Brain-Compatible Teaching and Learning: Implications for Teacher Education

by Jean L. Radin

Abstract

University schools of education are challenged to prepare future teachers using best practices. Knowledge of brain research helps provide one piece of a multidisciplinary conceptual framework for educators as they articulate and enhance effective teaching.

This qualitative study discovered recommendations for the best brain-compatible instructional characteristics from the current literature, and it investigated to what extent exemplary secondary teachers incorporate those characteristics into teacher preparation programs and classroom practice.

Findings indicate that, although the exemplary teachers could be labeled "brain-compatible," gaps exist in their ability to articulate their successful techniques. Recommendations include incorporating brain research within teacher preparation courses.

Introduction

Educators often experience an "aha moment" or epiphany when they discover that findings from brain research can enhance and validate best practices for teaching and learning. From pre-school teachers to faculty in university teacher preparation programs, various principles of brain-compatible teaching and learning can help educators better serve their students at all levels and better articulate the standards of their profession.

Most teachers employ a vast repertoire of teaching techniques, not all of which correlate with how the brain learns best. According to Schenck (2003), "[M]ore effective teaching is developed from old and new discoveries, if we as teachers are willing to grow and learn" (p. 9). Brain research is opening up new avenues of thought regarding teaching and learning. No longer do good teachers merely convey information, facts, and principles: they are also in tune with how the brain functions, and they use brain-compatible instruction to increase student achievement and their own job satisfaction. Understanding the best ways to learn has become as important as learning subject matter (Sprenger 1999). Many experts in the field expect the next frontier in education to involve technologies based on cognitive and brain sciences (Battro, Fischer, and Lena 2008).

Background

The development of brain-compatible teachers takes on new importance as education moves further into the Information Age. Educators need to build an adequate structure grounded upon the principles of educational psychology, biology, cognitive science, neuroscience, and pedagogy to bridge the gap from the outdated Industrial Era model of schooling to the Information Era model. It is no longer acceptable to continue the traditional lecture-based, controlling, fact-gathering approaches and to fill students' "empty" brains with unrelated, non-relevant information. It is difficult for teachers to relinquish control, power, and structure and change their perceptions of teaching and learning (Caine and Caine 1997).

Ever since President George H. Bush declared the 1990s the "Decade of the Brain," educators have struggled to interpret the implications of current brain research for teaching and learning. Practicing teachers, often unaware of the research regarding how the brain learns best, intuitively teach in ways that "seem right" and incorporate group projects, multiple intelligences, and challenges into their lessons (Kovalik and Olsen 1998). Busy teachers seldom have the time and energy to research brain-compatible instruction and make informed choices. Marzano, Pickering, and Pollock (2001) acknowledge that moving teaching "from an art to a science" leaves many questions unanswered (p. 9).

What about the preparation of future teachers? University schools of education are expected to teach "best practices"; however, most schools of education offer courses in educational psychology rather than neurology or biology (Sylwester 2003), and those psychology courses usually provide only indirect information about how children learn (Jensen 1998; Sylwester 1995; Caine and Caine 1997). Smilkstein, likewise concerned that many colleges of education provide little instruction about how the brain learns or how to implement research findings, adds that many education-college faculty members are themselves unaware of brain-compatible learning principles, not unlike a cardiologist who "studies veins, arteries, and blood chemistry, but never learns how the heart works!" (2003, 21).

A resolution passed by the American Federation of Teachers (AFT) in July 2000 noted, "It is vital that we identify what science tells us about how people learn in order to improve the teacher education curriculum" (AFT 2000, 3). The AFT further recommended that colleges adopt a rigorous pedagogical core curriculum based on the best research into how students learn. Additionally, recent findings indicate that teacher quality is the single most important variable affecting student achievement (Darling-Hammond 1997). Clearly, what we teach and how we teach are crucial to facilitating student achievement, especially in this age of accountability.

