Chapter 14
Importance of Brain-Based Learning in Effective Teaching Process

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14.1 Introduction

Neuroscience has been understood as the study of biological underpinnings of various cognitive processes such as learning, memory, and consciousness (Oktar 2006). It has been often referred to as neurobiology. It is the systematic and in-depth study of the nervous system which has the basic, structural, and functional unit as a neuron. So, in a way, neuroscience can be defined as the study of the neurons. Neuroscience is multidisciplinary by nature as it includes various fields like biology, psychology, and cognitive science. Extensive research has been happening in the past few years in this field in order to understand various cognitive processes like memory, consciousness, learning, perception, and their biological bases. While these researches have continued to happen, there are hardly any takeaways in terms of execution and implementation from these researches.

Although educational science and neuroscience seem far off in relation, they have a strong connection when it comes to use of cognitive science. Cognitions such as memory, attention, learning, reasoning, and problem-solving are very important in educational science to impart teaching and facilitate the learning process. Neuroscience, as mentioned earlier, deals with understanding the biological bases of these cognitive processes. The most important cognition of educational science being learning, this chapter exclusively explores the importance of including novel methods of teaching which are exciting to the brain. Further, these methods have been provided with evidence-based benefits such as enhancing cognitive processes that in turn facilitate meaningful learning processes. Firstly, learning and brain-based learning are explained. Following which neuroscience and teaching along

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with different strategies for teaching that enhance learning have been explored. The chapter closes with challenges and benefits which will be fruitful to inculcate these in classroom settings.

14.2 Learning

Learning is a process which is defined as the gaining of knowledge through various means like being taught, through experience, and through studying. It is also a process in which new information is acquired and modified with the existing information in our brain. It is a complex process which is found in humans and animals. One of the earlier studies related to the learning process in animals can be traced back to Skinner's studies (Winokur 1971).

It can be said that all learning can have a biological base. Our understanding about learning and the neural mechanisms that are involved in the process are increasing on a daily basis. This can be associated to the development in various technologies and researches that are extensively happening in the field of learning. The significance and meaning of the term "learning" vary depending on the context and the field in which it is used and applied (Howard-Jones et al. 2014).

We study extensively about the brain, neural systems, and various functions under the field neuroscience. In this field, "learning" is often equivalent to memory. We can say that memory is not localized to any particular brain region, but is spread throughout the brain. Along the same lines, it is also a fact that certain aspects of memory can be associated with particular areas/parts of the brain (Kalat 2016).

Neuroscientists opine that learning that happens through formation and development of memory is influenced by the changes in neural connectivity. It is also important to understand that forming neuronal connections/associations is not the same as that of forming connections/association between ideas. The former is supposed to happen in the brain, while the latter is supposed to happen in our minds.

14.3 Brain-Based Learning

According to Jenson (2011), brain-based learning is the ability to learn with respect to the brain's natural design (wiring) to learn. The ideas from brain-based learning can be adopted to increase comforts for students in learning. One of the underlying assumptions of brain-based learning is that the human influence has an impact on the ability to learn things. The brain always attaches an emotion to every event that takes place (Jenson 2011). This means that emotion plays a major role in learning. In order to enhance learning, teachers should give importance to the emotional content of each lesson. Furthermore, our emotional system drives our attentional system, which in turn drives all the other processes in our learning, including learning

and memory. In short, it can be said that it is impossible to learn something to which we don't pay attention (Chapman and King 2005).

