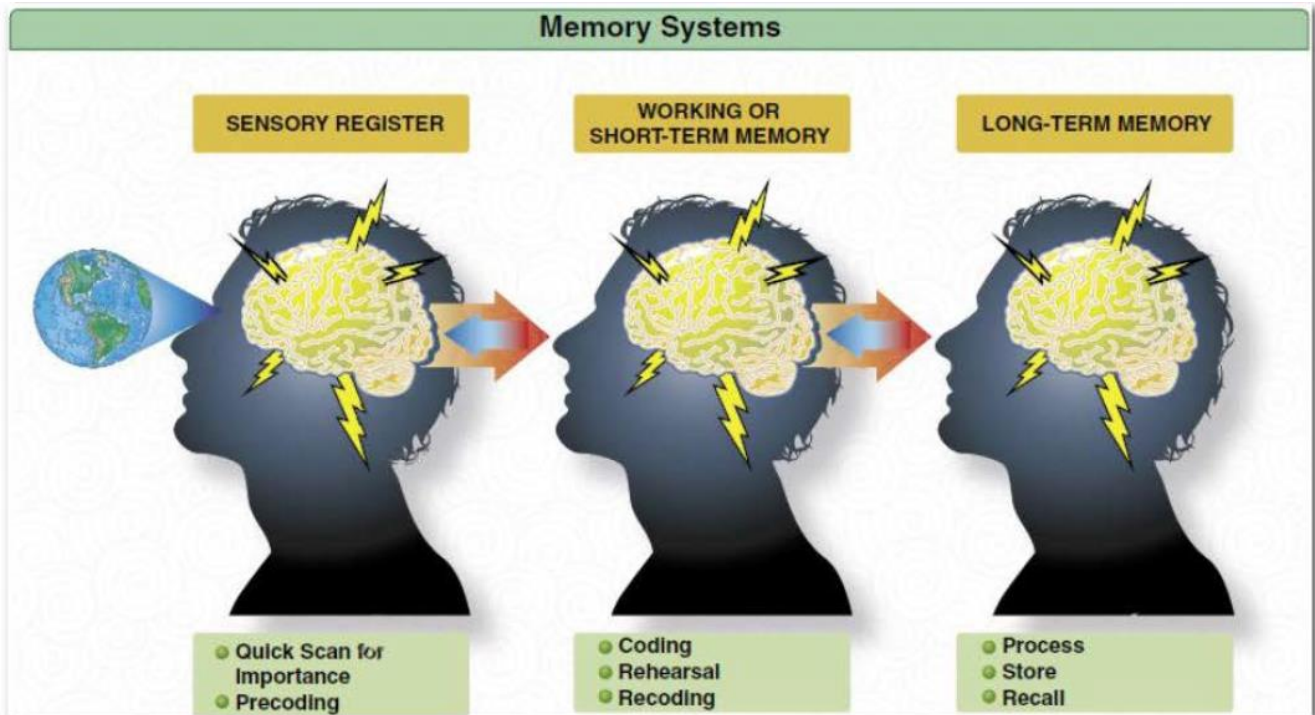


## Math Skills Center Tutoring

One goal is to get information into the long-term memory where it can be stored and recalled when needed.



### The Goals of Tutoring

1. Promote Independent Learning - A tutor helps students to help themselves and reduce their need for continual assistance. Confidence and self-reliance, along with knowing how to learn, enables students to successfully learn new tasks.
2. Respect Individual Differences – Tutors can personalize instruction by understanding that all students have different backgrounds and abilities. Working one-on-one or in small groups have benefits over classroom instruction. The tutor can use examples relevant to the students and drawn from their experiences, elicit students' ideas, and can more closely follow and anticipate student progress.
3. Promote Active Learning - A tutor's job is to make it easier for students to do their own work, not to do the job for them. Help students discover answers and brainstorm ways to find solutions to their questions.
4. Provide a Student Perspective - Rapport with students will come from being one of them. This is an advantage you have when working with the students. Credibility comes from the fact that you are a successful student.
5. Enhance Motivation – A tutor's focus is on how they can help the student be successful. Provide positive feedback and genuine praise. Motivation results from internalized feelings of success at meaningful tasks. The more success, the higher the motivation.

## **Responsibilities of the Tutee**

1. Come prepared with notes, textbook, questions, etc.
2. Be a willing participant in the process.
3. Don't expect the tutor to do all of the work and writing.
4. Take responsibility for their performance for work on which their grade is based.

## **Responsibilities of the Tutor**

1. Convey respect, support and encouragement to the tutee.
2. Give the tutee their full attention – greet the tutee, show interest, make eye contact, smile and listen attentively. Maintain a positive demeanor.
3. It is NOT the tutor's responsibility to explain the contents of the whole chapter to a student who has been absent from classes.
4. Be honest with the tutee if you do not know how to do a problem and seek assistance. Tutors are only human and may find themselves stumped or drawing a blank on a question. It is not bad for a tutee to witness a tutor going through the learning process.
5. Be patient. If there are a number of tutees at one time, work with one and then ask them to finish a problem or try another problem on their own as you go to help another student. Encourage students in the same class to sit together and work together.

## **Metacognition**

Metacognition is your awareness of how well you truly understand a concept.

Levels of processing says that memory is composed of a continuum of levels from shallow to deep.

1. Shallow levels involve studying meaningless, superficial properties of what you are trying to learn, like mindless re-reading or memorization.
2. The deepest levels of processing involve thinking about material meaningfully, interpreting the information and relating it to your prior knowledge or experience, or creating a mental image of the information.
3. Deeper processing leads to better recall.

The deeper you process information; the better you recall it.

1. Make connections from the old topics to the new topics.
2. Make connections between properties and identities and why you do the steps you do to solve problems.
3. Practice a variety of problems using the concepts within different scenarios.
4. Practice solving problems without referring to notes or other aids. Try to identify where and why you made an error.
5. Help others. Explaining how to do something to someone else helps you recall and remember the details.

## Two Modes of the Thinking Process

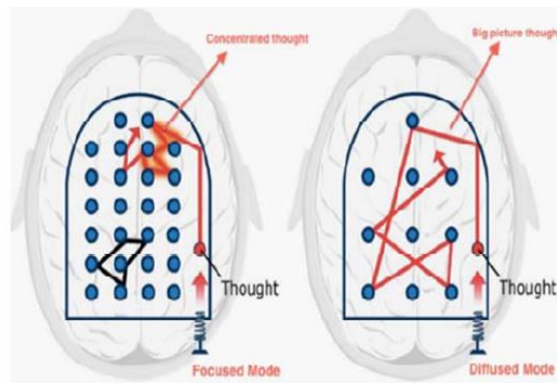
### Focus Mode

Focused-mode involves a direct approach to solving problems using rational, sequential, analytical approaches and is associated with the prefrontal cortex. Turn your attention to something and the focus mode is on.

