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Research Article

Teaching Methods of Architectural Design Based on Right Brain Development Concept

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Abstract

The human's right brain is the centre of image thinking. It determines human creativity and imagination. In the current teaching of architectural design, the outstanding problem for students is the lack of innovation in architectural design. Therefore, it is very necessary to focus on developing students' right brain function. In this context, this study adds the development content of right-brain function to the architectural teaching program, and then selects the students in the architecture department of four colleges as the objects of research for one semester training, using "decomposition and combination training + associative ability training", "decomposition and combination training", "associative ability training", and "General course teaching". During the experiments, students' architectural design levels and brain endorphin secretion were recorded and analysed. The results showed that the creativity and aesthetics of the first three groups of students' architectural design had been greatly improved, and the content of brain endorphins was significantly higher in the architectural design than the fourth group of students. This shows that the first three groups of students have stronger ability to mobilize the right brain during the architectural design. In addition, the combination of "decomposition and combination training + associative ability training" is better than any method alone. This fully proves the significance of focusing on the development of right brain function in architectural teaching.

Keywords

Right Brain Function • Image Thinking • Architectural Design • Teaching

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Architectural design is the core curriculum in architecture teaching. Specifically, architectural design refers to the process of designing and feasibility verification of a architectural plan as required by the designer before the building is constructed. This shows that the design of the architectural plan is the basis of architectural design, so the plan must not only meet basic needs but also be beautiful, creative, and imaginative. From the perspective of current architecture teaching, most of students are able to grasp the basic methods of plan feasibility analysis, but clearly, they're lack of imagination and creativity in architectural design, which leads to serious homogenization of plan design. Therefore, it's of great practical significance to improve the creativity and imagination of architectural design through the use of teaching methods.

Modern brain science research has found that human's right and left brains have a very detailed and precise division of labour. Specifically, the left brain is the centre of abstract thinking, focusing on functions such as language, numbers, concepts, and judgments etc.; the right brain is the hub of image thinking, focusing on the physical image, spatial position, and music image etc. (Motz *et al*., 2012). From the functions and focuses of the left and right brains, it's not difficult to see that the creativity and imagination of architectural design should be improved mainly through the development of the functions of the right brain. The right brain is mainly engaged in image thinking, so the cultivation of image thinking has become the main way to develop the right brain (Florian & Martin, 2014). Under the practical background and theoretical logic mentioned above, this study attempts to introduce image thinking training into architectural teaching, and then explore whether it can improve the quality of architectural teaching through the development of right-brain function and improve the imagination and creativity of architectural design. This shall provide the theoretical and methodological guidance for the architectural teaching practice.

Right brain function and image thinking

Functional division of the left and right brain

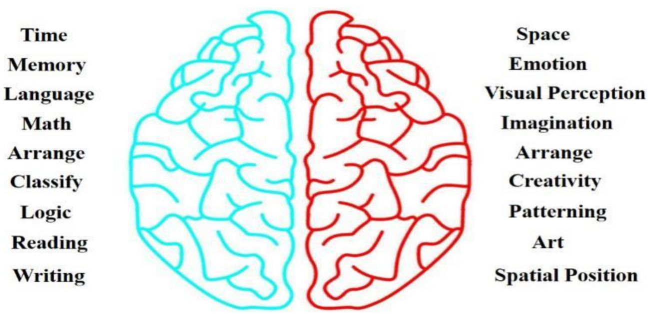


Figure 1. The Different Functions of Right and Left Brain

The human brain is divided into the left and right hemispheres (brains), which are connected by the corpus callosum. From the physiologically anatomical results, there is no significant difference between the left and right hemispheres. However, through human behaviour experiments, scientists have determined the different functional orientations of the left and right hemispheres. The left and right hemispheres of the human brain, as two different types of systems, are a unified whole and work together (Mills, 1991). As mentioned in Chapter 1, the left hemisphere is the centre of abstract thinking, while the right hemisphere is the hub of image thinking (Motz *et al*., 2012). The specific division of labour between the right and left hemispheres is shown in Fig.1.

