Athletic Training Education Journal: 2007;2(Jan-Mar):16-20

www.nataej.org

Applying Brain-Based Learning Principles to Athletic Training Education

Debbie I. Craig, PhD, ATC
Northern Arizona University, Flagstaff, AZ

Objective: To present different concepts and techniques related to the application of brain-based learning principles to Athletic Training clinical education.

Background: The body of knowledge concerning how our brains physically learn continues to grow. Brain-based learning principles, developed by numerous authors, offer advice on how to facilitate learning in students. Implementing these principles into clinical instruction lessons, whatever the instructional strategy being used, may potentially increase the retention of student knowledge and their ability to transfer that knowledge to different contexts.

Description: A review of brain-based learning literature was conducted through searches in Medline, ERIC, SPORTDiscus, and DAI. Common themes from the literature are described. Concepts to use when creating lessons and examples of techniques are then presented to aid the athletic training instructor in implementing some of the brain-based learning principles in clinical education. Examples using different athletic training proficiencies are offered.

Application: The profession of athletic training lends itself well to many of the brain-based learning principles. Specifically, the clinical education component of athletic training education is full of possibilities for incorporation of these principles. Many techniques are offered to enhance the athletic training instructor's ability to facilitate student learning through thoughtful incorporation of brain-based learning principles.

Key Words: brain-compatible learning, brain research, effective teaching research, teaching methodology

The profession of athletic training puts considerable effort into researching ways to help students optimize their learning. Methods such as cooperative learning, problem-based learning, and others have been shown to foster athletic training students' learning.[1-7] While brain-based learning also facilitates learning, it is not a specific methodology. Rather, it describes how human brains physiologically learn. Educators have researched how to apply this knowledge within educational settings. More and more classroom studies are being performed to test the efficacy of brain-based learning principles.[8-10] Many "how to" books have been published about how individual instructors may incorporate these principles.[11-14] Some elementary and high schools have transformed whole curriculums to incorporate brain-based learning principles.[9-10]

Debbie Craig has been the Director of the ATEP at Northern Arizona University since finishing her PhD in 2003 at Colorado State University. Prior to that, she had been a clinical athletic trainer for 12 years at the high school, community college, and 4-year Division I Levels.
Debbie.Craig@nau.edu

Conversely, some authors caution educators about how far to transpose the neuroscience research reports of how brains physiologically learn into the classroom.[15-17] Individual student learning is dependant upon dozens of variables, including the amount of sleep, nutrition, classroom environment, interest in the topic, learning style, and emotional state. With this in mind, it is important to conceptualize using brain-based learning principles *as a guide* when developing lesson plans – not as a *methodology* of teaching. These principles should be contemplated before and during the creation of lesson plans, rather than being plugged into lesson plans after they have been created.

The purpose of this paper is to offer practical applications for incorporating brain-based learning principles into athletic training clinical education courses. These courses are differentiated from fieldwork within this paper, though some of the same applications may be incorporated into fieldwork experiences. Seven brain-based learning concepts are presented with examples of applications in Athletic Training education:

1. building upon students' current knowledge base
2. teaching within context
3. teaching for transfer
4. making the lessons personal and including emotion
5. using kinesthetic learning
6. balancing challenge and stress
7. creating an engaging learning environment

Brain-based Learning Principles

In the past decade, new brain imaging techniques have allowed scientists to observe the brain while it is learning. The field of neuroscience has produced a body of empirical data that provides a new understanding of how the brain functions when it is learning, by exploring the neuroanatomy of cognitive functions. Research involving these imaging techniques has produced a body of knowledge that illustrates how we learn. Educators have attempted to apply this knowledge to education, terming this brain-based learning.[11]

Simply stated, brain-based learning describes how the brain learns at a cellular level. This is not a simple process and involves many different components. These processes are described well in the literature.[18-22] From this research, several brain-based learning principles have been proposed (See Table 1.)

Table 1. Brain-Base Learning Principles[23-27]

1. Learning is a process of forming novel neural networks or patterns.
2. Novel patterns can only form as extensions of existing patterns.
3. Learners need to recognize and connect patterns by themselves.
4. Each brain is unique.
5. Learning engages the entire physiology
6. The brain is a parallel processor (multitasking).
7. The search for meaning is innate and occurs through patterning.
8. The brain simultaneously perceives and creates parts and wholes.
9. Emotions are critical to patterning.
10. Learning involves both focused attention and peripheral perception.
11. Learning within specific context is best.
12. Learning is enhanced by challenge and inhibited by stress/threat.
13. Learners should be given choices to accommodate different learning styles.
14. Learning must apply to the real life of the learner.
15. Immediate feedback amplifies learning.