After multiple studies conducted in association with brain-based learning, experts have come up with 11 basic principles which underlie the brain-based learning. The first principle is regarding the brain's capability to parallelly process. This means that the human brain has the ability to perform multiple tasks simultaneously. The second principle is the involvement of entire physiology in learning. This means that in the process of learning, it is not only the brain which is involved; other parts of the body are also involved. For example, some people use hands to do simple math calculations. The third principle is that the search for meaning is innate. This means that whatever we learn or understand, when it is linked with meaningful and personal experiences, it tends to have an in-depth learning as a result of this. The fourth principle is about the patterns that help in search for meaning, which means that the brain is tuned in such a way that it makes and understands patterns. All information is stored in the form of a pattern in our brain. The brain cannot create meaningless patterns, nor does it accept meaningless patterns. The fifth principle is that emotions play a vital role in patterning. As mentioned before, no learning happens without us paying attention to it. The sixth principle is that the brain processes parts and wholes simultaneously. This statement means that even though the brain has two hemispheres and various parts in it, the brain is designed in such a way that it works together. The next principle is that both focused attention and peripheral perception play an important role in learning, which means that we have general ideas about our surroundings and we pay special attention to some parts of it. The eighth principle is that learning always involves conscious and unconscious processes. The ninth principle states that humans have two different types of memory at the least, which are autobiographical memory and taxon memory. Factual information is stored in taxon memory. The autobiographical memory establishes links between experiences, facts, etc. The tenth principle is that learning is developmental. The eleventh principle is that learning is inhibited by threat and enhanced by challenges (Caine et al. 2009). These principles can be of great help for teachers and can be implemented from preschool itself in order for the better and effective learning in students.

Neural plasticity is one of the significant features of the brain. Often referred to as brain plasticity, it enables the brain to make new neural connections and to keep up with the changes. All the experiences which we go through, be it good or bad, small or large, are said to transfer the connections between neurons, to help the brain to constantly undergo change. In neuroscience, plasticity plays a major role in primarily understanding development and learning (Dubinsky et al. 2013). The brain's capability to change is very important in growth mindset and learning equity. It has been found out that a growth mindset is associated mostly with increase in achievement, taking more challenges and adaptive responses toward those challenges, and consistent in terms of learning tasks (Rattan et al. 2015).

Brain-based learning studies throw light on the fact that despite differences, everyone can learn, despite each brain being unique and different people having

different styles of learning (Stern 2017). It is very important for teachers to get trained in all these aspects and to use research-based training strategies so that the students learn effectively and the learning stays in their memory forever.

14.4 Neuroscience and Teaching Practice

According to Hart (1983), the brain is considered as the organ for learning, and teachers are considered to be the primary source that fosters learning in students. The process of learning happens extensively in the brain. So, it is important for courses offered to train teachers to include the brain in the syllabus. Even though this idea is strongly there in the modern-day world, there are very few programs which include neuroscience in their curriculum (Ansari and Coch 2006).

It has been only a very few years since the whole idea of neuroscience and its importance in the field of teaching practice have come up. There has been new advancement in this field. One such advancement is known as the technology-enhanced learning. Technology-enhanced learning is the practice of including technology to facilitate the learning process. The main idea of this approach is to enhance the process of learning using the various technologies available (Howard-Jones et al. 2014).

As teachers serve as one of the important sources of spreading knowledge to children, it is important that the teachers use effective methods and strategies for an effective learning process. Recent literature has pointed out the importance of brain-based teaching-learning practices for the teachers to spread knowledge with the help of effective teaching practices and students to gain knowledge in a more effective way. A brain-compatible teacher or, in short, an effective teacher relies on areas like cognitive neurosciences, psychology, educational research, etc. in order to provide an apt learning environment for the students as well as an effective way of learning (Alton-Lee 2006).

An important fact which should be understood regarding this area is that learning is both a conscious and an unconscious process. Most of the peripheral signals perceived by us undergo unconscious processing in our brain, i.e., we are not aware about these processes. It has been found out that after sometime, the unconscious processes are brought into our conscious part and it influences some aspects of the process (e.g., our motives, behaviors, etc. associated with what we have perceived) (Lozanow 1978). So, the process of teaching should benefit the students abundantly in terms of learning by giving more attention to the unconscious processes that in turn makes learning effective.

Adding on to these benefits, literature on brain-based learning have found out various methods that can be adopted by teachers in a classroom setting in order to make the process of learning more beneficial for the students. Some of those methods are discussed below.

