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ABSTRACT

Developments in the field of brain research that focus on how humans learn is beginning to influence the way schools are being built and renovated. This report discusses how the brain learns, explores how this knowledge can be used to inform learning theory, and describes what instruction would be like in a brain-based learning environment as well as the implications on facility design. School designs incorporating house concepts, technology networks, and flexible spaces are examples of designs that are compatible with brain-based learning. Concluding comments provide the questions facility planners should ask their clients who wish to implement some of these design approaches to create brain-based learning environments. (GR)

CEFPI
ISSUETRAK
A CEFPI Brief on Educational Facility Issues

Turn On The Lights!

Using What We Know About The Brain And Learning To Design Learning Environments


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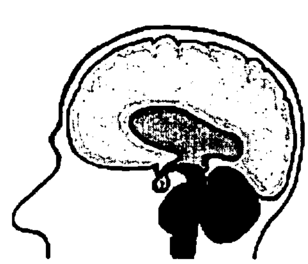
INTRODUCTION

Recent research on the human brain is providing new understanding of how we learn, information which is helping us to redefine intelligence. This new information, which is now being translated into classroom applications with the goal of increasing learning for all students, has broad implications for the design of learning environments since it is the facility which must support the educational program. As we explore facility designs for the 21st Century and beyond, we need to keep abreast of developments in the field of brain research, being mindful that their influence on the teaching/learning relationship will forever change the way we build and renovate school facilities.

Such recent scientific developments as Positron Emission Tomography (PET) and Magnetic Resonance Imaging (MRI) have rapidly advanced our knowledge of the brain and how it works, moving us out of the age of mythology and into a new era of brain mapping and understanding. New theories of consciousness, learning, and intelligence are emerging to help guide the next round of discoveries. For example, Gerald Edelman proposes that natural selection over the millennia has resulted in a modular brain with tens of millions of basic neural networks *hard-wired* at birth. Each of these networks is adapted to a very specific purpose, either monitoring and regulating the internal worlds of the body or intercepting and interpreting the messages from the environment. Included are emotional, memory, and reasoning systems which allow an individual to adapt to changing conditions during his or her lifetime. This knowledge presents a world of exciting opportunities as well as heavy responsibilities for educational facility planners worldwide!

THE BRAIN



Cortex
Brainstem
Limbic System

The brain is generally conceived to consist of three major blocks, which include the brain stem, the limbic system, and the cortex. The brain stem controls life functions, such as breathing and heart beat, while the limbic system appears to be the seat of emotion. The cortex contains the neural networks that allow reason. This is an oversimplified view since each of the three building blocks provides many additional functions but it suffices for this brief discussion. All three parts work through an electrochemical process, which distributes

both chemicals and electric charges through an incredible network of tubes extending throughout the brain and body. **It appears that learning consists of the growth of additional neural connections stimulated by the passage of electrical current along nerve cells (neurons) and enhanced by chemicals (neurotransmitters) discharged into the gaps between neighboring cells (synapses).** As a particular pathway is used, additional connections ease future use of the same neurons. This is analogous to water cutting channels that eventually grow into streams and rivers.

LEARNING THEORY

If learning consists of the development of connections between neural networks, then the cogent question is whether or not we can we enhance this growth through education. Among the notable theorists in this area, David Perkins has advanced a particularly powerful idea. He proposes that there are three different kinds of intelligence: neural, experiential, and reflective. Neural intelligence is that with which we are born. The networks established at birth vary somewhat from person to person, allowing some individuals to process incoming signals at a faster rate or with more discrimination than others. The second and third intelligences, experiential and reflective, are open to change. As we learn our way around a new subject or activity, he postulates that experience causes new neural connections to develop. As we reflect on how we behaved in past situations and see alternative routes, new connections are made.

Gardner's theory of multiple-intelligences takes a somewhat different tack but is not inconsistent with the work of Perkins. The current seven intelligences postulated by Gardner (spatial, musical, linguistic, logical-mathematical, kinesthetic, interpersonal and intrapersonal) exist at different levels in the neural networks of individuals at birth but could be enhanced, he believes, through experience and reflection.

The work of Hart, Caine and Caine, and others, which examine such human brain propensities as information seeking, processing, and organization, attempt to capitalize on these propensities by organizing instruction to be more brain-compatible. Since the role of emotion is now known to be of great importance in learning, strategies for its inclusion in instruction are now a component of these theories.

INSTRUCTION IN A BRAIN-BASED LEARNING ENVIRONMENT

Although rote learning, work sheets, and drill do not disappear in brain-based learning, their role is limited to those procedural and skill areas where these techniques are known to be effective. The role of the teacher changes from that of purveyor of information to one akin to a symphony conductor, bringing different elements of the orchestra to the attention of the audience at appropriate times, creating an atmosphere conducive to learning and encouraging the development of students' feelings and emotions. Using current learning theory, teachers will create events and introduce materials and ideas into the classroom that will encourage the development of neural network connections in their students. When this occurs, the classroom then becomes *constructivist*, one where students *construct* individual meaning from the information and activities presented.

The use of music, video clips, odors, and even tastes can be used to connect new learning to already existing brain pathways. The introduction of *discrepant events*, new information presented in a way that seems to be dramatically inconsistent with prior knowledge, is another entrée to significant learning because the brain appears to scan its environment to identify and explain the unusual and/or dangerous. This provides the teacher with a *hook*, a place to hang

important new concepts.

Both student and teacher are viewed as knowledge workers in a brain-based learning environment. **The young learner must actively manipulate information and material to grow new connections.** Creating stories, growing plants, and examining artifacts are activities now added to hearing and reading about new topics. Sharing ideas through group problem solving exercises and project work forges connections to existing memories thus enhancing growth. Observing competent peers and elders as they carry out activities is desirable both for learning new skills and for perfecting those already learned.

