How Emotions Affect Learning

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New developments in cognitive science are unraveling the mysteries of emotions; the findings have much to teach us about how students do—or do not—learn.

John Dewey began this century with an eloquent plea for the education of the *whole child*. If we get around to that kind of education by the end of the century, emotion research may well provide the catalyst we need.

Our profession pays lip service to the whole student, but school activities tend to focus on measurable rational qualities. We measure spelling accuracy, not emotional well-being. And when the budget gets tight, we cut curricular areas like the arts, expressive subjects that are difficult to measure.

We know emotion is important in education—it drives attention, which in turn drives learning and memory. But because we don't fully understand our emotional system, we don't know exactly how to regulate it in school, beyond defining too much or too little emotion as misbehavior. We have rarely incorporated emotion comfortably into the curriculum and classroom. Further, our profession hasn't fully addressed the important relationship between a stimulating and emotionally positive classroom experience and the overall health of both students and staff.

Recent developments in the cognitive sciences are unlocking the mysteries of how and where our body/brain processes emotion. This unique melding of the biology and psychology of emotion promises to suggest powerful educational applications. Current emotion theory and research bring up more questions than answers. Still, educators should develop a basic understanding of the psychobiology of emotion to enable them to evaluate emerging educational applications.

Following is a basic introduction to the role our emotional system plays in learning, and the potential classroom applications of this research.

Emotion and Reason

Studies show that our emotional system is a complex, widely distributed, and error-prone system that defines our basic personality early in life, and is quite resistant to change.

Far more neural fibers project from our brain's emotional center into the logical/rational centers than the reverse, so emotion is often a more powerful determinant of our behavior than our brain's logical/rational processes. For example,

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purchasing a lottery ticket is an emotional, not a logical decision. (The odds are terrible, but where else can one buy three days of fantasy for $1?) Reason may override our emotions, but it rarely changes our *real* feelings about an issue. Our emotions allow us to bypass conscious deliberation of an issue, and thus to respond quickly based on almost innate general categorizations of incoming information. This may lead to irrational fears and foolish behavior: Often we don't consciously know why we feel as we do about something or someone.

Emotion, like color, exists along a continuum, with a wide range of gradations. We can easily identify many discrete emotions through their standard facial and auditory expressions, but the intensity and meaning of the emotion will vary among people and situations. Moreover, emotional context, like color hue, may affect our perception of emotion. To understand our constantly shifting emotional system and its affect on our capacity to learn, we must understand the system's two parts:

- the molecules (peptides) that carry emotional information, and
- the body and brain structures that activate and regulate emotions.

Peptides: Molecular Messengers of Emotion

Traditionally, we've tended to think in terms of a body-brain split: Our brain regulates body functions, and our body provides support services for our brain. However, scientists now think in terms of an integrated body/brain system. Our emotional system is located principally in our brain, endocrine, and immune systems (which now are viewed as an integrated biochemical system), but it affects all other organs, such as our heart, lungs, and skin. Think of our emotions as the glue that integrates our body and brain, and peptide molecules as the physical manifestation of the process.

Peptide molecules are the messengers of our emotional system. We know a peptide molecule is a chain of amino acids that is shorter than a protein, and that more than 60 types are involved in emotions. But it's not yet clear how these molecules carry information, or even what that information is. Peptides developed within body/brain cells are called hormones and neuropeptides. (When similarly shaped molecules are developed outside our body, we call them drugs.)

To modulate our broad range of pleasure and pain, peptides travel throughout our body/brain via our neural networks, circulatory system, and air passages. They powerfully affect the decisions we make within the continuum of emotionally charged approaching and retreating behaviors, such as to drink-urinate, agree-disagree, and marry-divorce. In effect, the shifts in the body/brain levels of these molecules allocate our emotional energy—what we do, when we do it, and how much energy we expend.