Although focused mode is a required and important element of first learning the material, being in focused mode too long can detract from learning. When staying in focused mode too long – such as when they are stuck on a math problem – this becomes more problematic than helpful. By intensely focusing on the problem for too long, we experience tunnel vision and lose our ability to think outside the box in order to solve a problem.

### Diffuse Mode

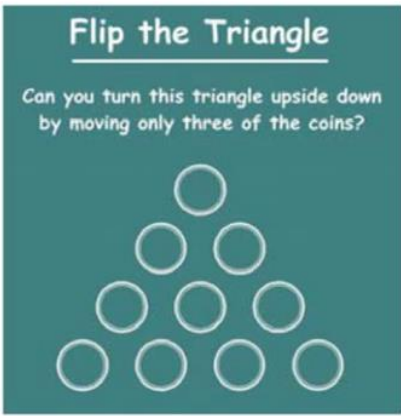
Diffuse-mode thinking is what happens when you relax your attention and just let your mind wander. This relaxation can allow different areas of the brain to hook up and return valuable insights. The diffuse mode cannot just be commanded to turn on.



Alternating between focused and diffuse thinking is the best way to master a subject or solve a difficult problem. First, we use the focused mode of thinking to understand the basics of a topic without any distractions. Then we use the diffuse mode to possibly internalize what we have learned and make connections to other things we already knew. Afterwards, we go back into focused mode and pare down the connections that we made to the best, most helpful ones. Focus mode can be compared to a tightly focused beam of flashlight versus a wide beam which represents the diffuse mode.

To get in the diffuse thinking mode, it helps to do something totally different, like:

- Go for a work-out or at least get moving: go outside and take a walk;
- Do something totally different: drink coffee, have small talk, play a game;
- Read about a totally, non-related subject;
- Sleep or take a nap.



By focusing on a problem too long, we begin to work within an arbitrary set of parameters and assumptions/premises. However, it could be that the set of parameters we arbitrarily set is not the correct or the best way to solve a problem. Thus, staying in focused mode too long can be detrimental to learning. So, the next time you are stuck on a problem, take a little break, let your mind go into diffused mode, and start again with a clean slate in focused mode.

“Thiss sentence contains three errors.”

Unfortunately, you cannot use both simultaneously, but you want to be able to switch between the two. Both are equally important. Stopping work for 10 minutes while you read a funny story or play a game online can give your brain enough downtime to switch into diffused mode and start churning away.

**Primacy-Recency Effect**



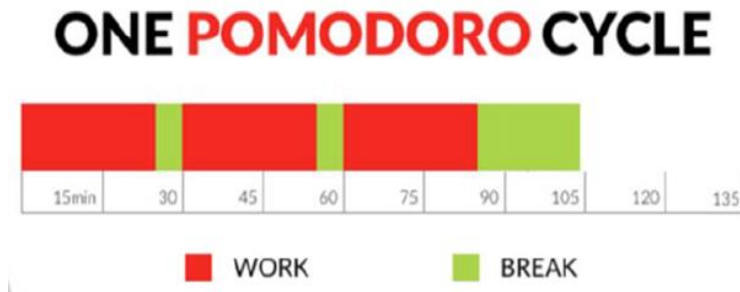
We remember best that which comes first, second best that which comes last, and least that which comes just past the middle. The first items are within the working memories capacity. As the learning episode concludes, items in the working memory are sorted or chunked to allow for additional processing of the arriving final items.

**Pomodoro Technique**



The “Pomodoro” (means tomato – named after a timer shaped as a tomato) is a technique that’s been developed by Francesco Chirillo to help you focus your attention over a short period of time.

- Go to a place that you can concentrate.
- Set a timer for 25 minutes.
- The stress of being under a timer has been found to be helpful. Learning under mild stress can help you learn to handle stress more easily.
- Completely focus on the task for 25 minutes with no distractions. Train yourself to ignore distractions.
- When done, take a break. Break time depends on the deadline that you are under.
- Concentrate on process (the way you spend your time) vs. product (what you want to accomplish).
- This allows you to go from focus to diffuse-mode.



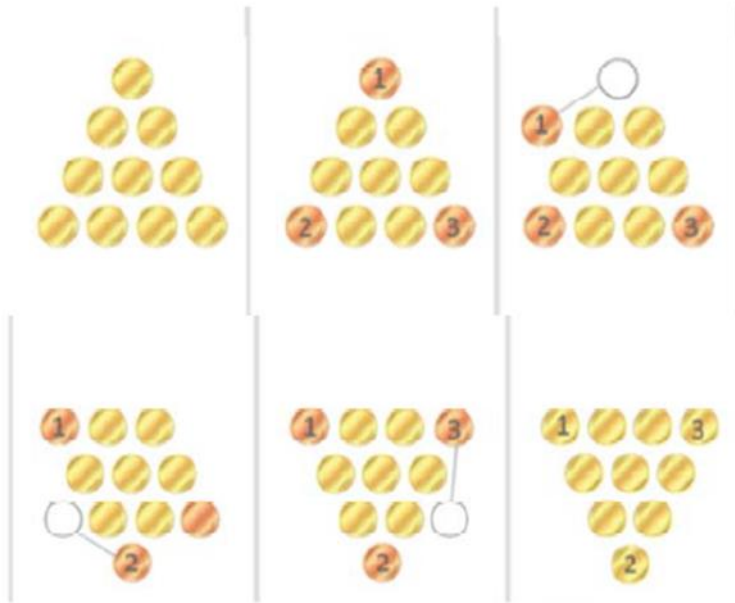
Turn off your phone and any sounds or sights that might signal an interruption. If you get distracted you’re going to have difficulty making a chunk. When you are first learning something, you are making new neural patterns and connecting them with preexisting patterns that are spread through many areas of your brain.

Additional Tips: Get a glimpse of what you are learning before returning later to more fully understand it. Take a “picture walk” through the section glancing at the section headings, graphics, diagrams and photos, summary and even questions at the end of the sections. This helps prime your mental pump. Look through a section (chapter) quickly and then more step-by-step.

### **Self-regulated Learner**

- Self-regulated learners are able to assess their learning accurately.
- They internalize their locus of control and feel empowered to attribute successes and failure to their own study habits and efforts.

Can you turn the triangle upside down by moving just three coins?



## Amygdala

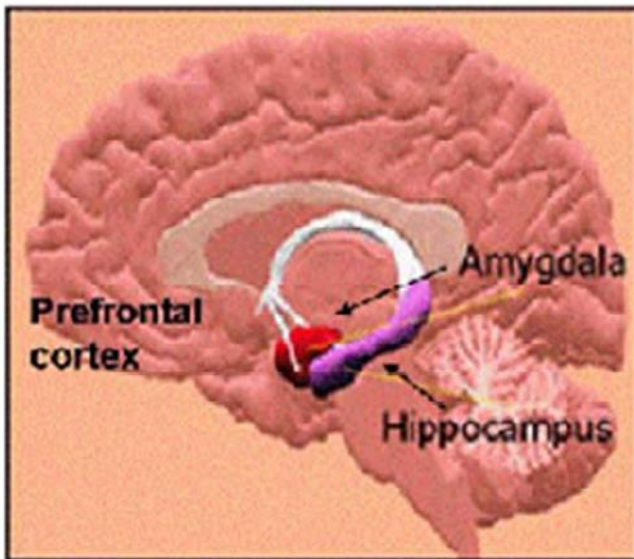
- Sensory receptor areas of the brain must travel through the amygdala to get to the prefrontal cortex.
- When the amygdala is in a state of stress, new information coming through the sensory intake areas of the brain cannot pass through the amygdala to again access to the memory circuits.