Older students, to learn their way around important cognitive or procedural arenas, need a depth of understanding. Apprenticeships, project work, and mentorships are just a few methods for achieving this. Exposure to ever-widening environments will lead older students into the community to learn alongside adults in offices, hospitals, zoos, and other places of work.

The work of all students, hence their learning, should be rich in technology although not dominated by it. Technology may be viewed as a tool for acquiring, organizing, and processing information to develop new knowledge. It will become an end in itself only for those individuals with a special interest in technology.

A LOOK AT SCHOOL ENVIRONMENTS

Traditional Classrooms	**Constructivist Classrooms**
Curriculum is presented part to whole, with emphasis on basic skills.	Curriculum is presented whole to part, with emphasis on big concepts.
Strict adherence to fixed curriculum is highly valued.	Pursuit of student questions is highly valued.
Curricular activities rely heavily on textbooks and workbooks.	Curricular activities rely heavily on primary sources of data & manipulative materials.
Students are viewed as blank slates onto which information is etched by the teacher.	Students are viewed as thinkers with emerging theories about the world.
Teachers generally behave in a didactic manner, disseminating information to students.	Teachers generally behave in an interactive manner, mediating the environment for students.
Teachers seek the correct answer to validate student learning.	Teachers seek the students' points of view in order to understand students' present conceptions for use in subsequent lessons.
Assessment of student learning is viewed as separate from teaching & occurs almost entirely through testing.	Assessment of student learning is inter-woven with teaching & occurs through teacher observations of students at work and through student exhibitions & portfolios.
Students primarily work alone.	Students primarily work in groups.
(Source: Brooks, Jacqueline Grennon, & Martin G. Brooks. _In Search of Understanding The Case for Constructivist Classrooms_. ASCD. Alexandria, VA, 1993. p. 17.)	

FACILITY IMPLICATIONS FOR BRAIN-COMPATIBLE LEARNING

The ideas presented here lead to a school much different from the egg-crate, factory production model we are used to. It may be helpful to think of the school and the spaces within

it as a *knowledge studio*. **The space needs to be adaptable to various sized groups and learning resources need to be both rich and plentiful.** Some aspects of children's museums come to mind. Students should be able to observe, collect information, and manipulate tools and artifacts. **School structure and site should be considered as an integral part of the learning environment, providing opportunities for neural growth around every corner.**

Fran Hunkins, in a speech at the University of Washington in May 1994, called for the development of spaces that *engage, challenge, and arouse*. **Brain-compatible learning requires much more interaction with the environment than current facilities allow.** The addition of Lexan-covered cutaways of plumbing, electrical, and HVAC systems allow children to see what happens to the pipes and cables that disappear into the wall. Planned nature areas and garden plots provide a multitude of learning opportunities that extend learning beyond the classroom walls.

Space for the construction and storage of student-created projects is vital. In addition to project production per se, new trends in assessment emphasize portfolio development (a collection of learning artifacts produced over time by each child) to demonstrate academic growth. Since these projects and learning artifacts may vary from electronically encoded discs or tapes to large three-dimensional models, it is clear that a variety of storage systems should be developed. Storage of such learning resources as large tools, musical instruments, models, and electronic equipment must also have a very high priority, possibly requiring innovative solutions. Adjacencies must be carefully arranged to provide the easiest access to resources and specialized environments. The inclusion of adult volunteers, specialists, and mentors creates a special need for parking, access, and work space. Consideration must be given to secure storage of coats and other personal belongings of these additional adults who may come into the schools.

QUESTIONS TO ASK

As a school facility planner with a client who wishes to implement some of the ideas presented above, you should attempt to obtain clear answers to a number of questions:

1. Can the client provide a narrative describing what the students and the adults will be doing while they are engaged in brain-compatible learning?

- Are they working individually or in groups? Do they need privacy? How many individuals/groups are there?
- Are they in regular classrooms or in some other studio or lab space inside? Outside?
- What kinds of materials are they using?
- What kinds of equipment are they using?
- Can you provide examples of the kinds of activities that will be carried out?

2. What environmental controls are required (heat, light, sound, shape or size of space, color, etc.)?

3. What technology resources are required?

4. What is the level of commitment to the ideas presented here?

- Are you ready to implement these ideas now or do you need a transition period to train staff and phase in the model?

- Do you want to easily adapt this space to return to current teaching models?

The help of a skilled facilitator who has a clear understanding of the new teaching models as well as experience in facility planning will prove invaluable as you begin to create the facilities for brain-compatible learning.

CONCLUSION

As the ideas presented here become widely known,* gaining a stronger foothold among stakeholders in the educational community, we will see a shift from merely envisioning such a brain-based learning environment to actually recognizing the need for it and then taking action to achieve it. Fortunately, **current trends in school design, such as *house* concepts, technology networks, and flexible spaces, are all compatible with brain-based learning.** As our knowledge of how we learn continues to expand, we must recognize the expanded role we, as educational facility professionals, will be expected to play in helping to support the educational program in the classroom. We must expand our focus on the built learning environment to include a broader understanding of its role in enhancing the neural network growth of the students it houses. We are no longer simply designers, builders, administrators, and suppliers of school buildings, we are now partners in facilitating the growth of students' minds.

*ISSUETRAK is prepared by The Council of Educational Facility Planners, International as a service to its membership. CEFPI wishes to thank Dr. Bob Valiant of SCM Consultants, Inc. of Kennewick, WA, for his invaluable time and expertise in preparing this brief. * For a copy of Dr. Valiant's recommended reading list on brain research and learning, please contact International Headquarters at 602/948-2337.*

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