To illuminate how brain research can shape classroom practice, the following analysis applies the literature's findings on brain-compatible teaching and learning to data from a recent study of ten expert brain theorists and six exemplary classroom teachers. The assumption is that integrating solid research from brain-related disciplines into teacher education will furnish better understanding and articulation of "teaching," as well as provide instruction that is in tune with how the brain learns.

Phased Study of Brain-compatible Teaching and Learning

Methodology

This qualitative study had two phases. Because qualitative research is "multimethod in focus, involving an interpretive, naturalistic approach to its subject matter" (Denzin and Lincoln 1994, 2), the study investigated two areas of interest regarding brain-compatible instruction. Phase I involved interviews with renowned theorists in brain-compatible instruction, and Phase II involved interviews with practicing teachers. This design provides a "complex, holistic picture . . . that takes the reader into the multiple dimensions of a problem or issue and displays it in all of its complexity" (Creswell 1998, 15). The study utilized the basic interpretive approach for several reasons: the interviewer posed "how" or "why" questions, had little control over events, and focused on a contemporary issue with real-life contexts (Yin 2003). Specifically, she sought to discover which principles of brain-compatible teaching and learning would emerge from the literature and whether they would be confirmed by expert theorists in the field. Last, she hoped to discover practicing classroom teachers' awareness of brain-compatible principles and if so, whether they incorporated the principles into their instruction (Radin 2005).

Phase I: Theorists' Perspectives

The ten theorists interviewed in Phase I possessed varied educational levels and career paths. Their areas of expertise ranged from neuroscience, biology, and psychology to educational applications of brain research. Several individuals concentrated more on scientific work with the brain than on teaching and learning. Others were heavily involved with pre-service teacher training and working in public schools. A few worked as consultants in professional development. Seven were college professors, two were educational consultants with learning companies, and one was a high school science teacher.

The interviews with the theorists confirmed, disconfirmed, or added to the principles of brain-compatible instruction that had emerged from a review of relevant literature. Three broad questions were asked of the brain theorists:

- How would you describe brain-compatible teaching?
- Are there certain principles or characteristics of brain-compatible teaching that you believe are most important?
- How would you describe a brain-friendly teacher? (Radin 2005)

All questions were aligned with the emergent characteristics of brain-compatible instruction. The technique of constant comparative analysis revealed common themes within each question, and subcategories were created. Initial categories of information were first formed, in *open codes* (Creswell 1998). Next the data were assembled in new ways, *axial codes*. Finally, *selective codes* were employed to tell the story and integrate the categories in the axial-coding model. The first open code from this study was "Characteristics of Teaching Process," with axial codes labeled 1) emotional climate of classroom; 2) physical setup of classroom; 3) caring for students; 4) encouraging students; and 5) relevant, inquiry-based work. The second open code, "Characteristics of Teachers," included the two axial codes: 1) lifelong learners and 2) lack of articulation.

The six characteristics of brain-compatible instruction that emerged from the Phase I interviews with the brain theorists include the overarching idea of an *enriched environment* with the following components:

- *emotional involvement*, from the standpoints of both teacher and student
- *physical systems,* to include movement, room arrangement, and homeostasis
- *lowered stress and threat levels*
- *experiences in the classroom*, including trial and error, exploration, practice, creativity, and critical thinking
- *challenge, problem-solving, and authentic work*, in which the students do the work of learning and create their own meanings

Each theorist made salient comments regarding these important principles or characteristics. Sample comments included:

> All long-term memory is emotionally tagged.

> You're teaching, first of all, to the entire person. If you think you're teaching only to the brain, you have a basic misunderstanding here of what's going on. Because the

> way it's wired to the rest of the body and how the brain is responding and using homeostasis to monitor and control what's going on, that needs to be kept highly in mind.
>
> I think classes need to be safe, physically and psychologically. The fight-or-flight response is identical.
>
> Probably the most important thing we have learned is that the brain is the only organ in the body that sculpts itself through experience. The teacher's part in this is that the teacher literally sculpts the kids' brains.
>
> Problem solving can clearly have an impact on that [students doing the work and linking it in ways that create longer-term memory system capacity], or it can die a natural death like it does in so many classrooms.

