BRAIN COGNITION-BASED LEARNING OF EDUCATIONAL STATISTICS

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Abstract
Brain cognition-based learning is an emerging educational technique inspired by neuroscience and cognitive science. This technique is known for its enhancement of learning efficiency. This paper analyzes the brain cognition mechanism in the learning of educational statistics, applies brain cognition-based learning to the learning of educational statistics, and evaluates the application effect through comparison with the traditional “spoon-feeding” teaching approach. The results show that, compared with the traditional teaching method, the brain cognition-based learning of educational statistics is in line with the cognitive rules of the human brain, and can fully arouse the learning enthusiasm and unlock the learning potential of learners. The research results provide an effective solution to problems of educational statistics learning, shedding new light on the reform of the educational system.

Key words: Brain Cognition-Based Learning, Educational Statistics, Learning Efficiency.

INTRODUCTION
In recent years, the development of brain imaging technology, neuropsychology and electrophysiology has made great breakthroughs in the field of brain cognition, which has caused great changes in the field of education. After identifying the function and structure of the brain, it is possible to use the cognitive characteristics of the brain to explore an optimal adaptive learning path suitable for learners, thereby helping students improve their learning efficiency (Jensen, 1995). This approach links learning to the structure and working modes of the brain, thus facilitating learning by mobilizing the entire body's nervous system. Moreover, the improvement of learning will further improve the development of the brain, thus forming a benign cycle. The study on cognitive habits of the brain and the links between neuroscience and educational behavior has been increasingly valued by researchers as a new milestone in the transformation of traditional educational models (Hansen & Monk, 2002). Brain cognition-based learning covers a variety of aspects, including cooperative learning, empirical learning, peer-coaching learning of right-brain theory, and trinity learning of left-brain theory. These learning concepts are especially suitable for the study of natural science, as they can maximize learning potential in a pleasant way and minimize rote memorization of natural science concepts and theories in an unstressed classroom environment (Priatna, 2017).

The educational statistics system based on symbol system and reasoning logic is a basic and important natural science system, which provides an important theoretical guarantee for the development of modern society, and helps people to know and understand everything in the world. Basic arithmetic knowledge is not only a necessity for people’s daily life, study and work, but also an important theoretical tool for training human’s logical reasoning abilities. With the development of informatization and the improvement of digitalization, importance of statistical cognitive ability study is increasingly evident. Compared with the study of other
subjects, the study of educational statistics usually requires a great deal of mental activity to understand relevant concepts and theories. Therefore, educational statistics has always been regarded as the most complicated and challenging subject (Ridley, 2012). The traditional teaching method is only a teacher-led spoon-feeding method, which only advocates the rote memorization of the concept and the repetition of exercises, but lacks the active participation of the learner’s own nervous system. In contrast, educational statistics learning based on brain cognition and cranial nerves is a new learning method that subverts traditional educational concepts. Based on the above background, this paper will probe into the theory of brain cognition and analyze its practical application in educational statistics teaching.

EDUCATIONAL STATISTICS LEARNING AND THE MECHANISM OF BRAIN COGNITION

Educational statistics learning mechanism of brain cognition

According to the theoretical research results of cognitive science, the learning of educational statistics knowledge can be divided into a series of ordered feedback processes, which process new or acquired information through brain cognitive activities to gain new cognition (Posner & Rothbart, 2007). The typical cognitive process consists of four parts, information input (input), information processing (processing), information output (output) and feedback. In order to process the existing or newly acquired information, it is necessary to reasonably arrange input and output links of information. Large-scale reception and fine processing of this information, as well as long-term storage of this processed information are required, so that it can be extracted at any time. Similar to the way a computer works, this series of information processing is an activity of encoding and decoding information. The feedback link is critical in this cognitive process, which compares the output information with the results to test the status of cognition or learning. Then, it will adjust the input flow, processing flow and output flow of information in time, so as to achieve a better learning effect. Therefore, how to coordinate this series of processes to allow the participation of all the cranial nerves in these processes plays a decisive role in the learning effect.