Subsequent research revealed that after presentation of pleasurable, comforting, positively reinforcing, intrinsically motivating stimuli, the amygdala could be moderately stimulated or warmed up to the alert state that actually facilitates active processing and neuronal transport of information. (Willis, 2006).

Amygdala hijacking – negative feelings cause the hormone cortisol to enter the bloodstream. Cortisol puts the brain into survival mode; this shifts the brain’s attention away from learning so it can deal with the source of stress... Stress in the classroom or elsewhere, especially when associated with anxiety or fear, releases a chemical called TMT, or trimethyltin, into the brain. TMT disrupts the brain’s cell development. In the hippocampus region, through which data must pass to be encoded as memory, stress-related release of TMT – both acute and chronic – suppresses the growth of dendrites and maintenance of neuron health.

When students feel positive about learning situations, chemicals called endorphins (provide feeling of euphoria) and dopamine (stimulates the prefrontal cortex) become active.

A stress state happens when a lesson is tedious, not relevant to their lives, confusing, or anxiety-provoking.



When we speak of the cortex pathway to anxiety, we're focused on interpretations, images, and worries that the cortex creates, or on anticipatory thought that create anxiety when no danger is present. The information passes through the amygdala, allowing your amygdala to react before your cortex can think. The amygdala forms and recalls emotional memories. The amygdala initiates the physical experience of anxiety. We have little control over the amygdala's rapid responses which means that we experience our fear and anxiety responses, rather than consciously controlling them. {There's actually two amygdala, but the reference is often singular.}

### **Anxiety**

- When stressed, we begin to lose the ability to connect pertinent ideas that are so innate to focused mode.
- A little bit of stress allows us to perform at our peak, but too much stress inhibits our ability to think clearly.
- This is why the brain doesn't work quite right when we are angry or afraid.
- Thus, the idea of taking a break when frustrated is grounded in factual evidence.

### **Anticipation**

The anticipation of negative situations creates threatening thoughts and images that can significantly increase anxiety. The experience of anxiety is often more distressing than the anticipated event.

## Procrastination

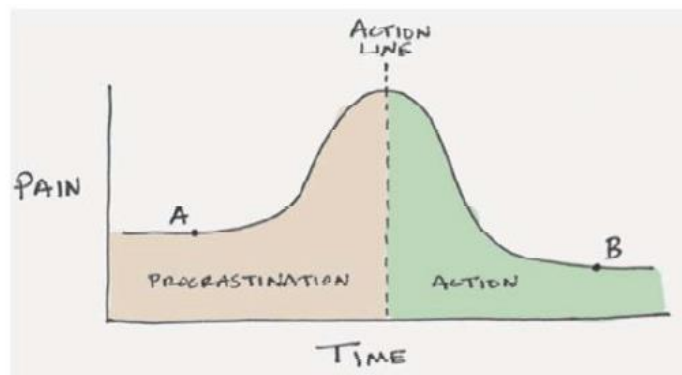


When you procrastinate, you are leaving yourself only enough time to do superficial focused-mode learning. If you cram for a test at the last minute or quickly breeze through your homework, you won't have time for either learning mode to help you tackle the tougher concepts and problems or to help you synthesize the connections in what you are learning.

A Typical Procrastination Pattern:

- You think about something you don't particularly like.
- The pain centers of your brain light up.
- You shift and narrow your focus of attention to something more enjoyable.
- You feel better, at least temporarily.

The anticipation is what is painful. "The dread of doing a task uses up more time and energy than doing the task itself." (Rita Emmett)



As soon as you cross the Action Line, the pain begins to subside. In fact, being in the middle of procrastination is often more painful than being in the middle of doing the work. Point A on the chart above is often more painful than Point B. The guilt, shame and anxiety that you feel while procrastinating are usually worse than the effort and energy you have to put in while you're working. The problem is not doing the work, it's starting the work. We procrastinate about things that make us feel uncomfortable. Mathphobes appear to avoid math because even just thinking about it seems to hurt. The pain centers of their brains light up when they contemplate working on math. It was anticipation that was painful.



When mathphobes actually did math, the pain disappeared. The dread of doing a task uses up more time and energy than doing the task itself.

Realize what launches you into procrastination mode...

Start new cues, such as starting homework at a given time. Give yourself a reward...sense of satisfaction...sense of pride in accomplishment...latte...movie...

Habits are powerful because they create neurological cravings. Only once your brain starts expecting the reward will the important rewiring take place that will allow you to create new habits.

The rewiring, sometimes called learned industriousness, helps brighten tasks you once thought were boring and uninteresting.

The trick to overwriting a habit is to look for the pressure point – your reaction to a cue. The only place you need to apply willpower is to change your reaction to the cue. It takes a bit of struggle through a few cycles of the Pomodoro technique before starting to enjoy the work on something new. The better you get at something, the more enjoyable it can become. You need to believe the system can work.

It is easy to feel distaste for something you're not good at, but the better you get at something, the more you'll find you enjoy it. (Oakley, 2014)

## **Controlling Anxiety**

- Breathing-Focused Strategies
- Muscle-Focused Relaxation Strategies
- Imagery

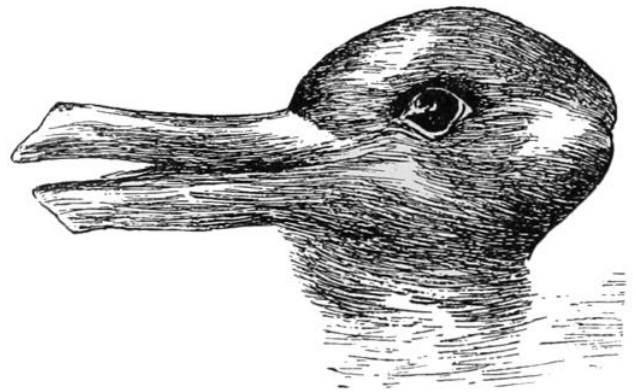
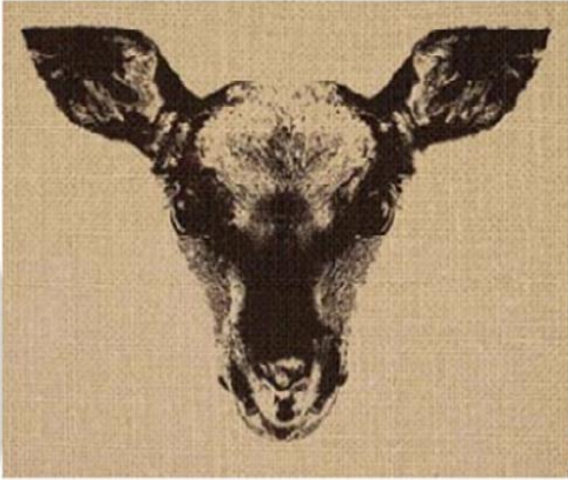
When anxious, we tend to breathe quickly and shallowly which may result in not getting enough oxygen and produces an uncomfortable sensation. Effective diaphragmatic breathing will cause your stomach to expand as you inhale and retract as you exhale. Your chest shouldn't move much at all. Try to focus on breathing deep in a manner that expands your stomach as you fill your lungs with air. The movement of the diaphragm has a massaging effect on the liver, the stomach and even the heart.