And finally:

> [Brain-compatible teaching] is the application of a meaningful group of principles that represents our understanding of how our brain works in the context of education. (Radin 2005)

Phase II: Teachers' Perspectives

Phase II of the study consisted of interviews with six secondary teachers in a Rocky Mountain state. Within the past three years, each teacher had either been nominated for or awarded an excellence in education award from the local public school district. The district includes more than 24,000 students, 1,735 teachers, 30 elementary schools, 8 junior high schools, 5 senior high schools, 3 charter schools, and 19 alternative schools and programs. The teachers' classroom experience, ranging from eight to thirty-nine years, included sixth grade, middle school social studies, science, and mathematics, as well as senior high school physics and physical education. Education attainments ranged from a B.S. with some graduate hours to an M.A. plus ninety hours of graduate work.

Interview topics ranged from the classroom environment, approaches to grading and evaluation, and activities and experiences used in teaching to familiarity, if any, with brain-friendly instruction. The interviews' approach mixed structured questions and semi-structured questions.

From the data two themes emerged:

- Characteristics of the teaching process
- Characteristics of teachers

The theme of "characteristics of the teaching process" emerged from the teachers' answers to questions about the classroom environment; grading and evaluation; activities and experiences the teachers use in their teaching; sources of teaching ideas; and maintenance of order. The brain-compatible teaching characteristics identified through the literature review and confirmed by the theorists were reconfirmed by the teachers' comments. They enriched their classrooms with positive, friendly, encouraging emotional climates and thoughtful physical layouts of grouped tables, diagonal rows, and other flexible configurations. The teachers were caring encouragers who viewed each student as possessing potential; they did not define students by grades or achievement. Discipline was carried out respectfully; threats and shame were not used to coerce good behavior.

Vocabulary terms used most often by the teachers to describe their teaching were *inquiry-based*, *problem solving, experiments, authentic, hands-on,* and *discover.* After establishing a knowledge base, the teachers encouraged students to explore and discover topics of personal interest through role-plays, research projects, simulations, experiments, and field trips. Students were empowered to construct their own meanings from the content.

Teacher characteristics also play a role in shaping brain-compatible instruction. All the interviewed teachers were lifelong learners. Because they have felt more comfortable in the classroom over the years, their teaching ideas come from "themselves." They view real-life experiences and social interaction as sources of inspiration for teaching and personal growth. Many participated in professional organizations, took graduate classes, mentored student teachers, and obtained grants to improve classroom instruction.

The answers to the question "Have you had any kind of brain-based instruction or professional development?" made it clear that the topic had not been addressed in either teacher preparation courses or professional development. Only one teacher, "Robin," had any familiarity with brain research. Although the teachers were incorporating many brain-compatible techniques in their classrooms, they were not able to articulate why those techniques were successful, nor did they have an understanding of brain physiology. Except for the one teacher mentioned, they were functioning intuitively; trial and error had taught them which strategies were "working." The teachers mentioned learning styles, cooperative learning, Madeline Hunter's work, and personality tests as possible components of brain-compatible instruction, but no one, except for "Robin," was sure what that entailed (Radin 2005).

Pulling It Together and Making Connections

The study revealed a gap in these teachers' ability to articulate their work. Comments from the theorists that support this concept include:

> The kind of brain-based teaching that educators should strive for is that which is informed by the most up-to-date research knowledge of the role of the brain in teaching and learning reading, writing, math, and other content domains.

> One needs a good introduction to awaken people to the fact that all learning comes from the brain, and give them an idea as to its magnitude.

One comment reinforces the idea of articulation:

> Sometimes we [teachers] are not considered to be professional because we cannot articulate our craft and what we do.