Image thinking and right brain function development

Research shows that the role of right brain function development is mainly reflected in the following three aspects: 1) Develop innovative capability; 2) Maintain the coordinated development of the left and right brains; 3) Overcome difficulty in learning and thinking (Dan *et al*., 2011; Taroyan, 2015; Brysbaert, 2004). Right brain development has many advantages mentioned above, but it only started in recent years when the right brain development was internationally recognized as the focus of education and teaching (Zhang, 2009). In the 1990s, European and American countries took the lead in the development of right-brain into elementary school education. In the middle school education and university education, they also carried out the trials. In China, currently the concept of focusing on the right brain development is still at an exploratory stage in the education system.

From the current academic research and the experience of right-brain development in European and American schools, image thinking training is the most effective form of developing the right brain (Barrett *et al*., 1999). Image thinking refers to thinking that uses the representation accumulated in the mind (Sally & Gurnsey, 2002). The representation mentioned here refers to the images of the objects and phenomena that has been previously perceived and now reproduce in the minds. Because image thinking uses image as material for thinking, from the perspective of thinking process, it has the following features: no strict steps and rules, breaking convention and prototype, not being constrained by stereotype, being very active and agile (Derakhshan, 2009; Goulet & Joanette, 1994). Image thinking is of directness, agility, and creativity. It does not deliberately pursue the minutiae but focuses on grasping things as a whole (Joanette *et al*., 1988). The above features of image thinking are concentrated on the main methods it adopts, namely trainings on association and imagination (David, 2010; Bogen, 1997).

Teaching experiment design

From the current image thinking mode, the most effective ways include decomposition and combination training, and the associative ability training. Therefore, these two training methods were adopted in the design of specific architectural teaching programs in this paper.

Teaching program

The first teaching program adopted in the experiment was decomposition and combination training for students of architecture majors. Decomposition and combination training is the process of processing and summarizing the received information and further decomposing and recombining the information. It can strengthen the ability of students to grab the main information, and also cultivate students' three-dimensional and spatial sense. In the specific training process, Rubik's cube, puzzles, and simulation splicing tools were used in the experiment to train students' decomposition and composition ability.

The second teaching program used in the experiment was the associative ability training for students of architecture majors. Associative ability training refers to the process of thinking training in which A thing is associated with B thing; it can be further subdivided into free associations, and comparative associations etc. The purpose of associative training is to cultivate students' excellent imagination and indispensable creative ability in the field of architecture. At the same time, it can also cultivate the students' ability to grasp the main information and features of things. In the specific associative training, the same thing was shown to the students, such as a pair of pants, and they're asked to use the information of the pants to make associations, carry out architectural design, and ultimately the teacher made evaluations.

Experimental subjects

The subjects of this experiment were mainly junior college students of architecture department from four schools in Beijing. For each school, the students of one classroom were selected to do the experiment. Statistics show that 21 students from school A, 25 from school B participated in the experiment, 20 from C, and 23 students from D participated in the experiment.

Before the experiment, first of all, the basic information of the students in each school was obtained and analysed, including the academic record, length of schooling etc. According to the results of non-parametric estimation, there is no significant difference among students in each school, meeting the basic requirements of the experiment.

Table 1.
Students' Basic Information

	School A	**School B**	**School B**	**School D**	**P**
Length of Schooling	14.25±0.78	15.07±0.34	15.30±1.01	14.74±0.23	0.27
Academic Record	78.93±4.26	80.76±3.43	81.80±5.21	80.11±2.34	0.65

Experimental process

The four groups of students were arranged as follows: for students of A school, use the combination mode of "decomposition and combination training + associative ability training + general course teaching"; For students of B school, use "decomposition and combination training + general course teaching"; for students of school C, "associative ability training + general course teaching"; for students of school D, "common course teaching". All teaching experiments for students were conducted during the first semester of the 2017-2018 school year and lasted for a full semester.

During and after the experiment, two methods were adopted to examine the results of the image thinking training: First, the expert evaluation method was to organize experts to score and statistically analyse the architectural design level of all students before and after the experiment; secondly, related instruments and equipment were applied to detect brain endorphin secretion of students, because scientific research shows that humans secrete large amounts of brain-endorphins when they are thinking by the right brain, and their amount of secretion can be used to determine the vitality of the right brain (Joanette, Goulet, Ska, & Nespoulous, 1986). Fig.2 below shows the main process of the entire teaching experiment.