Take a brief inventory of your entire body to see where you're holding your tension at the moment (shoulders, jaw, lips, fist, toes, ...).

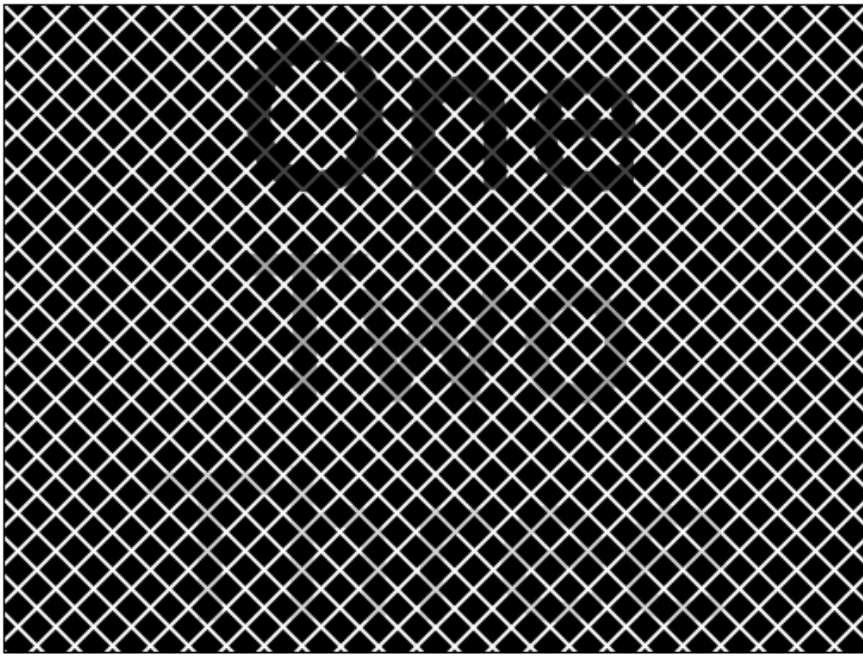
Take yourself to another location in your imagination. Close your eyes and allow yourself to experience the special place in detail. End the session gradually by counting backwards slowly from ten to one.

## Cognitive Restructuring Strategies

Change interpretation to reduce anxiety.



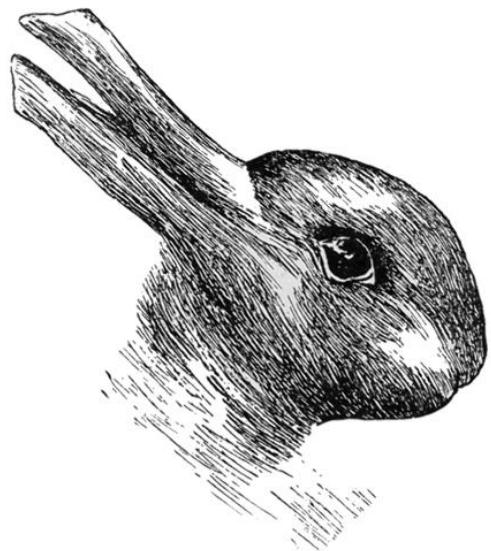
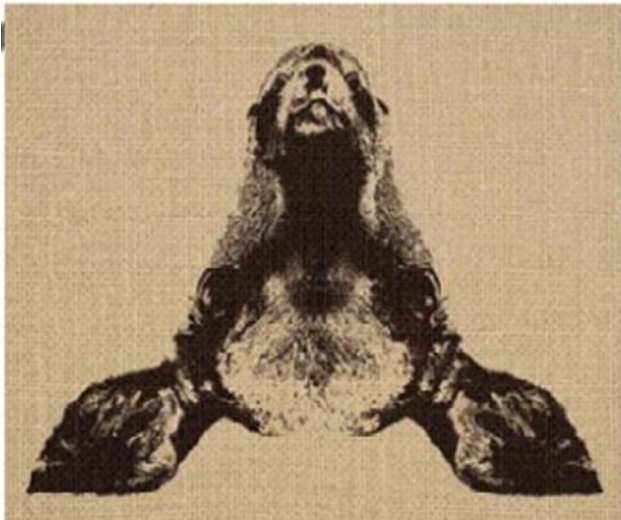
**Andoriccg to recesarh at Cdabmirge Unirtvsiey, it dseon't mettar in waht oredr the lerttes in a wrod are. The olny itponamrt tnihg is taht the fisrt and lsat letetr be in the rhgit plcae. The rset can be a tatol mses and you can sitll raed it woutiht any prlebmos. Tihs is bacseue the huamn mnid deos not raed evrey leettr by iteslf, but the wrod as a wlohe.**



<http://www.brainbashers.com/showillusion.asp?>

Learn to control what you're imagining, thinking, or telling yourself. By changing your thoughts, you can establish new patterns of responding in the brain that become stable and enduring.

Example: A student looking at a graded paper with comments and corrections and thinking that the teacher must think they are a terrible student. Instead, they could think of it as the teacher giving helpful feedback they can learn from and do better next time.



## Assessing Pessimistic Tendencies

Part of the cortex's job is to help interpret experiences and make predictions about what's likely to happen in the future. A general perspective can have a strong impact on this process.

A pessimistic attitude can make a student less willing to try to change their anxiety because they don't expect success.

Deliberately attempting to take a positive view of a situation has been shown to activate the left hemisphere. This shows that pessimism can be modified.