Many athletic training instructors may already incorporate some of these brain-based learning principles without purposefully doing so. For instance, giving immediate feedback is commonly practiced during clinical education when the student is practicing a new assessment technique with an Approved Clinical Instructor (ACI) watching. Other principles may be less prevalent in a lesson, such as using emotions to aid in learning. Several common teaching techniques are complementary to brain-based learning (See Table 2), and may incorporate a mix of brain-based learning principles.

To date, there have been few empirical studies to document outcome measures when using these proposed brain-based learning techniques. The difficulty in designing such studies lies in controlling for extraneous variables. Therefore, there is little evidence in the medical field to support these techniques. A majority of the research is housed within the education field itself.

Application of Brain-based Learning in Clinical Education and Fieldwork

The application of brain-based learning principles into clinical education and fieldwork lessons can be accomplished in a variety of ways (See Table 2). It is ideal to design the different lessons before the semester begins. The following are several concepts to keep in mind when assigning specific instructional strategies to a lesson:

Concept 1. Ask students what knowledge they already possess on the topic. Recall that learning occurs when novel neural patterns are formed in the brain, and those patterns can only form as extensions of existing patterns. Therefore, you must assess what your students already know and build upon that base. "The challenge for each teacher is to find ways to engage the students and take advantage of the novelty-seeking property of the human brain to facilitate learning." [30(p. 36)]

Concept 2. Teach the lesson within the context of how students will be using the information. For instance, it's quite easy to put a list of categories into a powerpoint slide of items that need to be included in a medication log during a Pharmacology unit. That information, however, is not in the context that the students will be seeing or using it. A better strategy, therefore, would be to ask the students to bring to class, a copy of a blank medication log being used at each of their clinical sites and compare those logs. Which categories are similar and which are different? Discuss why different categories may have been included or excluded. Then have each student design their ideal medication log to use in their ideal professional setting. Lastly, have them record a true medication distribution at their clinical site on this log and hand this in to assess their understanding of the proficiency. By doing this, they aren't just handed abstract knowledge and asked to memorize it. They discover the knowledge themselves then connect that to their personal clinical setting. Facts are empty without being linked to context and concepts.

Concept 3. Teaching for transfer is critical. It helps students to draw upon the knowledge they've already learned while in different contexts or situations. Once a basic skill or knowledge set is taught in one context (hopefully the one a student will most likely draw upon), you then facilitate their ability to draw upon that knowledge in different situations. If a student does well performing a shoulder assessment in the didactic and clinical education portions of a course(s), they must then be able to transfer and draw upon that knowledge, for instance, in the middle of a football game on the busy sidelines. Further, making a return-to-play recommendation to the supervising ATC must include transfer of not only their assessment skills, but of their wound healing and injury biomechanics knowledge. It is this skill – the ability to transfer knowledge – which may separate successful students in the field from those who simply do well on the BOC exam but struggle to be successful in the clinic.[19,25,28]

When teaching for transfer, you must have the students problem-solve to make the transfer and create that new neural pattern on their own.[23-27] Think of a piece of knowledge as a bicycle wheel axle in the brain: the more directions one accesses that knowledge from (creating spokes), the stronger (more learned) that piece of knowledge becomes. That piece of information can

Table 2. Instructional Strategies that Incorporate Brain-Based Learning Principles

	Tate[28]	Prigge[29]	Smilkstein[12]	Erlauer[13]	Sprenger[14]
Discussion	•	•	•	•	•
Cooperative learning	•	•	•	•	•
Problem-solving	•		•	•	•
Humor	•	•		•	•
Emotions		•	•	•	•
Experiments/labs	•	•	•	•	
Movement	•	•	•	•	
Apprenticeships	•		•	•	•
Writing/journals	•	•	•	•	
Teach students about their brains		•	•	•	•
Positive atmosphere/ no stress		•	•	•	•
Environment		•	•	•	•
Personally relevant to students		•	•	•	•
Transfer and repetition		•	•	•	•
Storytelling	•	•	•		
Role playing	•	•		•	
Immediate assessment/feedback			•	•	

then be accessed by and connected to more pieces of information to create even larger neural patterns.[19] If we simply give the necessary information to the students without having them problem solve, there is less likelihood of them truly learning that information.[20] Problem-solving is the brain's natural and preferred way of learning, not listening to a lecture.[12-14]