14.5 Movements

Learning is a process that involves both the body and the brain. In the educational setup, the process of learning can be enhanced by using movement. This movement involves the physical movements of both the students and the teachers. Based on the recent studies, we now understand that the physical movements that take place in between the classes such as a teacher moving around the class while teaching, students moving to different parts of the room for activities, etc. are very effective in terms of increasing engagement and enjoyment in the process of learning as well as teaching (Benes et al. 2016). In the process of teaching, inculcating movement in their traditional classroom environment can be beneficial for the teachers as it leads to increased physical awareness, enhanced social interactions, and a sense of autonomy where they feel more responsible for improving in their teaching (Sevimli-Celik and Johnson 2015).

Therefore, movement or physical activity can be beneficial in the learning process. In terms of cognitive functioning, physical activity or motor movement has been proven to boost attention, memory, mood management, etc. that form an integral for each type of learning (Jenson 2011). Additionally, in the domain of physical health, engaging in motor activities prevents metabolic, cardiovascular, and respiratory diseases (Giorgio et al. 2018). Moreover, engaging in motor activity has been strongly correlated with the production of new brain cells – neurogenesis (Jenson 2011). Lastly, within the classroom, movement integration improves on-task behavior, boosts positive affect, and increases perceived effort and competence (Webster et al. 2015). In totality, we understand that movement proves to be beneficial in improving socio-emotional, physical, and mental health.

Furthermore, literature rooted in application of movement in the real-life settings reveals that physical activity or movement in the classroom settings reveals that since physically active classroom lessons are more interesting and enjoyable for both the students and teacher, they result in improved academic performance. Additionally, these lessons do not require more preparation on the part of teachers and are cost-effective (Donnelly and Lambourne 2011).

Therefore, while preparing for the classroom lectures, teachers can think about incorporating motor-based activities that can range from simple to complex ones such as having students stand up after every class to push-ups. And these can be modified based on several factors such as student capabilities, time constraint, etc. Moreover, by inculcating movement breaks which can include jumping jacks, toe touches, arm circles, one-legged hops, etc. in the school curriculum, stress levels can be reduced for both teachers and students (Reilly et al. 2012).

14.6 Emotions

Our earlier understanding that learning is independent of emotional and social domains of our lives has been challenged by new findings in the field of neuroscience. These findings suggest that the process of learning in the educational setup is

deeply connected to the emotional and social aspects of an individual. Moreover, the fundamental reasons that drive the learning process are rooted in emotional and social factors. Students engage in the process of education for various emotional and social reasons such as pleasing the parent, escaping the punishment, or getting admission in a good college (Immordino-Yang 2011).

Emotions, therefore, are essential in the process of learning. Furthermore, the human emotional system is spread throughout the body, originating from the brain to the endocrine and the immune system. These systems have an impact on other parts of the body. One such impact of emotions can be found on the attentional system. Since emotions have a huge impact on attention, this in turn influences the process of memory and learning (Sylwester 1994). Additionally, emotions can also modulate the selectivity of attention which is closely linked to the process of learning and can aid the process of encoding and retrieval of information. The neuroimaging results show that the prefrontal cortex and the amygdala along with the medial temporal lobe work in an integrated manner which leads to the long-term retention of information and successful learning (Tyng et al. 2017).

Therefore, teachers need to understand that stressful class environments will inhibit the process of learning and a positive classroom atmosphere enhances the process of learning. Teachers can enhance the learning process by incorporating positive emotions in the class which will create a positive learning environment. For this, teachers can make students engage in activities like meditation, mindfulness, yoga, etc. and can employ appropriate humor to consolidate the learning process and decrease the stress levels in the students (Waters et al. 2014; Terrell 2014).

14.7 Music

In the past several decades owing to the technological advancements in the field of scientific enquiry, we have been able to explore at a deeper level the positive impact of music on human beings. Areas that have been of primary interest to these scientific studies include brain areas that are activated and responsible for the perception and processing of music, along with the cognitive and neural process that is involved in musical treatments. With the growing evidence from such studies and the rise of new scientific domains, there has been increased encouragement to utilize the benefits of music within the educational system (Stefanija and Aida 2015).