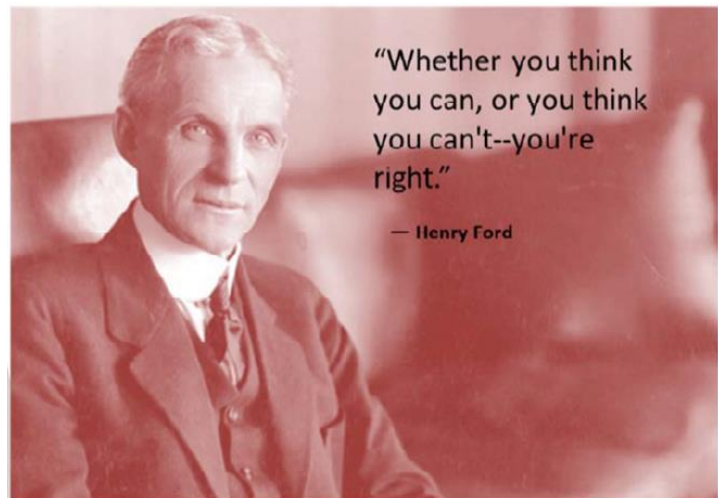
The nucleus accumbens, a structure in the frontal lobes is the pleasure center in the brain that's involved in hope, optimism, and the anticipation of rewards. It's where the neurotransmitter dopamine is released, and studies have shown that when the brain levels of dopamine are higher, negative expectations are reduced and optimism increases. (Pittman & Karle, 2015)

Remind yourself that your thoughts don't determine what happens. You're an observer of your cortex, not a believer of everything it produces.

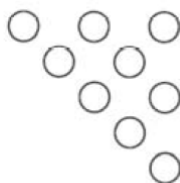
What can we do to help out students avoid unproductive anxiety?

Help them...

- experience success
- become accountable
- avoid procrastination
- be organized
- build problem-solving strategies
- develop good study habits
- understand how the brain learns.



What is the minimum number of coins you can move to change this triangle into a square?



Solution:



Here are the factors that do contribute to your academic success:

1. Minimizing distractions; Maximizing focus

- a. Prepare for class by reading the section ahead of time.
- b. Take notes on reading material.
- c. Write down questions to ask when you get to class.

2. Developing accurate metacognition

- a. Complete any reading assignment
  - i. DON'T GUESS at the multiple choice problems. Really focus on understanding why one answer is the best choice.
- b. Write the steps for your homework solutions in your notebook.
  - i. If your answer is incorrect, be sure you understand where you went wrong and why it was incorrect.
- c. TRY first. Then refer to notes or ask questions if needed.

## Neuroscience

- Teachers are brain changers! Tutors are teachers.
- The more we know about how the brain learns, the more equipped we will be to help students succeed.
- The more we know, the more equipped we are to tell fact from hype when it comes to brain research.

Here is a summary of excerpts regarding neuroscience research and possible implications to teaching methods.

- After 10-20 minutes, mental fatigue or boredom with an item occurs and focus drifts.
- For focus to continue, there must be some change in the way the individual is dealing with the item.
- Help students make connections and see patterns.
- Rote learning is inefficient.
- We remember best that which comes first, second best that which comes last, and least that which comes just past the middle. The first items are within the working memories capacity. As the learning episode concludes, items in the working memory are sorted or chunked to allow for additional processing of the arriving final items.
- Increase student engagement by supporting their intrinsic motivation and refraining from more directed lecture instruction and from solving problems for them.
- The person who thinks, learns.
- Encourage them to try first and then ask for assistance.
- Frequent feedback is critical.
- Positive reinforcement can be a powerful factor, and technology can help provide external reinforcement and reward when the instructor is not there.
- If students can always get immediate help, they may become dependent and never learn to solve problems for themselves.
- Feedback is a key contributor to motivation. Effective feedback is timely. Good feedback is also specific. Positive feedback stimulates the prefrontal cortex to reflect on ways to improve.
- No one teaching method exists that is best for all students all the time. Successful teachers use a variety of methods, keeping on mind that students are more likely to retain and achieve whenever they are actively engaged in the learning. Numerous studies have shown that teacher lecture often results in the lowest student retention compared to other instructional methods. Elaborative rehearsal is minimal or nonexistent. It's not what the teacher presents, it's what is learned. Interactive lecture included the teacher providing information and direction, but the students have periodic opportunities during the lesson to give feedback on what they have learned.
- Practice does not make perfect. Only perfect practice makes perfect. – Vincent Lombardi
- Practice makes permanent.
- Early practice (guided practice) should be done in the presence of an instructor.
- Once the information is successfully retrieved, it still needs to be reviewed between four and even times to ensure retention.
- If the student unknowingly practices the skill incorrectly, they will learn the incorrect method well.
- Practice should take place in short, intense periods when the working memory is running in prime-time.
- New learning should be practiced frequently (massed practice).
- New learning should continue to be practiced over increasingly longer time intervals (distributed practice).
- Spending a lot of time on ask in and of itself is not sufficient to ensure effective learning.
- 70 – 90% of new learning is forgotten within 18 to 24 hours after the lesson.
- Processing and transfer needs adequate time to process.
- It is during sleep that the brain reaccumulates the greatest amount of the neurochemicals needed to stimulate dendritic growth.
- The period of deep sleep is the critical time when the brain transforms recent memories into long-term memories by building and extending the dendritic branches.
- It is not the strongest species that survives, nor the most intelligent, but the ones most responsive to change. – Charles Darwin

Sousa, D. (2011). *How the Brain Learns*. Thousand Oaks: Corwin, A SAGE Company.

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## **The Didactic and Socratic Methods**

In the didactic tutoring style, the tutor begins by presenting the student with an explanation of the material the student is meant to learn in the interaction. After the initial explanation, the tutor leads the student through a directed line of reasoning similar to that used in the Socratic condition, except that the questioning plays more of a role of drawing the student's attention to information that the tutor has already explained, rather than eliciting this information from the student.

Socratic is eliciting information from students through a direct line of reasoning. The tutor strives as much as possible to avoid giving information away.

That hurried and harried demeanor is something we see in many of our students, who often come to the tutoring center in desperation, looking for quick answers and a regurgitation and recitation of several week's worth of material. But instead of just giving students the quick answers they seek, we try instead to teach them a process – the process of learning how to learn. (Cleveland, 2008)

As a tutor in the MSC, make an effort to practice the Socratic Method line of questioning because the student should have already been introduced to the topic and needs to be challenged to recall it.

## **Leading Questions**

The tutee may be expecting some answers! Instead, the tutor starts asking them questions. What notes do you have on the class lectures? How does your instructor introduce this section of the material? What chapters have you been assigned to read? What are the main topics of these chapters? What key words do you recall from the reading? Yes, they come to a tutor to get help, and no, the tutor's job is not to give them the answers.

The MSC tutors will be encouraged to resist passive learning by the tutee and to ask probing questions to force students to recall, use and process prior knowledge. This allows the tutor to guide the tutee in small gradual steps to lead to understanding the larger concept. This is no easy feat. Also, utilizing questions promotes active learning and prompts tutees to think on their own and make connections.

Students learn to approach seemingly complicated learning tasks by breaking them up into small parts. The questions are structured so the student is forced to think independently. They provide the tutor with continuous, reliable feedback about the student's comprehension and offer frequent opportunities for the tutor to praise the tutee's success.

The following is a sample dialogue illustrating the application of leading questions between the tutor Kevin and the tutee Sharon.

A problem in Sharon's textbook appears as follows:

Solve the equation.  $\sqrt{3x-5}+11=15$

Sharon: "I'm not sure how to begin."