At the cellular level, peptides synthesized within one cell attach to receptors on the outside of another, sparking increased or decreased cellular actions. If this occurs in large populations of cells, it can affect our emotional state. Cell division and protein synthesis are two such actions; both are heavily involved in the emotion-charged body changes during adolescence (Moyers 1992).

A peptide's message can vary in many different body/brain areas, just as a two-by-four can be used in many different ways in the construction of a house. In this way peptides are similar to many drugs. Alcohol, for example, can excite or sedate, depending on the drinker's emotional state and the amount ingested.

Cortisol and the endorphins are two good examples of peptide molecules that can affect students' behavior in the classroom. When our inability to fend off danger triggers a stress response, *cortisol*—a sort of all-purpose wonder drug—is released by our adrenal glands. It activates important body/brain defensive responses that vary with the nature and severity of the stressor. Developed eons ago when physical dangers most threatened our survival, our stress responses do not differentiate between physical and emotional danger.

Because most contemporary stress results from emotional problems, these responses are often maladaptive. For example, a 2nd grader refuses to complete an arithmetic assignment. The irritated teacher's stress system inappropriately responds by releasing clotting elements into the blood, elevating cholesterol levels, depressing the immune system, tensing large muscles, increasing the blood pressure—and much more. It's a response that makes sense only if the recalcitrant student is also threatening with a knife or gun.

We pay a high price for chronic emotional stress. While low levels of cortisol produce the euphoria we feel when we're in control, high levels triggered by the stress response can induce the despair we often feel when we've failed. Moreover, chronic stress can also lead to a variety of circulatory, digestive, and immune disorders.

Chronic high cortisol levels can eventually destroy hippocampal neurons associated with learning and memory (Vincent 1990). Even short-term stress-related elevation of cortisol in the hippocampus can hinder our ability to distinguish between important and unimportant elements of a memorable event (Gazzaniga 1989). Thus, stressful school environments reduce the school's ability to carry out its principal mission.

More positively, *the endorphins* are a class of opiate peptides that modulate emotions within our pain-pleasure continuum; they reduce intense pain and increase euphoria. Endorphin levels can be elevated by exercise and by positive social contacts—hugging, music, a friend's supportive comments, among other things—thereby making us feel good about ourselves and our social environment (Levinthal 1988). A joyful classroom atmosphere that encourages such behaviors produces internal chemical responses in students that make them more apt to learn how to successfully solve problems in potentially stressful situations.

The Emotion Regulators

Although the endocrine and immune systems participate in processing our emotions, two interrelated brain systems share the regulating task:

The finger size brain stem at the base of our brain and the limbic system structures surrounding it focus inward on our survival, emotional, and nurturing needs. The brain stem monitors involuntary activity, like breathing.

The cerebral cortex, which regulates higher functions, addresses our interactions with the external world (Edelman 1992).

Regulator I: The Brain Stem and Limbic System

Extensively connected in looped circuits to body organs and systems, the brain stem and limbic system responds relatively slowly (from seconds to months) as it regulates basic body functions, cycles, and defenses. The system is loaded with peptide receptors. The *reticular formation* at the top of the brain stem integrates the amount and type of incoming sensory information into a general level of attention (Vincent 1990).

The ***Limbic system***, composed of several small interconnected structures, *is our brain's principal regulator of emotion and plays important roles in processing memory*. This may explain why emotion is an important ingredient in many memories. The limbic system is powerful enough to override both rational thought and innate brain stem response patterns. In short, we tend to follow our feelings. Memories formed during a specific emotional state tend to be easily recalled during a similar emotional state later on (Thayer 1989). For example, during an argument, we easily recall similar previous arguments. Thus, classroom simulations and role-playing activities enhance learning because they tie memories to the kinds of emotional contexts in which they will later be used.

The limbic system influences selection and classification of experiences that our brain stores in two forms of long-term memory—*procedural* (unconsciously processed skills, such as walking and talking) and *declarative* (conscious recall of facts, such as names and locations).

Limbic system structures that process emotion and memory are the amygdala complex, the hippocampus, and the thalamus and hypothalamus.