Concept 4. Lessons should be personal and emotional to make the lessons relevant to each student's life and thus, motivate them to learn. Things that are personally meaningful motivate us. Motivation is essential for any long-term learning.[31] Give personal examples, share stories, and ask students to share their stories. Include emotion with the examples and stories as poignantly as possible. If students do not know how certain knowledge is going to be useful to them, they may be less willing to contemplate that knowledge and truly learn it. Making it personal gives them reason to learn that knowledge. Even something as simple as sharing an example of how a classmate was faced with drawing upon that same knowledge may motivate a student to see its importance and learn. When students learn a piece of knowledge with an emotion tied to it, the learning becomes much more permanent and recallable.[30-33]

Concept 5. Kinesthetic learning, or learning through body movement, and incorporating our senses into lessons are critical components of learning.[5] Athletic Training lends itself well to kinesthetic learning, as it is a hands-on profession. The clinical education component should be composed of mostly kinesthetic lessons. Incorporating all senses (smell, touch, taste, hearing, and sight) may require the instructor to put more thought into planning their lessons. Being cognizant of the different learning styles of students will aid in which senses to incorporate most often.

Concept 6. There is a fine balance between challenging a student and creating stress for them. When a student is stressed, their brain functions in more of a survival mode, during which higher-order cognitive functions are less accessible.[11,18,20,22,23] An evident example of this is learning CPR skills in a classroom, but then freezing when called upon in an emergency situation. Stress impairs learning and has no place in education. On the other hand, our brains enjoy challenge. Problem solving is the brain's innate way of learning.[12,19,20] In clinical education, posing problems to students and giving them ample time to solve those problems, may challenge students without creating excessive stress. Conversely, giving unannounced pop quizzes or instilling fear about an upcoming exam, only impairs learning. Many students are fearful of examinations. By giving students choices on how they want to be evaluated, you may reduce the amount of stress they feel and give them personal ownership in the examination.

Concept 7. Look at your clinical education laboratory. Is it engaging and interactive? Does it promote a positive atmosphere for learning? Walking into a sterile environment does not create excitement or motivation for your students. Students must feel challenged and safe at the same time in the classroom and clinical laboratory. Posing a "question of the week" or a puzzle or riddle creates an interactive environment. Having students design bulletin boards each month for the academic or clinical laboratory, rather than keeping the same thing up year in and year out, engages students.

Example Lessons

With the seven concepts in mind, consider some instructional strategies for teaching proficiencies in the clinical education environment. Following are examples of specific instructional strategies for various athletic training proficiencies. This section is intended to spark creative thoughts for your own lessons, not to be prescriptive for the proficiencies illustrated.

To approach a unit on concussion assessment, ask the students if they have previously watched or performed a concussion assessment. If they have, talk about what was included in those assessments. This establishes their base knowledge. Next, rather than proposing a list of assessment steps, create a group research project. Assign various readings to each group on concussion assessment research and return to play guidelines. Their task is to read the literature and come up with their own assessment plan and return to play guidelines. They then present and defend that plan to the rest of the class. Next, bring in an athlete or ex-athlete with permanent brain impairments from repetitive concussions. Have them share their story with as much emotion as possible. At the end, assess your students' concussion assessment abilities by having them perform their concussion assessment on the impaired athlete. Lastly, have them attempt to transfer the return to play guidelines learned previously to that assessment outcome and verbally instruct the athlete accordingly.

In this example, we have included the brain-based learning principles of: having the student's problem solve to connect their

own knowledge and create novel neural patterns; including emotion; proposing challenge; creating transfer; putting the learning into context with a real athlete sharing her/his story; and making it personal to each student. We have included instructional strategies of brainstorming, discussing, including emotion, using movement, problem solving, cooperative learning, and storytelling.

Consider a lesson on anterior cruciate ligament (ACL) reconstruction rehabilitation. You know your students have already passed a unit on knee assessment and have a good understanding of the anatomy and biomechanics of the knee and specifically the ACL. Earlier in the semester, they learned the general phases of rehabilitation programs and the tools available for various programs. To begin the lesson, show a 45-minute video of an actual ACL reconstruction surgery of an athlete. Break the students into groups and have each group come up with a list of the anatomical structures that were altered in that surgery, from skin to ligament to bone. Next, have them extend that list by creating a narrative of how they would care for and rehabilitate each anatomical structure on their list, separately. Lastly, from this detailed list of anatomical structures and their separate rehabilitations, have them create a full six-month ACL reconstruction rehabilitation plan. This entire process may take up to one or two weeks, depending on the amount of detail you desire. To assess their learning, have them prepare a professional presentation on their rehabilitation plan and deliver it to the class or in their clinical setting to their ACI, peers, coaches, athletes, and you.