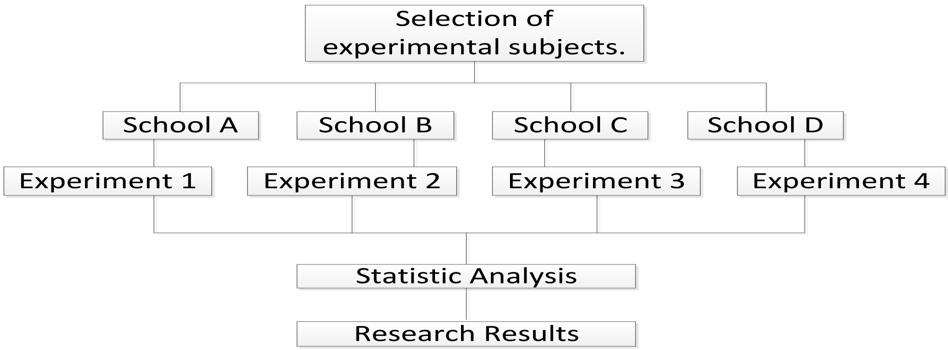


Figure 2. Experiment Process

Experimental results and discussion

Before and after the experiment, the expert evaluation method was used to evaluate the students' architectural design level. During the experiment, all subjects were required to make the architectural design every two weeks and then the endorphin secretion of the subjects was recorded.

Comparison of architectural design level before and after experiment

In the specific scoring process, experts need to consider three aspects, namely, creativity, aesthetics and practicality, at full score 10 points for each item, and a total score of 30 points. Table 2 shows the scores of the students in the four schools before the experiment. In terms of creativity, the average scores of students in four schools were 5.78, 5.56, 5.91, and 5.75 respectively; in terms of aesthetics, the average scores of students in four schools were 6.72, 6.65, 6.43, and 6.88 respectively; in terms of practicality, the average scores of students were 7.65, 7.87, 7.78, and 7.43 respectively. From the data, it can be seen that before the experiment, students in the four schools did not have significant differences in creativity, aesthetics, and practicality of architectural design. One common feature is that the practicality of students' architectural design basically meets the needs, but the creativity is obviously insufficient, for the average score of innovation didn't exceed 6 points.

Table 2.
Students' Score before Experiment

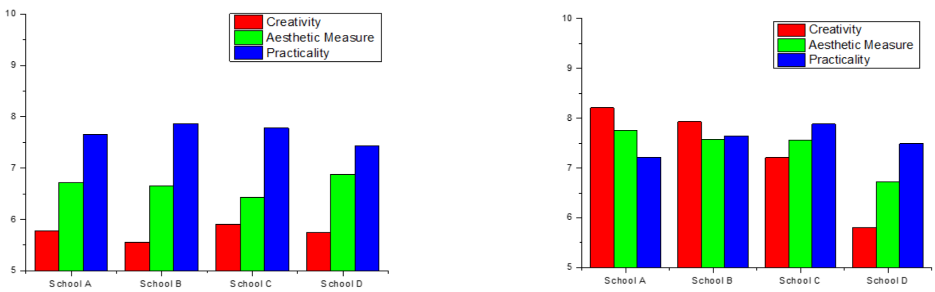
	School A	School B	School C	School D	P
Creativity	5.78±0.21	5.56±0.37	5.91±0.90	5.75±0.19	0.45
Aesthetic Measure	6.72±0.77	6.65±0.12	6.43±0.56	6.88±0.71	0.12
Practicality	7.65±0.26	7.87±0.37	7.78±0.55	7.43±0.11	0.23

After one-semester teaching experiments, expert evaluation method was used again to score students' creativity, aesthetics, and practicality of architectural design, which were then recorded in Table 3 below. It can be found that the architectural design of the students from A, B, and C has significantly improved in terms of creativity and aesthetics (statistical analysis results $P<0.05$), while the practicality of the design changes little (statistical analysis results $P> 0.05$). There was no significant change in the creativity, aesthetics, and practicality of the architectural design for the School D students (Statistical analysis results $P>0.05$). Specifically, in terms of creativity, the average scores of students in four schools were 8.21, 7.93, 7.21, and 5.81 respectively; in terms of aesthetics, the average scores of students in four schools were 7.76, 7.57, 7.56, and 6.72 respectively; In terms of practicality, the average scores of students in four schools were 7.21, 7.65, 7.88, and 7.49 respectively. In addition, it can be clearly seen that the level of creativity in student architectural design has increased the most, followed by the increase in aesthetics, and practicality has not improved. School A students also outperform students in schools B, C, and D in terms of innovation and aesthetics (differential statistical analysis results $P<0.05$).