Amygdala complex. This is the principal limbic system structure involved in processing the emotional content of behavior and memory. It is composed of two small almond-shaped structures that connect our sensory-motor systems and autonomic nervous system (which regulates such survival functions as breathing and circulation). The amygdala is also richly and reciprocally connected to most other brain areas. Its principal task is to filter and interpret sophisticated incoming sensory information in the context of our survival and emotional needs, and then help initiate appropriate responses. Thus, it influences both early sensory processing and higher levels of cognition (for example, ignoring the feel of a comfortable shoe, but responding to one with a tiny pebble in it).

Hippocampus. The amygdala adjoins the hippocampus, two finger-size structures that convert important short-term experiences into long-term declarative memories that are stored in the cortex. Think of the amygdala as processing the subjective feelings you associate with an event, and the hippocampus as processing the objective location, time, and actions that defined the event.

The brain's amygdala and the adjoining hippocampus can modulate the subjective and objective strength of a memory. Kandel and Kandel (1994) suggest that this helps explain, for example, the repressed memories of sexual abuse. The fearfulness of the abusive experience can lead to the release of certain substances (noradrenaline neurotransmitters) that strengthen the connections processing the emotional memory of the event. Conversely, the painfulness of the experience can lead to the release of opiate endorphins that weaken connections processing the conscious memory of the factual circumstances surrounding the event.

Subsequently, the victim tends to avoid anything that triggers the fearful emotion, but doesn't consciously know why. Years later, a chance combination of similar characters, location, actions, and emotions may cause the strong emotional memory to trigger the recall of the weak factual memory of the original circumstances of the abuse.

Thalamus and hypothalamus. The walnut-size thalamus and adjoining pea-size hypothalamus are two other important related limbic system structures that help regulate our emotional life and physical safety.

The *thalamus* is our brain's initial relay center for incoming sensory information; it informs the rest of our brain about what's happening outside our body. The thalamus has direct connections to the amygdala, which permits it to send a very rapid but factually limited report on a potential threat. This can trigger a quick, emotionally loaded (but perhaps also life-saving) behavior before we fully understand what's happening. And it is the mechanism that underlies many explosive emotional outbursts during a typical school day.

The *hypothalamus* monitors our internal regulatory systems, informing our brain what's happening *inside* our body. When our brain has no solution to a threatening situation, the hypothalamus can activate a fight-flight stress response through its pituitary gland contacts with the endocrine gland system.

Pheromones are a newly discovered but poorly understood addition to our sensory system (although they've long been known to regulate many animal behaviors). They are molecules that are released into the air from the skin, entering a tiny vomeronasal organ in our nose, although they are not part of our sense of smell. This triggers neural activity in areas of the hypothalamus that regulate sexual behavior, levels of comfort, and self-confidence. The cheek area next to our nose is rich in pheromones, which may explain why we humans like to kiss while nuzzling our nose in that area.

Regulator II: The Cortex

The ***cerebral cortex***, which occupies 85 percent of our brain's mass, is a large sheet of neural tissue that's deeply folded around the limbic system. It is organized into myriad highly interconnected and outwardly focused neural networks that respond very rapidly (in milliseconds to seconds) to various *space-time* demands. The system

- Receives, categorizes, and interprets sensory information;
- Makes rational decisions; and
- Activates behavioral responses.

Space: Viewed from the unfolded top, the neocortex is divided into right and left hemispheres along a line that goes directly back from our nose. A simplified view of tasks of the two hemispheres suggests that they focus on different perspectives of an object or event. The right hemisphere *synthesizes* the background or contextual information (the forest); the left hemisphere *analyzes* the foreground information (a tree in the forest).

Although the research isn't conclusive on the roles the hemispheres (or lobes) play in emotion, some general patterns are apparent (Corballis 1991). The right hemisphere seems to play the more prominent role overall in processing emotions. It processes the important emotional content of faces, gestures, and language (intonation, volume)—*how* something was communicated; while the left hemisphere processes much of the objective content of language—*what* was said.