Kevin: "Well, what does the word 'solve' mean?"

Sharon: "Find what x is...?" (said with uncertainty in her voice.)

Kevin: "Exactly. That's very good. Now, would you agree that 'to find what x is' means we have to get x alone on one side of the equal sign?"

Sharon: "Yes"

Kevin: "Can you think of an operation you could do to both sides of the equation that would get you closer to isolating x?"

Sharon: "I'm not sure."

Kevin: "Well, would you be closer to isolating x if you could eliminate the '+11' from the left side."

Sharon: "Yes."

Kevin: "Exactly. That's good."

[At this point, Sharon does the work shown at the right.]

Kevin: "Now what's the next symbol you'd like to eliminate from the left side?"

Sharon: "I guess the square root sign."

Kevin: "That's right. Can you recall how to get rid of the square root signs?"

$$\begin{array}{r} \sqrt{3x-5}+11=15 \\ -11=-11 \\ \hline \sqrt{3x-5} = 4 \end{array}$$

Sharon: "No... I'm not sure."

Kevin: "Well, here's a hint. Usually, in order to undo something, we use the opposite or reverse process, like when you wanted to undo +11, you chose to subtract 11 from both sides. So what would you think of as being the reverse of taking a square root?"

Sharon: "Squaring."

Kevin [nodding and smiling]: "Exactly. But should we just square the left side?"

Sharon: "No. We need to do the same to both sides."

$$\begin{array}{r} (\sqrt{3x-5})^2 = 4^2 \\ 3x-5 = 16 \end{array}$$

Kevin: "Okay and what happens to the left side when we square the square root?"



Sharon: "It just disappears."

Kevin: "Very good. Go ahead."

[At this point, Sharon does the work shown at the right.]

Kevin: "Nice job. What's next?"

Sharon: "I add five to both sides."

Kevin: "You got it. I bet you know how to finish it from here."

Sharon: "I think so."

[At this point, Sharon does the work shown at the right.]

Kevin: "Terrific work, Sharon. Now, what can you do to be 100% sure that 7 is the correct answer?"

Sharon: "Plug 7 back in for x in the beginning."

Kevin: "That's right. We check by substituting 7 for x. What should we do after we substitute?"

Sharon: "We work out both sides to see if they are the same."

Kevin: "Precisely. Why don't you do that."

[At this point, Sharon does the work shown at the right.]

Sharon: "Yes. It checks. The answer is 7."

Kevin: "Great work, Sharon. Congratulations."

$$\begin{array}{r} 3x - 5 = 16 \\ + 5 = + 5 \\ \hline 3x = 21 \\ \frac{3x}{3} = \frac{21}{3} \\ x = 7 \end{array}$$

$$\begin{array}{l} \sqrt{3(7) - 5} + 11 = 15 \\ \sqrt{21 - 5} + 11 = 15 \\ \sqrt{16} + 11 = 15 \\ 4 + 11 = 15 \\ 15 = 15 \end{array}$$

After you have helped a student successfully solve a problem by asking questions, try having them solve a similar problem on their own while explaining to you what they are thinking and why they are doing each step.

## Probing Questions

Probing questions are open-ended questions that encourage students to think more deeply. The tutor does not have any particular work or phrase in mind as the answer to the question. They prompt students to think critically and conceptually about a topic and not just memorize information. A probing question may follow a leading question to get the student to elaborate.

### Three Types of Probing Questions

1. **Clarification probes** are used when a tutor wants to get a better picture of what the tutee does and doesn't understand.
  - a. "What exactly do you mean by \_\_\_\_\_?"
  - b. "Can you explain what \_\_\_\_\_ means?"
  - c. "Could you be more specific about \_\_\_\_\_?"
2. **Critical Thinking probes** are used to enrich their understanding by asking the student to justify or explain the reasons behind an answer.
  - a. "Why is it true that \_\_\_\_\_?"
  - b. "Can you give an example of \_\_\_\_\_?"
  - c. "How did you come up with \_\_\_\_\_?"
  - d. "What does your answer represent?"
3. **Connection probes** prompts student to investigate the potential relationship between two idea or topics.
  - a. "How does \_\_\_\_\_ relate to \_\_\_\_\_?"
  - b. "Can you see a connection between \_\_\_\_\_ and \_\_\_\_\_?"
  - c. "If \_\_\_\_\_ is true, what does that tell you about \_\_\_\_\_?"
  - d. "Since you've established that  $0 = x^2 + 4x + 7$  has no real solutions, what does that tell you about the graph of the parabola  $y = x^2 + 4x + 7$ ?"

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Rose, M.V. (n.d.). *A comparative Evaluation of Socratic versus Didactic Tutoring*. Retrieved August 5, 2014.

### Application Problems Strategies

#### Polya's Problem Solving Technique

When helping a student solve application problems, ask questions that lead them through a technique that they can repeat when they are by themselves. One method is George Polya's basic principles of solving.

1. Understand the Problem
  - a. This may seem obvious, but some may not even know what the problem is asking.
    - i. Do you understand what the problem is asking?
    - ii. What are you asked to find or show?
    - iii. Can you restate the problem in your own words?
    - iv. Can you think of a picture or a diagram that might help you understand the problem?
2. Devise a Plan
  - a. The skill at choosing the appropriate strategy is learned by solving many problems. The strategies may include:
    - i. Guess and check
    - ii. Consider special cases
    - iii. Solve an equation
    - iv. Draw a picture
    - v. Use a formula
    - vi. Solve a similar problem

### 3. Carry Out the Plan

- a. Take time and patience to see if the plan you devised is correct. If it doesn't work, discard it and choose another. That is how mathematics is done.

### 4. Look Back

- a. Reflect and look back on what you've done, what worked and what didn't.
  - i. Does the solution answer the question being asked?
  - ii. Does the solution make sense?
  - iii. What were some keys to this problem that can help solve a future problem?

(Polya's Problem Solving Techniques, <http://math.berkeley.edu/.../polya.pdf>)

## Steps to Solving an Application Problem

### 1. Define the Unknown(s).

- a. What is the problem asking you to find? What do you need to know to find the solution? Use a variable, variables or an expression to represent the unknown. Even if a student has not been taught solving equations with more than one variable, they may still use more than one variable and apply the substitution method.
- b. Defining the unknowns can be done using words, a diagram or a table.

### 2. Write an Equation(s).

- a. Often one English sentence represents one algebra sentence (equation). This may not always be true, but it does help break the problem into pieces when they are looking for more than one thing.

### 3. Solve the Equation(s).

### 4. State the solution in a complete sentence.

- a. This is where step one helps. Once they solve the equations they can refer back to step one to see what the variables represented.
- b. Writing the solutions in a sentence helps them check that they understand the problems and they actually answer the questions that the problem was asking.