Figure 1 shows a typical flow of the brain cognition-based learning process (Gagné, 1975), in which "executive control" and "expectation" are the two links that students obtain in their previous studies, which determine the way the students choose information processing in the current study, that is, to determine how students pay attention to, store, encode, and extract information. The importance of the “executive control” not only lies in that it influences attention and selective perception, affects the choice of coding methods to determine how information is stored in long-term memory, and also affects the way students search and extract information, but also in that it determines the strategies for students to summarize and solve problems, thus affecting the quality of thinking in learning. The importance of “expectation” stems from the fact that it is a concrete expression of students’ motivation to achieve their learning goals. Expectation is a continuous set oriented to the completion of the learning goals, thus guiding students to choose the output mode at each processing stage. The "environment" in this figure actually refers the role of a learning scenario in which the brain is fully involved. The information processing procedure given by the model is actually the cycle of environment → receptor → sensory register → short-term memory → long-term memory → reaction generator → reactor → environment, of which “reactor → environment → receptor” is the feedback link of learning. The learning process presented by this model is proposed by cognitive psychologists during simulation of computer processing of information. Information from the environment first passes through the sensory organs and is encoded at the physiological level of action and then passed to the sensory register. After the action of the sensor register, the visual, auditory or tactile effects are generated, allowing the learner to pay attention to certain information (at random attention), and then the information that receives attention enters the short-term memory (working memory), and is processed in short-term memory, which is then transferred to the long-term memory. When the learner needs this information stored in the long-term memory, it can be retrieved (or activated) and transferred to the short-term memory. After the conversion by the reaction generator, predetermined reactions are produced, which
are finally transferred to the actuator of the reaction, the reactor, wherein the various reactions are carried out. The actions of the reactor on the environment lead to environmental changes, which can be used as a kind of feedback information to be transmitted back to the center via the receptors, thus to be compared with the intended purpose of learning. This brain cognition-based learning model describes the general process of learning from a macro perspective, from which it can be seen that the cognitive mode of the learner's brain plays an important role in the learning process, with functions including how the sensor accepts the input of the information, how the register processes the information, how the memory stores the information, and the feedback effect of the whole process.

**Brain cognition and educational statistics learning**

During educational statistics teaching, many teachers find that learners are unable to understand abstract statistical concepts. This is how most students feel when they study educational statistics themselves at school (Fitzsimons, Jungwirth, Maaß et al., 1996). Many students say that the bad impression about mathematics and statistics developed during childhood have produced a subconscious resistance in their brain, resulting in difficulties for quickly understanding and learning related knowledge. In the traditional educational statistics teaching system, both teachers and students agree with the idea that better results in educational statistics can only be achieved by rote memorization coupled with massive boring exercises. This approach is extremely unfriendly for a fairly large number of slow learners. For such students, even if they gain some knowledge, they cannot flexibly use it. For example, if the symbols of the variables have changed in another scenario, they may not understand the original concept that is just learned. This traditional mechanical learning method separates educational statistics from learners, creating a huge gap and even affecting their future learning career. The impact of this malignant learning method can be explained by the neuroscience of the brain. The perceptual representation system (PRS) is a concept in the field of cranial nerves, which is often used to...
explain the brain, but each sensory organ has a PRS, which enables us to recognize words and symbols in a book (Eichenbaum, Schoenbaum, Young et al., 1996). Moreover, even if we don't know the meaning of words and symbols, PRS can help us to deal with these objects in our minds. Figure 2 illustrates the process of external information stimulation based on PRS, in which the three major strategies of cross-sensory connections extract visual and perceptual information from different sources and transmit this information to the brain for information processing. Thus, if the brain's PRS can be used to handle the educational statistics tasks, the learner will understand similar statistical problems such as how the variables correspond to changes.