Therefore, we are now able to understand that music can be used to improve and enhance the process of learning. Furthermore, cognitive neuroscience reveals that music has an impact on enhancing the attentional system, improving brain plasticity, providing multi-sensory input, and improving memory (Curtis and Fallin 2014). In the domain of attention, music has been found to enhance attention by increasing arousal and improving mood and thereby improving visual attention (Chen et al. 2012). In the context of music and brain plasticity, studies reveal that even brief music training can induce brain plasticity (Moreno et al. 2011). Additionally,

individuals who practice a musical instrument often perform better on working memory and reasoning tests (Nutley et al. 2014).

However, in the case of music, certain elements need to be monitored. The first factor that needs to be understood is the presence or absence of lyrics. Music with lyrics interferes with the visual focused attention and thus affects the performance as compared to music without lyrics (Shih et al. 2012). The second factor includes the type of music which enhances cognitive abilities. The genre of music also seems to influence the efficiency of focused attention. Sedative music increases the production of alpha rhythms in the brain and therefore increases the efficiency of focused attention (Boring 1981). Lastly, the tempo of the music is a factor that influences the performance speed. Listening to music with high temp seems to enhance the speed of the performance (Jamshidzad et al. 2018).

While considering the abovementioned factors, music can, therefore, be used as an educational tool in the schools. The schools can inculcate music as a part of learning by using music as a part of activities such as cooperative activities, throwing and catching, and jumping the rope. Furthermore, music can also be employed as a classroom management strategy which will lead to maximized learning and participating and a significant decrease in the student's misbehavior (Konukman et al. 2012).

14.8 Interactive Learning Environment

With the gradual paradigm shift owing to the brain-based model of learning, teaching models are now focusing on optimizing student learning. However, in the present situation, the process of learning is more focused on attaining curriculum goals rather than enhancing student's cognitive abilities. Owing to this, the process of learning only focuses on providing various information to the students rather than actively engaging them in learning, which does not yield positive responses from the students. Furthermore, the role of the students is reduced to passive receivers of information (Sesmairni 2015).

Therefore, by creating an interactive classroom environment, the teachers can stimulate the student's thinking ability. Furthermore, neuroscience reveals that students who actively engage or participate in the learning process by explaining their ideas and then engaging with other students' ideas have higher achievement scores (Ing et al. 2015). Additionally, using collaborative learning activities enhances student satisfaction and improves learning. However, in this process, the teachers need to be open to these interactive teaching strategies (Lo 2010). Therefore, the teachers must aim to create an active learning environment by incorporating games, puzzles, simulation, group discussions, etc. into the classroom settings to avoid making the classroom boring and uncomfortable (Sesmairni 2015).

14.9 Visual Stimulation

In the past decade, the field of education and teaching has been revolutionized by the research on neuropedagogy. The cross development in the fields of neuroscience, class teaching, and brain science has led to the changing trends in the field of education (Dai et al. 2018). Owing to these developments, the field of education has been transformed from traditional classrooms to active learning spaces. Moreover, the traditional chalkboard medium of instruction has been replaced by more technologically advanced methods such as the use of PowerPoint presentations which provides a platform to use multiple visuals such as videos, pictures, movies, animation, and words (Vazquez and Chaing 2014).

Therefore, visual stimulation became an integral part of the learning process. Furthermore, neuroscience reveals that using visual aids in teaching can substitute the monotonous teaching method and enhance the learning environment and stimulates thinking. Moreover, visual aids can be used to gain the attention and enhance retention of information and interest of students and can be used by teachers to explain the concepts more easily and clearly (Shabiralyani et al. 2015). Therefore, schools, as well as teachers, can inculcate visuals in their curriculum in the form of posters, charts, models, pictures, maps, diagrams, PowerPoint slides, and short videos or clips from YouTube to make the process of learning in the classrooms more interactive and interesting. Moreover, by using such visual aids, the teacher can cater to the needs of different types of learners in the classroom (Macwan 2015).

