, or alternate them to store the knowledge in your memory using several sense-modes, thus making it easier to retrieve.

MULTIPLE ANSWERS: One thing can remind you of several associated items. This is useful for real life problem-solving and creative thinking, because it gives you different "options" to choose from. [similar to *fanning*]

EDITING FLASH-CARDS: After you've used the cards awhile, you can change the cues to make them more appropriate and minimal. Or sort cards into piles, like well known pairs vs. those needing review, essentials vs. optionals, according to topic,... Use paper clips or rubber bands to keep each group together.

REVERSIBLE CARDS are useful in some situations. For example, in learning a language you'll probably want to translate in both directions. To learn English -> Spanish translation, use the English side of the card as cue; for Spanish -> English translation, just flip the cards over. / Or to learn a chemical reaction like "A + B -> C" in both directions, put "A + B -> __" on one side and "__ -> C" on the other; then alternate which side you use as cue.

TWO COLUMN self-testing: Put cues in one column, answers in the other, as in my end-of-chapter "flashcard" sections. Then use the flash card method: cover the answer column, look at the cue and predict the answer, then check by sliding the cover down one line at a time. This format is good for some purposes, like memorizing language vocabulary in both directions. And one page is more compact than many cards. But flash cards are adaptable to a wider variety of situations, and cards can be shuffled to avoid using one card as a cue for the next -- as occurs, for example, when you hear a CD often, and one song reminds you of the next song.

In any form, flashcards force you to actively search your memory to find a response to the cue, and this activity will help you remember.

Active Reading

FLEXIBILITY: **Decide what your purpose is**, and adjust your reading accordingly. You may want to aim for maximum understanding, to get out of a book everything the author put into it. Often, however, your goal is more specific: to learn the book's main ideas, to look for a specific fact, to gather ideas for a term paper, or...

Each goal requires a different approach, but here is a basic principle: unless you really need "total comprehension", you should resist the compulsion to read every word in a chapter or every page in a book. <snip .....>

STOP-AND-GO READING: A good way to understand and remember ideas is to read for awhile, stop and think, read more, stop and think, read, stop, and so on. What should you do when you stop? Think, recite, write.

Think: Read for awhile, then do one or more of the thought-activities described earlier. Try to comprehend what the book is saying, do critical thinking, and let the author's ideas inspire your own ideas.

Recite: When you find something worth remembering, look away from the book and say the idea to yourself, either mentally or aloud. This activity helps move the idea from temporary **short-term memory** where, like the "vanished name-introduction" of Section 20.3, it can be easily lost, into permanent **long-term memory**. Recitation provides **original awareness with intention to remember** and makes you practice the **active recall** you'll need for answering questions and solving problems on exams. Timing is important, because you must capture ideas while they're still in your short-term memory. Don't wait until the end of the chapter to do reviews; recite often, during stop-and-go breaks, while you're reading.

Kenneth Higbee, Ph.D., author of the excellent book "Your Memory -- How It Works and How to Improve It", summarizes the scientific research on recitation: "The effectiveness of recitation does not depend on whether the learners are dull or bright, whether the material is long or short, whether the material is meaningful or not -- in virtually every case it is more efficient to read and recite than to just read. A recent introductory psychology textbook discussing learning strategies concluded that 'recitation is the most powerful tool in all learning'."

Write: Use a pencil to underline, circle or bracket the most important parts [as shown in these three paragraphs] , or highlight them with a translucent marker. You can also write your own notes (comments or summaries) in the book's margin or on a separate piece of paper. If you have good book-marking or notes, it preserves much of the thinking you've done while reading; this will help when you review or re-read the chapter.

Will stop-and-go reading slow you down? Yes, but that can be good. If original awareness is minimal and you don't understand-and-remember what you read, it would be more appropriate to call it "wasting time" than "reading". Activity breaks may help you understand and remember; because of increased learning efficiency, frequent brief stops will save you time in the long run.

RE-READING: Use "successive approximations" to get an increasingly accurate and complete understanding. It is often useful to do three readings: a quick survey, careful reading, and re-reading. Depending on your time, purpose and motivation, re-reading can be done carefully, or a quick review of the important points (use your notes and book-marking as a guide), or just read what you need for doing problems.

Use the welder's "search for insight" strategy to develop an effective way to combine your reading (survey, careful, re-reads) with other important activities: listening to lectures, making a summary, problem solving practice, and reviewing.