## Effective Tutoring Behaviors

1. Be friendly. This seems obvious, but remember that some students feel very uncomfortable and insecure about asking for help. Being friendly is the first step in helping students feel comfortable and welcome.
2. Be clever, creative, and flexible. Tutoring is hard because you have to constantly devise new ways of presenting information and strategies, as well as ways to have the student practice.
3. Be patient (and encourage the student to be patient). Learning takes time.
4. Build confidence. Do not always focus on what the student is doing wrong but give equal time to what the student is doing right.
5. Be sensitive, respectful, and understanding. If learning is partially dependent on background knowledge and experiences, you might need to consider a student's racial, ethnic or cultural background.
6. Empathize with your students. One of the reasons peer tutoring works so well is that tutors can share their recent experiences in learning a new concept or skill, making mistakes, feeling pressured, and struggling with learning.
7. Do not be afraid to make mistakes and admit that you do not know. Mistakes are a necessary part of learning and discussing them is an excellent teaching tool.
8. Do not feel guilty if your tutee does not do well on an assignment or task. Review what they did well, the mistakes they made, and the next steps to getting back on track.
9. Maintain confidentiality about students and professors. Be careful of where conversations take place and who might be listening.
10. Be dependable. Be on time for your shift and expect the same from other tutors.
11. Be organized. Log tutoring contacts regularly.
12. Be professional. This includes being respectful of professors. Help students develop constructive strategies for dealing with issues or frustrations they might have with professors.

## Tutoring Techniques

### Modeling Clear Thinking

- Be mentally prepared for your shift and take time during your shift to gather and clarify your thoughts.

### Model Strategic Thinking and Learning

- Share a wide range of strategies that you and others have found effective and explain that developing effective strategies leads to independence.
- There are many study skills that are discipline specific, so part of your job is helping students understand and practice how to read, write, and study effectively for math.
- Make sure you build on the skills and strategies that the tutee is already using. Research suggests that if a student has a strategy that is partially working, it is more effective to help the student adapt, adjust or refine that strategy, rather than introducing a new strategy.
- Suggest a variety of ways the student might practice and apply what they are learning.
- Do not do the work for the student. Your tutee needs to understand that your job is to help them develop effective learning strategies and find answers for themselves, not to give them the answers. In this process, you will need to focus both on asking questions and on modeling clear thinking, strategies, and behaviors.
- Do not hold a pencil. That is hard to do, but is important. All the writing should be done by the tutee to make sure they are doing the work. If you are using the board, make sure you are not doing all of the writing. Invite the student up to work at the board and work through the problem(s).

### Listen and Observe

- Ask a lot of questions. Monitor how much you talk and your tutee talks. Think about ways to ask questions and then how to follow-up on those questions to both diagnose the problem and guide the tutee's understanding and learning. Consider your wait time after asking a question and consider appropriate ways to answer a student's question with another question.

### Monitor Your Communication with your Tutee

- You may use certain words or phrases that may mean something entirely different or may mean nothing at all to your tutee. Think about the subtle as well as more obvious ways you communicate information. Consider your body language, nonverbal communication, tone of voice, pace, and wait time when you ask questions.

### Focus on Critical Vocabulary

- Confusion often can be traced back to misunderstanding about the major vocabulary of a discipline.

### Consider Learning Style

- Both you and your tutee have a preferred style of taking-in and conveying information. Your learning styles may be similar or different. Think about ways to share information in several different formats, for example auditory, visually, or kinesthetically.
- Consider ways of breaking ideas and tasks into smaller parts and ways of making the information or skills as concrete as possible. Try to think about a teaching progression that moves from the concrete to the semi-concrete to the abstract.

### Learn From Your Fellow Tutors

- Talk with other tutors about their approaches and strategies that work.
- Brainstorm alternatives, but remember to maintain confidentiality about specific students.

## **Tutoring Tips**

### **Be Patient**

It is often tempting to give the tutee the answer to a difficult problem, but this approach is not beneficial. Instead, try giving hints in the form of questions. Ask questions to help the tutee progress step-by-step. This technique helps the tutee reason through the problems. If the tutee is still struggling, ask them to explain the basic concepts to you. Often this will make the tutee realize their mistakes.

### **Be Understanding**

Determine the tutee's background knowledge by asking review questions. It is also helpful to examine mistakes the tutee has made on previous homework or exams to see if there is a pattern. Try to approach the problems from the tutee's perspective. Ask to see the tutee's notes and listen fully to the tutee's questions before answering it. However, do not engage in negative conversations about the professor. Remembering your own experience, have realistic expectations and do not cover too much information in one session.

### **Make the Tutee Feel Comfortable**

Because many students are apprehensive about seeking help, it is important that tutees feel comfortable. Start with questions you know the tutee can answer to build confidence. Talk positive to the tutee, congratulate them for the material they do know, and praise improvement. Never laugh or make fun of a tutee, but a little bit of humor helps to ease the frustration. Make good eye contact and do not talk too fast. Most importantly, be friendly and flexible.

### **Explain Things Multiple Ways**

If a student does not understand something, try to explain it another way. Relating concepts to practical examples often makes the concepts easier to grasp. Ask the tutee the main idea of the section and try using visual aids such as analogies and diagrams. When problem solving, break down your process into small steps. Have the tutee write as much as possible and encourage them to repeat what you have explained. Then ask the tutee to apply these steps to another problem without your assistance.

### **Group Tutoring**

In drop-in situations, make each tutee feel equally important. Help one student at a time; however, if the number of students overwhelms you, suggest that they work together. Do not be afraid to tell a tutee that they need to work on their own first and encourage all tutees to prepare specific questions. If a student is really struggling, suggest that they talk with their professor.

## **The Art of Questioning**

Question – What Can I Do If:

- I am having difficulty determining the tutee's specific needs?
- I am having difficulty determining what they know from what is unclear?
- The tutee seems to be passive and uninvolved?
- I want the tutee to focus on process as well as a final answer or product?
- The tutee is not drawing on their prior knowledge or experience?
- I find myself giving long explanations and doing all the talking?
- The tutee is becoming too dependent on me?

Suggestion: Use a Questioning Strategy

The ability to ask probing questions is critical for a tutor. An effective questioning strategy challenges the tutee to become more active in their learning process and helps both the tutor and the tutee determine the level of understanding, diagnose the problem areas, and move toward next steps and solutions. Often answering a tutee's questions with another question guides them to think critically, discover answers, and solve problems on their own. Questions help to focus on the tutee's knowledge rather than a display of the tutor's knowledge or lengthy explanations.

### **Preface Questions**

Preface questions allow the tutor to gather necessary information and establish a good rapport with the tutee.

- What is your name, dorm, etc.?
- Who is your instructor?
- Have you taken any other math courses?
- How can I help you?

### **Pace Questions**

Pace questions allow the tutor to set a reasonable pace. By determining what the tutee already knows, the tutor can decide on what to accomplish.

- What can you tell me about ...?
- Tell me everything you know about ...?

### **Probe Questions**

Probe questions allow the tutor to determine more specifically, what the tutee knows and the information or concepts about which they are unclear. They help the tutee maintain a searching attitude. Probe questions begin with what the student knows and move toward the unknown. Usually, most tutoring is at the probe level.

