

Findings about Brain Research and Brain-Friendly Instructional Strategies

The term “brain-friendly” makes more sense than “brain-based” or “brain compatible” because *all* learning is brain-based (involves the brain). “Brain-friendly” describes strategies and techniques that parallel or capitalize on the way the human brain learns naturally.

1. Adopt a brain-friendly, and hence learner-friendly, curriculum, one that

- is constructivist. It consistently starts with and builds on students’ existing knowledge; activities are structured at each step along the way so that students acquire knowledge and skills required for subsequent learning.
- grows the brain (dendrites) by challenging students to solve problems. Ask students, “Can you figure this out?” The best problem-solving activities are novel, appropriately challenging, non-threatening, and stimulate emotions.
- recognizes the importance of emotions. Emotion drives attention; attention drives learning and memory. Activities and materials that have an emotional component include role-playing; reading selections that are sad, dramatic, suspenseful, uplifting; celebrations and rituals; things that surprise or create anticipation. Things become real to the brain when we feel them emotionally.
- capitalizes on collaborative learning.
- addresses multiple intelligences and learning styles by providing learning options that involve color, sound, movement, etc.
- incorporates practice, practice, practice in a variety of ways, formats, and contexts. Providing multiple contexts for learning the same thing creates the most neural pathways. The more ways students learn something, the better. Present it in various situations and in ways that draw on multiple intelligences, including hands on. Incorporate more emotions. Use multiple forms of media, such as videos, computer software, educational simulation games, and audio. Bring in experts and guest speakers.

2. The brain grows from novel input and by actively trying to solve a problem, *not by whether it solves the problem or by what it expresses.*

3. Incorporate brain-friendly instructional strategies such as

- using an inductive approach (humans are better pattern seekers than data gatherers)
- making learning more concrete (hands on materials and by using analogies, metaphors, parables, personal examples, and realia)
- letting students know “what’s in it for them.” Explain the relevance of what they are learning; they often are unsure as to how it will benefit them.
- breaking a class session into several segments in order to create more learning opportunities that are powerful. The more segments, the more beginnings and endings. Beginnings and endings promote recall. Also, since change signals that something else is coming, it gets students’ attention.
- having classroom rituals (high-fives, humorously exaggerated sighs done in unison, stretch breaks) and specific class opening and closing routines (greeting each other; thanking nearby classmates at the end of class, repeating a class motto, such as “Keep reading!”), and music (Olympic music, fanfares, “Simply the Best,” “Rocky” theme, “Superman” theme, “Happy Trails to You”, etc.). These give the beginning and end of class (or a class segment) an emotional component.
- using “think-alouds.” Ask, “Tell us how you went about figuring that out.” (We remember 90% of what we do *if we talk it through as we’re doing it.*) You can also do think-alouds by reading passages out loud and explaining your thought processes as you go. Ask students

bring passages for you to use. Since you will encounter some unfamiliar material, you will be demonstrating what they can do when they deal with unfamiliar material.

- helping students develop schemata more accurately and quickly by moving from individual activities to pairs/small group to whole class discussion or debriefing. There is an important self-correcting aspect to this process.
- setting up appropriate problems for students to solve since the process is more important to learning than the actual answer. The brain continues to process even after we've come up with the answer. Authentic learning situations increase the brain's ability to make connections and retain new information.
- using learning communities and paired courses.
- giving students choices whenever possible. Having a choice lowers stress and triggers the release of helpful brain chemicals. Students also feel more positive and in control of their learning. (Feelings of helplessness trigger the release of norepinephrine, a neurotransmitter that has a strong inhibitory effect).
- when students take tests, allowing them sit in the same place they always do.
- preparing tests in a slightly larger point size (or enlarging the test on the copier before duplicating it); running tests on colored paper for better contrast; including a reassuring or supportive comment on the test ("You can do it!"), a reminder to take a deep breath, hold it, and then exhale slowly, a suggestion to stretch, or a cartoon.