The study of educational statistics education based on brain cognition and cranial nerves focuses on a long-term learning process and the emotional characteristics of the dynamic cognition and participation that determine the process. Only a full understanding of the relationship between emotion and brain cognition can better help the learner to find out the problems in learning, so as to avoid mistakes, especially some simple mistakes. The concept of brain storage can help us understand the learning process of educational statistics. The human memory system is similar to a computer's storage system, mainly including internal/external memory (Memory), plot buffer (Cache), and central executive (CPU). These parts cannot be used indefinitely. The brain is an important prerequisite for all processes of consciousness and also an important prerequisite for cognitive processes. In an emotion-enriched life situation, people are able to experience their feelings of emotions and sorrows, which are also reflected in the memory effect of people at work and their ability to consume memory. Since people have limited memory capacity at work and in learning, it must be admitted that people do not have sufficient capacity to support all cognitive processes. Moreover, the impact of emotions on cognitive processes is enormous. Many cognitive abilities depend more on the emotion of the learner at the time of learning than on a centralized cramming cognitive style. Many research results at home and abroad show that the traditional centralized cognitive process will significantly increase the number of errors in the learning process, especially some small errors (Boaler, 2002). Neuroscience needs to distinguish between brain systems with different specific functions, which are associated with related emotional types. Therefore, cognitive processes and emotional processes exist in different brain systems that are located in different parts of the brain and have their own memory system and specific functions that they are responsible for. Furthermore, there is a strong connection between the emotional system and the body system, so the activated emotional system can make the body to produce different responses (Immordino-Yang, & Damasio, 2007). Although emotional system usually works unconsciously, it can be consciously activated to promote a benign response in people's body system, thereby facilitating people's learning activities of educational statistics.

ENLIGHTENMENT AND APPLICATION OF BRAIN COGNITION MECHANISM IN EDUCATIONAL STATISTICS TEACHING

To establish a comfortable learning environment

A person's emotions can affect his memory and brain function. When he feels happy, his brain releases endorphins, thus enhancing his memory (Taylor & Lamoreaux, 2008). Senses of security and pleasure are the first concerns of the brain before it gets other information. On an educational statistics class, if the student is hungry or afraid of something, it will become difficult for him to focus on what's going on in class. There are many reasons for this sense of insecurity, which may be due to over-crowded classroom or strict teachers. In this case, the brain's cognition is completely preoccupied by this insecure feeling, thus cannot acquire new information. In order to establish a comfortable learning environment and eliminate the insecure feelings of students, it is necessary to consider the following aspects. First, it is necessary to remove things in the classroom that may put psychological stress on students, such as overcrowded classrooms, dimly lit indoor environment, or outdated facilities. In addition, safety education or presentations can be provided for students on a regular basis, so that they can feel secure about the learning environment deeply in their heart. Teachers shall also undertake the tasks of psychological counselors. For those who are not sociable,
teachers shall encourage them to turn their attention to extracurricular activities, and encourage other students to study and communicate with them, thus shaping the positive attitude in students. Finally, it shall be noted that teachers shall help students to control their learning status. Sousa believes that a relatively concise and coherent lesson is easier to be accepted by students (Sousa, 2016). Therefore, teachers can use a variety of strategies in daily teaching to help students to master a large amount of information at any time, enabling their brain to learn knowledge in a relaxed atmosphere, thus to achieve the goal of helping students to control their learning status.

To adopt a classroom teaching model with participation of multiple senses

The more sensory organs that are involved in learning, it is more likely that the brain can receive and process the information. By allowing multiple senses to participate in the learning process, students will more easily match the newly received information with their original knowledge, which will deepen their understanding and memory of the knowledge (Schiller, 2012). More concrete materials shall be used as much as possible to express abstract concepts in the classroom, so as to achieve this goal. In general, familiar concepts or tangible objects can help students to break down the idea into details. For example, when explaining the abstract three-dimensional geometry knowledge, the teacher can display the actual three-dimensional items to the students, thus to help them to deepen their understanding of these geometric shapes. In addition, teaching shall not be only confined to the classroom, but shall allow students to be fully exposed to the natural environment. The natural environment has a special magical power, which allows students to motivate multiple senses, including visual, auditory, and tactile senses. The knowledge learned through this learning process with participation of multiple senses is often more difficult to be forgotten in the future compared to that from teachers’ lecturing sitting in the classroom (Stipek, Givvin, Salmon et al., 2001).