Brain-based learning principles addressed in this example include: connecting novel knowledge to existing knowledge; creating those new neural patterns by themselves; applying it to their real life by presenting it in their clinical settings; including emotions through watching the video of an actual surgery (careful of students with volatile stomachs); learning within a specific context; challenging the student to come up with their own lengthy rehabilitation plan; and creating transfer of wound healing knowledge, anatomy knowledge, knowledge of rehabilitation phases and tools, and biomechanical knowledge of the injury, the surgery, and the sport the athlete is returning to. If possible, have the student compare their full rehabilitation plan with what one of their current ACLR athletes is doing in their rehabilitation at the student's clinical site. This opportunity would make the students' learning even more personal. This example has included instructional strategies of: brainstorming, discussing, problem solving, including emotion, visual guides, cooperative learning, and transfer.

A brain-based learning lesson on how to fit crutches will be used as a third example. Rather than handing the students crutch fitting instructions, which are also available in their text, hand them a pair of crutches and require them to use those crutches for a full 24-hours. This will certainly include an emotional aspect in their learning, through frustration. They will quickly look in their text to find the fitting procedures, in order to reduce their armpit abrasions. And, they will quickly learn how to navigate stairs and doorways as they crutch through their classes, to and from their car, and around their house or apartment. To assess their learning, simply have them fit a pair of crutches and give instructions on their use to you or a peer with your supervision. This lesson would incorporate emotions, problem solving, learning within a specific context, kinesthetic learning, and posing challenge to the student. The empathy they would have for their future clients on crutches would be invaluable.

Teaching students about designing an athletic training room can, at times, be a rather dry subject. Once again, whatever text you use likely has all of the information in it they will need. Thus, rather than repeating that information, give them a space with specific square footage, a budget range, a supply catalog, and refer them to building compliance measures in their text. Their task would be to create their own ideal athletic training room that stays within their budget and conforms to all building codes. Assess their knowledge by creating a blueprint of their project, with all necessary information in the margins. Once again, they are not being tested by a multiple-choice test with several questions about code and functionality. They are being asked to consider those things while they actively design their own facility. This is much more within the context that they will be utilizing that information in the future.

As a last example, consider a lesson on eating disorder intervention. Once students have learned about eating disorders and how patients may present in their clinical setting do a role play for the intervention. Invite a psychologist to class who has counseled athletes with eating disorders and ask him/her to be the athlete. Have one of your students lead the intervention with you being the coach or parent. The student would be in charge of the process and the rest of the "players" would be responsive to their lead. Whether the student does well or poorly, let the scenario play out to the finish. Following the demonstration, discuss what happened as a whole class. What went well or poorly? When did the student leading the intervention lose control (if that happened)? How did the student handle the athlete's denial? Was this realistic? What emotions were each of the players feeling? At the end, have the guest psychologist comment on whatever he/she feels is important or has been left out of the process. To end the session, have each student write an individual reflection paper (1-2 pages) on how the role-play affected them, what they learned, and how they can apply that learning in their professional life.

In this scenario, the brain-based learning principles incorporated were: using emotions, creating novel patterns from existing patterns, learning within specific context, connecting it to the real life of the learner, and proposing challenge. It should be noted that whatever student is selected to role play as the leader must be able to handle the challenge as just that, and not view it as stressful. A confident and composed student would be best.

Summary

The intent of these five detailed scenarios was to provide examples of creativity when teaching athletic training proficiencies in ways that incorporate brain-based learning principles. When creating lessons, consider the seven concepts presented (build upon students' current knowledge base, teach within context, teach for

transfer, make the lessons personal and include emotion, utilize kinesthetic learning, balance challenge and stress, and create an engaging learning environment). Now, the challenge is yours. Consider what you want your students to learn and how you can facilitate that learning without using lecture. What knowledge do students already have about the subject? How can you build upon that knowledge? In what context will students be using the new knowledge? In what other contexts will they need to transfer that knowledge? How will you make it personal to their lives? How will you assess their knowledge? Each of these questions must be addressed with the creation of each lesson.

Conclusion

It is a challenge for athletic training instructors to break away from the traditional lecture format that many came through their schooling with. Specifically, giving up some control in the classroom or clinical lab and giving that control to students to hopefully discover the necessary knowledge, can be uncomfortable. It is important to understand that the role of the instructor who incorporates brain-based learning principles is that of a facilitator of learning, rather than a dispenser of knowledge. It is up to each of us, individually, to keep up with advances in neuroscience research around learning. It is the intention of this manuscript to wet the appetite of athletic training instructors to discover the benefits of incorporating brain-based learning principles into their own teaching.