4. Increase the quantity and quality of feedback.

- Students need feedback at least once every 30 minutes. Along with challenge, feedback is crucial to learning.
- Feedback doesn't always have to come from the teacher—in fact, it shouldn't. Students can use self-correcting activities, checklists, peer feedback, write a quick summary, create concept map, explain something to a partner, or check another students' work when you go over an assignment in class. You can also use a grid so groups can compare their multiple-choice answers. Instructional software provides immediate, individual feedback.
- Praise should be specific and come immediately *after*, not before, an activity since premature, unearned praise creates stress. (Excessive stress, however, releases cortisol. It impairs a student's ability to sort out what is important and what is not, and affects both short-term and long-term memory. Chronic stress also depresses the immune system. Moderate to low-level stress, however, can enhance performance.)
- Because of the role of emotion in learning, affirm the student even when you must reject the content of his or her answer. When a student doesn't quite have it, try phrases such as, "You're really close . . . "; "You've almost got it . . . "; "Great start . . . "; "I can see you've mastered the first step/part. The next step is . . . /Now try . . . "; "I'm so glad you said that. I forgot to alert you to this tricky part/common error. Your comment reminded me _____. This will let you avoid making this error on the homework/on the test"; "That's part of it! Anyone want to take it from here?")
- It may take 30-50 learning trials to undo a severely negative experience a student has had. After a student's 3-5 tries, a teacher may conclude the student is lazy, unmotivated, or unintelligent. At any given time, a student may be only a few learning trials away from "getting it."
- Use formative assessments (such as a 1-5 Likert rating scale) to gather on-the-spot feedback about students' levels of understanding.
- When giving feedback (and talking with students, for that matter) use language that matches their learning styles. Doing so makes students feel understood. Listen for clues to learning styles in students' language. For example, visual learners say things such as, "I just don't see what you're getting at. *Looks* impossible to me." Auditory learners may say, "That *sounds* really confusing." The tactile learner makes statements such as, "I don't have a *feel* for stated main ideas. I don't know how to *handle* complicated paragraphs. I can't *get my arms around*... (If a student is upset, you can also mirror his or her posture, rate of speaking, and even breathing for a few minutes, too.)

5. Improve and enrich the classroom environment.

Full-spectrum fluorescent lights, which simulate natural daylight, make a difference. The flickering quality and barely audible hum of regular fluorescent lights take a toll. The brain releases cortisol and the eyes blink excessively; both are signs of stress. Studies show students in classrooms with full-spectrum light miss significantly fewer days of school. Students with seasonal affective disorder (SAD) benefit even more from full-spectrum lights.

- Include some plants. Ficus and dracaenas are good choices.
- Post positive reminders placed higher up on the walls.
- Post examples of students' work.
- Use music. An MP3 player, such as an iPod, and a compact set of travel speakers are all you need. It's the fastest way to alter a class's mood. Use it sparingly, however. Upbeat music while students are entering and leaving class are always two good choices.
- Occasionally go outside for class.
- Keep the classroom 67-70 degrees.
- Change where you stand in the room (especially if you have to say something negative or call a student down, move from where you usually stand).

6. Teach students to challenge their negative beliefs and automatic negative self-talk. Repeatedly doing so eventually changes their brain structure. Have them create a list of the *why* their negative beliefs may be wrong, *what* they might do about it, and *when* they'll start. This puts them in control and helps move them out of a victim mentality.

7. Learning feels good physically. Since humans' survival depends on the ability to learn, humans have an inborn desire to learn. Moreover, the brain reinforces our innate desire to learn by releasing endorphins, serotonin, and dopamine when we learn. (See section 10, Motivation.)

8. Build in movement.

- In-class stretches every 20 minutes or so. Students can remain seated or stand up.
- Drama/skits (such as "The Kingdom of Paragraph"); role-playing (keep some props on hand).
- Cross-lateral movement to "unstick" the brain. Both sides of the brain are always involved in learning, but the activity appears to shift from one side to the other in approximately 90-minute cycles. At these times, students either feel "stuck" or they feel overwhelmed. Touching the opposite hand to opposite shoulder (in pats on the back) or touching the shoulders or knees with the opposite hands (10-12 times) seems to "reset" the brain as it shifts the majority of the mental activity from one side of the brain to the other. Making sideways figure-8s with the thumb up (three times using one first hand and then with the other, while following the movement with the eyes) is another good cross-lateral activity.
- "Walk Abouts" and "Opinion Walks." In response to questions or statements, students walk toward signs posted on various walls. (For example, you can give a strong opinion statement. To indicate their stance on an issue, students walk towards signs ranging from "strongly agree" to "strongly disagree." Ask various students what they base their opinions on—what evidence, who influenced their opinion, and why. You can ask others whether listening to any of their classmates has changed their opinion and, if so, why.)
- Hands-on materials; having groups hold up A-B-C-D or True/False answer signs
- Changing where students sit in class (but not on test days); regrouping them for various activities
- Sometimes ask students to stand when they speak. This increases oxygen to the brain; students also learn to "think on their feet."
- Have students walk or march in place as they repeat something since this increases circulation and helps spatial-episodic memory.

9. Address both brain hemispheres' roles in learning.

- All learning involves both sides of the brain.
- Present the global, "big picture" first (visually or verbally)
- Next, give a "you are here" road map that shows the sequence of all steps.
- Put posters and peripherals of the whole unit/skill/topic on the wall (along with global "map").
- For important material, always let students know what is coming next.
- From the start and throughout, encourage students to map out their understanding on paper.