The right hemisphere processes the negative aspects that lead to withdrawal behaviors (for example, fear and disgust), while the left hemisphere processes the positive aspects of emotion that lead to approaching behaviors (for example, laughter and joy).

Moir and Jessel (1991) have suggested that the average male brain appears to follow this pattern of hemisphere specialization, while the average female brain may diffuse more emotional processing across the two hemispheres. If true, these organizational differences may help to explain commonly observed gender differences in emotional processing.

Time : The neocortex is divided into sensory and frontal lobes along an imaginary line drawn along our skull from ear to ear. Sensory lobes in the back store sensory memories (the past). Frontal lobes focus on critical thinking and problem-solving strategies (the present), with the front part of the lobes in charge of planning and rehearsal activities (the future).

The frontal lobes play an important role in regulating our emotional states and judgments. Our frontal lobe's regulation of critical thinking and problem solving permits it to override the execution of automatic behaviors, and of potentially destructive illegal or immoral behaviors that are sparked by emotional biases.

Classroom Applications

Although the educational applications of emotion research are still quite tentative, several general themes are emerging—and they tend to support a perspective that many educators have long advocated. This isn't surprising, since we're continually learning what does and doesn't work when dealing with students' emotions. What this research may provide, however, is biological support for the profession's beliefs. Here are some general principles and their applications to the classroom:

1. Emotions simply exist; we don't learn them in the same way we learn telephone numbers, and we can't easily change them. But we should not ignore them. Students can learn how and when to use rational processes to override their emotions, or to hold them in check. ***We should seek to develop forms of self-control among students and staff that encourage nonjudgmental, nondisruptive (and perhaps even inefficient) venting of emotion*** that generally must occur before reason can take over. We all can recall past incidents that still anger us because we were not allowed to freely express our feelings before a decision was imposed on us.

   Integrating emotional expression in classroom life is not difficult. Try drawing a class into a tension-releasing circle (after a playground fight, for example) and playing a game of circle tag before talking out the problem. Once the students' collective limbic systems have had their say, rational cortical processes can settle the issue. If that doesn't work, sing a song. (As British playwright William Congreve suggested, “Music hath charms to soothe a savage breast.”) In other words, when trying to solve a problem, continue the dialogue with continuous emotional input.

2. Most students already know quite a bit about the complexity of emotions and the ways they and others experience them (Saarni and Harris 1991), although they may not be able to articulate what they know. ***Schools should focus more on metacognitive activities that encourage students to talk about their emotions, listen to their classmates' feelings, and think about the motivations of people who enter their curricular world***. For example, the simple use of *why* in a question turns the discussion away from bare facts and toward motivations and emotions. *Why* did the pioneers settle where the two rivers came together? is a much more emotionally loaded question than *Where* did the pioneers settle?

3. ***Activities that emphasize social interaction and that engage the entire body tend to provide the most emotional support***. Games, discussions, field trips, interactive projects, cooperative learning, physical education, and the arts are examples. Although we've long known that such activities enhance student learning, we tend to think of them as special rewards, and so withdraw them when students misbehave, or when budgets are tight, eliminate them altogether.

4. Memories are contextual. ***School activities that draw out emotions—simulations, role playing, and cooperative projects, for example—may***

provide important contextual memory prompts that will help students recall the information during closely related events in the real world. This is why we tend to practice fire drills in an unannounced, emotionally charged setting: in the event of a real fire, students will have to perform in that kind of setting.

5. ***Emotionally stressful school environments are counterproductive because they can reduce students' ability to learn***. Self-esteem and a sense of control over one's environment are important in managing stress. Highly evaluative and authoritarian schools may promote institutional economy, efficiency, and accountability, but also heighten nonproductive stress in students and staff.

In short, we need to think of students as more than mere brain tissue and bodies. Powerful peptides convert that body and brain tissue into a vibrant life force—the whole child that John Dewey urged us to educate.

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