References

1. Clark R, Harrelson G. Designing instruction that supports cognitive learning processes. *J Athl Train*. 2002;37: S152-S159.
2. Peer K, McClendon R. Sociocultural learning theory in practice: Implications for athletic training educators. *J Athl Train*. 2002;37: S136-S140.
3. Heinrichs K. Problem-based learning in entry-level athletic training professional-education programs: A model for developing critical-thinking and decision-making skills. *J Athl Train*. 2002;37: S189-S198.
4. Mensch J, Ennis C. Pedagogic strategies perceived to enhance student learning in athletic training education. *J Athl Train*. 2002;37: S199-S207.
5. Walker S. Active learning strategies to promote critical thinking. *J Athl Train*. 2003;38:263-267.
6. Kahanov L, Wilkinson S, Wughalter E. Learning temperaments and instructional strategies of athletic training students and educators. *J Athl Train.* 2002;37:79.
7. Vela L. The effects of learning style based instruction on achievement and its relationship to measures of self-efficacy. *J Athl Train.* 2001;36:47.
8. Caulfield J, Kidd S, Kocher T. Brain-based instruction in action. *Educ Ldrshp.* 2000;58:62-65.
9. Jennings W, Caulfield J. Moving your school to brain compatibility. *Networker*. 1997;9:36-42.
10. D'Arcangelo M. Changing schools to reflect new knowledge. In *The Brain and Learning*. Alexandria, VA: ASCD; 1998.
11. Sousa D. *How the Brain Learns: A Classroom Teacher's Guide. 2nd ed*. Thousand Oaks, CA: Sage; 2001.
12. Smilkstein R. *We're Born to Learn: Using the Brain's Natural Learning Process to Create Today's Curriculum*. Thousand Oaks, CA: Sage; 2003.
13. Erlauer L. *The Brain-Compatible Classroom: Using What We Know About Learning to Improve Teaching*. Alexandria, VA: ASCD; 2003.
14. Sprenger M. *Becoming a "Wiz" at Brain-Based Teaching: From Translation to Application*. Thousand Oaks, CA: Sage; 2002.
15. Davis A. The credentials of brain-based learning. *J Phil Educ.* 2004;38:21-35.
16. Jensen E. Brain-based learning: A reality check. *Educ Ldrshp.* 2000;57:76-79.
17. Winters C. *Brain Based Teaching: Fad or Promising Teaching Method*. Chicago, Ill: ERIC document #ED455218, Clearinghouse #SP040143; 2001:1-9.
18. Craig D. Brain-compatible learning: Principles and applications in athletic training. *J Athl Train*. 2003;38: 342-349.
19. Diamond M, Hopson J. *Magic Trees of the Mind*. New York: Plume Books; 1999.
20. King J. Brain function research: Guideposts for brain-compatible teaching and learning. *J Gen Educ*. 1997;46:276-290.
21. Cabeza R. Imaging cognition II: An empirical review of 275 PET and fMRI studies. *J Cogn Neurosci*. 2000;12:1-47.
22. Kovalik S, Olsen K. The physiology of learning: Just what does go on in there? *NASSP*. 1998;3:32-37.
23. Caine R, Caine G. *Making Connections: Teaching and the Human Brain*. Menlo Park, CA: Addison-Wesley; 1994.
24. Liston D. Basic guidelines for brain-compatible classrooms: Theory to praxis. Presented at: Annual Meeting of the American Educational Research Association; April 18-22, 1995; San Francisco, CA.
25. Howard P. *The Owner's Manual for the Brain: Everyday Applications from Mind-Brain Research.* 2nd ed. Atlanta, GA: Bard Press; 2000.
26. Jensen E. *Teaching with the Brain in Mind*. Alexandria, VA: Association for Supervision and Curriculum Development; 1998.
27. Bimonte R. Mysteries of the brain. *Momentum*. 1998;29:16-18.
28. Tate M. *Worksheets Don't Grow Dendrites: 20 Instructional Strategies that Engage the Brain*. Thousand Oaks, CA: Sage; 2003.
29. Prigge D. 20 ways to promote brain-based teaching and learning. *Interv Sch Clin*. 2002;37:237-241.
30. Perry B. How the brain learns best. *Instructor*. 2000;110:34-36.
31. Dwyer B. Training strategies for the twenty-first century: Using recent research on learning to enhance training. *Innov Educ Tchg Intnl*. 2002;39:265-270.
32. LeDoux J. *The Emotional Brain*. New York: Simon & Schuster; 1996.
33. Scherer M. Social and emotional learning. *Educ Ldrshp*. 1997;54:98-103.