- Why?
- Can you give me reasons for that?
- What makes you think so?
- Can you tell me more about that?
- Can you give me examples?
- Would you explain what you mean by ...?

### **Prod Questions**

Prod questions encourage the tutee to guess. Guessing or generating hypotheses and then testing them is critical in the comprehension and learning process.

- If you had to guess, what would you say?
- What do you think it is?
- What do you feel it is?
- What might you conclude from ...?
- Can you guess why ... happened?

## **Prompt Questions**

Prompt questions provide hints or explanations in the form of questions. These questions help the tutee discover the answer.

- What do you suppose would happen if ...?
- Does this follow ...?

## **Process Questions**

Process questions challenge the tutee to expand or extend their thinking about the information. For example, they ask the tutee to compare, contrast, integrate, combine, or evaluate information and propose or plan a next step.

- We may have enough examples. What do they have in common?
- How would you compare or contrast this concept with ...?
- How does this concept fit into the overall scheme of the course?
- What would you do if ...? or What would happen if ...?
- Can you work through some examples of this?
- Do you feel you can work on this next assignment?

At the end of every tutoring session it is important to ask the tutee to summarize the important points in the session and determine several next steps toward addressing the work in the course. Restating past questions is a good way to do this.

- Now what can you tell me about ...?
- Now tell me everything you know about ...?

## **Note:**

You might not go through all levels of questions in one session, but make sure you include some process questions. You might also skip back and forth between levels. Sometimes an explanation rather than a question is the best approach, but you might try to offer the explanation in a question form.



## **Public Speaking Suggestions for Tutors**

### **Communication with Tutee**

- Begin with the objectives of the tutoring and a basic overview of the topic.
- Ask questions to diagnose the tutee's strengths and areas of need.
- Monitor how much you and the tutee talk. Remember to talk to a tutee and not at them.
- Ask questions and wait for responses. Remember this is leading a discussion and not a solo presentation.
- Encourage questions and anticipate a range of responses. Do not impose your own opinion.
- Be careful not to make the question harder than it really is – simple answers are often all that the tutee wants. If in doubt, ask for clarification.
- Stay flexible but keep the conversation on topic. Stay organized during the discussion, yet be flexible enough to accommodate unplanned relevant topics that may come up.
- Be confident, enthusiastic and positive. Make good eye contact. Be relaxed and open to ideas and responses. Do not be afraid of moments of silence.
- If you don't know the answer, don't bluff. Admit that you don't know and refer the student to the professor. (Remember, you are not the expert, but rather compliment the professor's work.)
- Verbal communication skills rely on volume, speed, pauses, pitch, inflection, and emphasis. If you need a moment to gather your thoughts, simply pause. Don't rush to answer. Pauses can be powerful and give you time to formulate an answer. Avoid verbal fillers such as "Uh, umm, like, you know, OK."
- Think about humor and wit to engage the tutee.

### **Checklist for Successful Speaking as a Tutor**

When I communicate with a tutee (or professor), I:

1. understand the objective of the session and keep them in mind throughout the session
2. have clear focus on essential points
3. use well reasoned and clear arguments
4. provide a clear sequence of ideas that are easy to follow
5. provide an appropriate repetition of ideas
6. use an appropriate delivery; voice, gestures, mannerisms
7. use appropriate humor
8. use appropriate visual aids
9. avoid verbal fillers
10. provide adequate summary of relevant points

## Typical Tutoring Problems

A tutee who is not prepared or showing little effort:

- Students may be unprepared because they don't understand what tutoring is all about. A well-structured first session can eliminate this problem.
- If a tutee continues to be unprepared or shows little effort, explain their commitment and responsibilities to tutoring, as well as yours. The tutee needs to make a commitment to prepare for the tutoring sessions and to show some real effort. Talk with them about this and remember to let them do the work.

An angry student or one who is overly demanding:

- Some students might get very frustrated and even angry if they do not understand your explanations or cannot apply your suggestions. Be patient.
- Try analyzing the concept or task in more detail to see where the problem really occurs.
- Go back to basics. Try another method.
- Share your responsibilities and general goals as a peer tutor. Be sure they understand the limits of your job responsibilities.
- Encourage them to meet with their professor.

A tutee demanding immediate help when you are busy:

- It is always hard to say no. Make sure you explain that you are the only tutor on duty and there are other students who need help. You will make every effort to help each student equally.

A tutee whose academic difficulties appear more extensive than just math:

- Do not hesitate to refer students to the director of the MSC or to Student Accessibility Services for an extensive study skill evaluation.
- If you are having difficulty helping the tutee with a problem, ask them to see their course instructor.
- As a tutor, you are there to help facilitate learning, but the instructor has the ultimate responsibility.

A tutee that is becoming too dependent:

- If you feel a tutee is becoming over-dependent on you or you are too involved with their needs, begin by reviewing your responsibilities and goals with them. This explanation might help them to see the limits of your job as a peer tutor.
- Consider ways you can wean the student by doing less and less for them. You might need to suggest they work with another tutor. Remember that as a tutor, you must learn how to maintain professional objectivity.

A tutee who complains about the professor:

- Do not allow a session to become a complaint fest. You may need to take some time to calm down a student or discuss their options, but quickly refocus on the tutoring tasks.
- Do not share your personal feelings about faculty members.

During group tutoring, too many students ask for help at once:

- Our basic model is first come, first served.
- Try a triage system of getting everyone busy and then rotating, spending a few minutes with a student and then having them work as you move on to another.
- Consider asking students to work together, to explain information to each other, and to share their approaches to a problem.
- If this condition persists, speak to the director to see if another tutor can be assigned to the same shift.

## What is Dyscalculia?

Dyscalculia is a specific learning difference or disability involving all sorts of numerical tasks.

Dyscalculia in children often involves struggling with one or more of the following:

- simple mathematics – memorizing and applying math facts: addition and multiplication
- the order of operations
- the ability to visualize a small or large quantity
- to mentally connect a number with a size or quantity (number sense)
- learning to tell time

Dyscalculia in adults often involves one or more of the following difficulties:

- uncomfortable with all sorts of number related activities
- mistakes in copying and memorizing numbers – trouble with everyday calculations like estimating shopping total or change given
- difficulty keeping a checkbook and managing a bank account; getting directions and using a map is often confusing
- time related issues

The brain of a person with dyscalculia is wired slightly differently and a mathematical stimulus is processed differently. This is pictured with functional MRI: when a child or adult with dyscalculia does a math problem, the areas of the brain that are best equipped for numerical tasks are bypassed and other less efficient areas are used instead. We also know that the brain can be trained to unleash that previously hidden capacity.

Watch a ten minute youtube video by one of the leading experts in dyscalculia, Professor Brian Butterworth.

[https://www.youtube.com/watch?v=p\\_Hqdqe84Uc](https://www.youtube.com/watch?v=p_Hqdqe84Uc)