10. Boost motivation.

- External rewards (rewards that are predictable and have "market value") are not motivating, and ultimately can decrease intrinsic motivation. When students achieve or succeed at something that matters to them, their brains automatically reward them by releasing "feel good" chemicals. (*Celebrating* accomplishments and successes, however, is not a reward. Celebrations are appropriate since the brain has already delivered the important, in-built, physiological reinforcement for learning).

To help increase students' *intrinsic* motivation:

- Reduce stress. Too much stress immobilizes students and shuts down learning. Take an anonymous survey that asks students what inhibits their learning in your class and how this could be changed; ask what would make learning in your class easier and enjoyable. Brainstorm with colleagues about factors that create stress for students and ways to reduce the threat. Sources of threat include threatening comments, sarcasm, humiliation, unforgiving deadlines or policies, pop quizzes, cultural and language barriers, even praising students before they do something ("Rosa, you always have the right answer. What did you identify as the author's argument in this selection?").
- Build in transition time at the start of class and between activities. This can be as simple as music, students greeting each other, welcoming each other back after the weekend, taking a minute to breathe deeply or to stretch, using a class ritual of some sort, or doing a five-minute review of what was learned at the last class session.
- Set some in-class goals on a daily basis (allow students a choice whenever possible). Prime students for what's coming by piquing their interest and pointing out the relevance to them. ("Do you think you can be manipulated by advertisers?" [Ask for a show of hands.] "Well, today we're going to look propaganda techniques. When you see an ad on TV, hear one on the radio, or see one in a magazine, you experience propaganda techniques. If you're like most people, you don't even realize this is happening. How can you protect yourself from being manipulated by advertisers and others who use these techniques?")
- In every way possible, influence positively students' beliefs about themselves and their learning (affirm their achievement; use positive nonverbals; foster teamwork; positive posters; a rich, positive classroom environment; relationship building among students).
- Help students learn to manage their emotions. In the classroom, incorporate rituals, celebrations, movement, drama, "art," service work, educational games, and win-win competitions.
- Feedback is crucial in this regard (group work, peer review, computer software, checklists, self-evaluation). (See section 4, Feedback.)
- Focus on what you can do to help *students' brains* to provide natural motivation rather than what you can do to motivate students.

11. Vocabulary development

Provide options to accommodate different learning styles by using

- Games and hands-on materials
- Vocabulary in context
- Websites
- Vocabulary cards
- Commonly confused words
- Tapes, including commercial ones

12. Learning, gender, and time-of-day differences

- Brain and body biorhythms are affected by hormonal release and balance. Memory is connected to emotions and chemical balance, so learning is affected.
- The brain seems to recall more literal, specific, and detailed material in the morning.
- Males do better with spatial and gross motor tasks in the morning, and in the afternoon with ones related to verbal and writing skills.
- Females do better verbal and writing skills in the morning, and in the afternoon, they perform better on spatial and gross motor tasks (the reverse of males).
- For both genders, midday is best for easier, repetitive learning, and evenings are better for global understanding and relationships (which has implications for those involved with evening classes).
- Minimize rote recall questions; give students more choices about when they are allowed to learn things; give important material an emotional component; help students develop memory skills that work for them.

13. Understand the effects of stress and avoid creating undue stress.

- Low to moderate stress can lead to better performance. High stress and threats are damaging and have no place in the classroom.
- In response to too much stress (including perceived threat), the adrenal glands release cortisol, which has potent effects on the brain and the rest of the body. Chronic stress affects thinking, the ability to sort out what's important from what's not, memory formation; it impairs creativity, and it depresses the immune system. It affects the eyes/vision, self-esteem, and academic achievement. Too much threat can induce helplessness, leaving students unable to detect patterns, solve complex problems, understand connections, or detect larger levels of organization. Learning narrows to memorizing isolated facts. Too much threat is paralyzing, but students usually blame themselves ("I can't do anything right," "I'm stupid"). Anxiety, depression, and restlessness can result.
- Threats, and even harsh comments and sarcasm, trigger chemical imbalances. Serotonin levels fall, and the result is often impulsive, aggressive, or even violent behavior. (Generally, males have 20-40% lower serotonin levels than females. Serotonin puts the brakes on behavior.) Students who feel constantly threatened (such as those, for example, who come from an abusive home or live in a dangerous neighborhood) are constantly on alert, scanning constantly for "predators" (or prey). This makes it very difficult to get their attention in the classroom.
- Here are some sources of stress and solutions: (1) regular fluorescent lights (switch to full-spectrum ones); (2) social situations (have students work in groups and change roles in groups often); (3) expectations and disappointments—things that go wrong every day (use classroom rituals and procedures to establish reassuring predictability and transition time).
- Explain to students the effects of stress and teach them stress management techniques such as breathing, time management, the value of down time, peer support, conflict resolution, etc.
- Decrease stress in the classroom through discussions, games, peer support, celebrations, etc. Provide for transition time at the start of class (stretching, greeting tablemates, journal writing). Reduce threats from other students by having clear expectations about classroom behavior and language; model appropriate emotional intelligence. Unrealistic deadlines cause stress; you can avoid this by asking things such as, "How many of you could use another few minutes on this?" and "How many of you think a one week deadline is realistic?" Give them choices whenever possible: it reduces feelings of helplessness. Ask students what's causing them stress.