Should pre-service and practicing teachers understand how the brain learns, in addition to brain-compatible teaching and learning? Two theorists advocated formal pre-service training in neuroanatomy so prospective teachers can "learn where learning really begins." One theorist, citing the need for concentrated training to master the knowledge base, cautioned that teachers should not rely solely on the media, popular books, or workshops for information about neuroscience. Two other theorists supported this idea: they stated that teachers should base their teaching upon biological findings of how the brain constructs knowledge. Another theorist addressed the practice of "rough draft" learning, in which teaching often sacrifices accuracy for simply getting something "close." Teachers must know how to increase the importance and relevance of learning so they can upgrade rough drafts for improved meaning and accuracy.

The findings revealed that brain research is seldom available through local school districts unless teachers actively seek out opportunities to learn it. This study revealed additional stumbling blocks to learning about brain research: the time and diligence required to understand it; poorly communicated or dull presentations; professional development that ignores current, peer-reviewed research; and brain-compatible teaching's focus upon learning rather than test scores, which can make it unattractive to administrators (Radin 2005).

Implications for Educators

Because these teachers lacked a working knowledge of the brain, they did not fit the theoretical conception of brain-compatible teachers. Intuitively they were doing the right things, but the problem with intuition, according to one of the theorists, is that it's "sterile." Kovalik and Olsen (1998) confirm that practicing teachers are often unacquainted with research about how the brain learns best. Several quotes from the theorists confirm the need for teacher preparation programs to incorporate knowledge of how the brain operates:

> Right now our better teachers are doing a seat-of-the-pants thing; you know they've got a feel for it. "This really works." But I think we can narrow it down so we're not guessing so much.
>
> [A brain-compatible teacher] draws on cognitive neuroscience, psychological, and educational research in a continual search to provide the best possible instructional environment for students.
>
> A [brain-compatible] educator is one that understands why she does what she does. It is also one who stays constantly updated through continuous professional development.
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> When I mention to colleagues in disciplines outside education that teachers receive no formal training in the brain, the organ of learning, as part of their formal pre-service teacher education, they are appalled. Yet when I suggest to colleagues within the field of education that there be such a requirement, they are equally appalled. They retort that teachers have been teaching effectively without knowledge of the brain for years. That is and is not true. Many master teachers have been effective without knowledge of the brain. At the same time, many students with learning differences [normal variations] or learning disabilities [atypical variations] have not had their educational needs met. If more teachers had greater understanding of the brain, we might be able to optimize the learning of all students.
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> So a teacher that I think is brain-compatible is aware of how the brain learns, and how kids learn, and is using that information to engage students in a meaningful, relevant curriculum. Brain research is a piece of the big picture. (Radin 2005)

Conclusion

A knowledge of current brain research helps provide a part of a conceptual framework for educators as they seek to enhance effective teaching. A conceptual framework recognizes the "system of interacting components, all of which must be orchestrated to achieve literacy and numeracy goals" (Berninger and Richards 2002, 304). The interacting components of neuroscience, combined with cognitive science, educational psychology, biology, and educational research, can validate good teachers' practices and motivate other teachers, including pre-service teachers, to begin to articulate their craft. As Jensen (2008) notes, "Each educator ought to be professional enough to say, 'Here's why I do what I do'" (p. 409). This conceptual framework will also aid teachers in becoming highly qualified and optimizing achievement for all students. As noted by the American Federation of Teachers (2000), it is vital that teachers learn from scientific research how people learn.

> Imagine all the teachers teaching well, experts in nature-nurture interactions, who fill the mind in individually tailored ways, guided by scientifically supported principles of the brain and instruction, and by cultural sensitivity. (Berninger and Richards 2002, xvii)

To become true professionals, teachers need to become articulate about what they do and why. Rough draft teaching and learning have no place in today's schools. Brain-compatible teaching is essential for optimal learning; educators at all levels, preschool through higher education, need this component to round out their conceptual framework. If pre-service teachers are expected to learn about recent developments in neuroscience and cognitive science, then their teachers—university faculty—should understand these topics in depth (Smilkstein 2003). University-level teacher educators should lead the way in role modeling best instructional practices, not only for teacher preparation programs, but also throughout the university. What, then, does the brain have to do with learning? Learning about how the brain learns is one of the first steps in becoming an articulate professional educator.

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