14.10 Throwing Challenges

Educational neuroscience is the scientific field that focuses on our understanding of how the brain operates in connection with the learning process (Mayer 2016). Gradually, brain-based education shifted its focus from the initial establishment of vocabulary needed to understand new knowledge to the establishment of various brain-based disciplines (Jenson 2008). However, over a period of time, one of the important contributions of educational neuroscience is the 12 fundamental principles that they propound underlie the learning process. The twelfth principle focuses on the need for challenges to enhance complex learning. This means that students can benefit optimally when the tasks assigned to them are challenging while the classroom environment is supportive and safe (Connell 2009).

Therefore, focus should be on building socio-emotional conditions where learning will thrive through challenges that are non-threatening (Gulpinar 2005, as cited in Gozuyesil and Dikici 2014). Furthermore, cognitive neuroscience reveals that incorporating challenges in the classroom setting can foster the growth of dendrites and therefore thickening of cerebral cortex in the learners. Additionally, challenges can be used as a strategy or technique for active learning which engages learners of

varying learning styles and promotes the brain enhancement for learning. Henceforth, one of the ways through which teaching instructors can inculcate challenges in the classroom settings while keeping the stress level in check is by providing choices with assignments whenever possible and by not instilling fear of examination or tests (Craig 2003). Thus, the process of learning should be relevant, interesting, and challenging that will thereby inspire the students to actively participate and achieve success (Sesmairni 2015).

14.11 Challenges and Benefits

Brain-based learning, thus, seems to affect several areas involved in teaching and learning process and seems to be very beneficial. However, neuromyths have been identified as one of the challenges. Neuromyths are considered to be wrong assumptions or beliefs about the process of learning and teaching which is barely based on any findings (Geake 2008). One such is about the information that is put across to students in their preferred learning style. It was found out that over 97% of the teachers believed this to be true (Dekker et al. 2012) which in reality was not. To support this claim, there are different neuronal networks and pathways that work and process information for auditory, visual, etc., that work together. Additionally, there is no scientific evidence to prove that learning is enhanced significantly if delivered in the preferred style of the learner (Pashler et al. 2009).

Further, there are other challenges that are important to note about different strategies that were mentioned in the chapter for brain-based learning. While there is evidence about all the abovementioned strategies, practically implementing them might become a hurdle to the teachers as well as management. For instance, for movement inside the classroom, there might not be enough physical space, and to take all the children outside the class for a short break could divert attention and might not be suitable if the numbers are huge. Furthermore, using activities suggested with music could be possible for lower grades, while for higher grades, implementation could be difficult, and covering the syllabus could also be challenging. Adding on to these challenges, interacting with every student is practically not possible, and this opportunity will be made use of only by some students, while others tend to become silent spectators. Thus, all these activities are not as easy to implement although it is evidence-based. However, initiating such activities once in a while can be possible. For example, jumping and sitting on benches for physical activity, music activities once in a fortnight, or using aura technique to teach and/or as an activity for the students in class and reinforcements such as praise for interacting can be beneficial for other students to participate.

There have also been few benefits which have been identified in connecting neuroscience and teaching practice. One such benefit is the content of pedagogical knowledge. Shulman (1987) suggested that this novel information is a crossing point between a teacher's knowledge about teaching itself and their subject

knowledge. Furthermore, in terms of the strategies mentioned above, they have great potential to enhance longer and meaningful learning processes that will make a difference in the learner's life. These will also alleviate boredom and make learning interesting.

14.12 Conclusion

Neuroscience has contributed enormously to understand the process of effective and impactful teaching and learning. Presently a lot more resources are available to make learning and teaching impactful. One such is technology, which has revolutionized learning space via smart classrooms and online learning. While incorporating neuroscience in education seems far off and challenging, it is quite simple and beneficial. Based on the learning principles and several strategies proposed in this chapter, it is quite easy to implement them in the actual classroom setting. For each of them, evidence-based advantage and ways to inculcate provide a roadmap for execution. Although there are some challenges in execution, ways to overcome the same have also been mentioned in the chapter. Thus, evidence clearly indicates that brain-based teaching has more benefits that outweigh challenges. Finally, "brain-based teaching" needs to be included in the curriculum that is used to train teachers so as to benefit the learning and teaching process.

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