14. Teach students about the care and feeding of their brains.

- *Hydration.* The brain is made up of a higher percentage of water than any other organ, so dehydration has a powerful effect on it. Encourage students to drink lots of water. Allow them to bring a bottle of water to class or to leave to get a drink of water. Water helps reduce stress levels (a lack of water raises blood pressure and increases the production of two hor-

mones associated with stress). Students lose attentiveness and become lethargic. Soft drinks, tea, coffee, and juice don't help and, in fact, add to the problem.

- *Exercise.* Exercise supplies oxygen to the brain. It also releases endorphins, which create a sense of wellbeing and lower stress levels.
- *Adequate rest.* Most college students average about six hours sleep per night; they need nine to nine-and-a half. This may be due in part to the fact that hormonal changes during puberty shift teenagers' natural bedtime to around midnight with waking time around 8:00 a.m. Having to wake up too early for class or work runs counter to what their body clock dictates. Having to wake up too early also disrupts all-important REM sleep. Staying awake in early classes becomes difficult for many of these students, so they learn less. Some may exhibit behavior problems.
- *Proper nutrition.* Most students (most people!) eat too few vegetables, fruits, and complex carbohydrates. Encourage students to include leafy green vegetables, nuts, salmon, lean meats, fresh fruits, milk, and yogurt in their diets. Vitamin and mineral supplements may also help. Most students eat so they'll stop feeling hungry rather than to feed their brain. Since the brain is still actively developing and maturing up to age 25, this is especially unfortunate. Don't assume students know this information or even that they know about proper nutrition.
- *Avoiding smoking, drugs, and excessive alcohol consumption.* Don't assume students understand how truly destructive these are to the brain.

15. Other considerations

- Talk to students about how their brain works, how learning and remembering occur and factors that affect each, what they need to "feed" their brain (oxygen and glucose), the importance of adequate exercise and rest, and the role emotion plays in learning. (There are several excellent Web resources students will find interesting and illuminating, such as www.PBS.org's information for the *Frontline* series episode, "Inside the Teenage Brain.")
- Humor (cartoons, jokes, funny stories) lowers stress, helps the immune system, and increases the flow of neurotransmitters needed for alertness and memory.
- Use games and game formats. Modify *Bingo*, *Monopoly*, *Trivial Pursuit*, *Chutes and Ladders*, *Jeopardy*, *Hangman*, and make crossword puzzles. Whenever possible, have students create the games since the process is more important to learning than the product.
- Auditory—vary voice level, pitch, and tone; use music; tapes; group work, talk-alouds; oral repetition; debate; and story telling. Use country-and-western songs to introduce tone, point of view, inference, and figures of speech. Simon and Garfunkel songs work well for teaching for metaphor. Use sound effects (chimes to signal groups they have two minutes to finish up; other sound effects). Set new words or concepts to familiar tunes so that students can learn them more easily.
- Journals—have students reflect on their learning and how information and skills they are acquiring might relate to other courses and to their lives.
- Color—Use colored markers on the board and color on transparencies. Have students use colored highlighters to designate different things (such as one color for topic and another for stated main idea of a paragraph, or different colors for roots or affixes). Print things on colored paper (especially tests and important sheets that will be referred to throughout the semester).
- Aroma—Smell affects the limbic area of the brain, which is responsible for attention. Peppermint, citrus, and cinnamon odors stimulate brain function; lavender is calming. (Watch for students who have allergies.) Buy lemon essence sprays (not perfumey room deodorizer spray) and mist the room. You can also use a spritzer bottle that contains 16 ounces of water mixed with one half-teaspoon of essential oil (available at health food stores) and one ounce of vodka (makes it last longer). Shake the bottle before spritzing with it. Keep on hand sugar-free peppermint, lemon, and cinnamon hard candies students can suck on while learning or studying a subject, and then do the same thing when taking a test over the material. The aromatic association serves as a cue to the brain.