To stress personalized teaching practice

Each student has its own unique characteristics, including education, family, temperament, intelligence and body conditions. These unique characteristic differences exist in students in any teaching environment, thus will inevitably lead to differences in their individual development and learning style. The traditional teaching method adopts a "one-size-fits-all" approach, trying to meet all students’ knowledge needs with a solidified pattern, which leads to educational imbalance. On the one hand, teachers shall be aware of each student’s own characteristics, adopt the most acceptable teaching methods for them, and segment the knowledge for personalized teaching so as to maximize the learning efficiency of each student. On the other hand, teachers shall vigorously promote the hands-on exercises. Compared to the traditional way of learning only through textbooks, the hands-on exercises can increase the probability of long-term storage of information in the brain by 75%, as those excises can mobilize those rarely used cranial nerve modules (Hannford, 1995). Moreover, hands-on exercises can provide students with another learning option, thus reducing their learning difficulties due to their own differences. By incorporating sensory inputs into the learning framework, hands-on learning allows students to test learning effects with experiments and errors, which increases the opportunities for students to understand knowledge and establish knowledge systems. Furthermore, in order to eliminate the influence of individual differences and provide students with an adaptive learning method, a comprehensive learning method can be adopted to maximize the learning effect. For example, concepts of educational statistics, reading, and writing can be combined together, so that students can have a comprehensive understanding of the knowledge of each subject, which can greatly expand the scope of learning. Students shall also be encouraged to review the knowledge learnt in time, so that the learning results can be better consolidated.

CONCLUSIONS

With the arrival of the information age, various kinds of knowledge have witnessed an explosive growth. In this case, the traditional teaching concept can no longer meet the demands of students for diverse knowledge. As an important research field, the brain cognition and brain neuroscience have broadened our understanding of education. With the
participation of cranial nerves and multi-sensory system, the students can make full use of their cranial nerves that are rarely used under the traditional education system, and mobilize their own emotions so as to learn more new knowledge and obtain greater development. The new teaching model based on brain cognition theory encourages students to understand the expressive entities of different types of statistical knowledge and fully mobilize their emotions through various ways. In order to successfully combine the theory of brain cognition with educational reform, there is a need for cooperation between statistics educators and neuroscientists. Only with the active cooperation, can both parties make mutual progress and further development in the two research fields, finally realizing the progress and reform of educational practice.

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REFERENCES

Boaler, J. (2002). Experiencing school mathematics: Traditional and reform approaches to teaching and their impact on student learning. Routledge.

Eichenbaum, H., Schoenbaum, G., Young, B., & Bunsey, M. (1996). Functional organization of the hippocampal memory system. Proceedings of the National Academy of Sciences, 93(24), 13500-13507.

Fitzsimons, G. E., Jungwirth, H., Maaß, J., & Schloeglmann, W. (1996). Adults and mathematics (adult numeracy). International handbook of mathematics education, 755-784.

Gagné, R. M. (1975). Essentials of learning for instruction. Dryden Press.

Hannford, C. (1995). Smart moves. Why learning is not all in your head.

Hansen, L., & Monk, M. (2002). Brain development, structuring of learning and science education: Where are we now? A review of some recent research. International Journal of Science Education, 24(4), 343-356.

Immordino-Yang, M. H., & Damasio, A. (2007). We feel, therefore we learn: The relevance of affective and social neuroscience to education. Mind, brain, and education, 1(1), 3-10.

Jensen, E. (1995). Brain-based learning & teaching. Brain Store Incorporated.

Posner, M. I., & Rothbart, M. K. (2007). Educating the human brain. American Psychological Association.

Priatna, N. (2017). The application of brain-based learning principles aided by GeoGebra to improve mathematical representation ability. AIP Conference Proceedings, 1868(1), 050030.

Ridley, J. R. B. (2012). The perceptions of teachers regarding their knowledge, beliefs, and practices of brain-based learning strategies (Doctoral dissertation, Tennessee State University).

Schiller, P. (2012). Start smart: building brain power in the early years. Gryphon House, Inc.

Sousa, D. A. (2016). How the brain learns. Corwin Press.

Stipek, D. J., Givvin, K. B., Salmon, J. M., & MacGyvers, V. L. (2001). Teachers' beliefs and practices related to mathematics instruction. Teaching and teacher education, 17(2), 213-226.

Taylor, K., & Lamoreaux, A. (2008). Teaching with the brain in mind. New directions for adult and continuing education, 2008(119), 49-59.