Table 3.
Students' Score after Experiment

	School A	School B	School C	School D	P
Creativity	8.21±0.77	7.93±0.45	7.21±0.85	5.81±0.13	0.00
Aesthetic Measure	7.76±0.14	7.57±0.34	7.56±0.54	6.72±0.31	0.00
Practicality	7.21±0.21	7.65±0.42	7.88±0.51	7.49±0.19	0.19

The above teaching experiment results show that after using the image thinking training of "decomposition combination training + associative ability training + general course teaching", the students' architectural design level has significantly improved. More specifically, the creativity and aesthetics of their architectural design have been greatly improved.

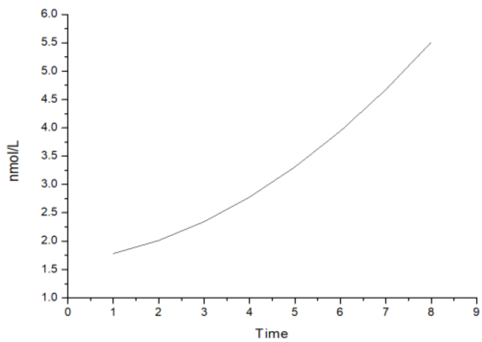


Before Experiment ***After Experiment***

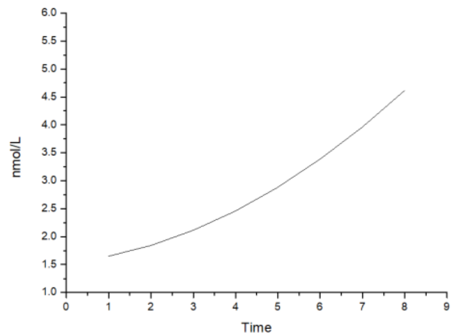
Figure 3. Students' Score before/after Experiment

Brain phenolphthalein secretion record

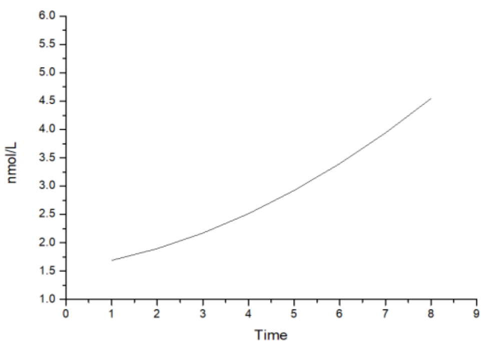
In the course of teaching experiments, the students were asked to complete one simple architectural design every two weeks and then the experimental instruments were used to record the secretion of brain endorphins during the design process. Fig.4 below records the endorphins secretion of students from School A, School B, School C, and School D, respectively. From the basic recorded information, it can be seen that the secretion of brain endorphins by school A students increased with teaching experiments; the content for the first recording was 1.78 nmol/L, and that for the last recording was 5.51 nmol/L. The amount of brain endorphins secreted by school B students also rose with the teaching experiment, but the increase was consistently lower than that of school A students; the first record was 1.65 nmol/L, and the last was 4.62 nmol/L. The brain endorphins secreted by school C students also increased with teaching experiments, but the increase was also consistently lower than that of school A students, but there was no significant difference from school B students; the content for the first recording was 1.69 nmol/L, and the last recording was 4.55 nmol/L. The amount of brain endorphins secreted by school D did not change significantly in the entire teaching experiment; its content was 1.72 nmol/L for the first recording, and the last recording was 1.78 nmol/L.



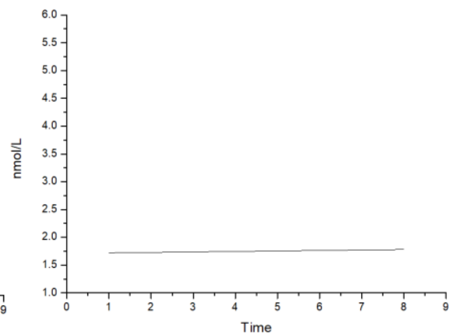
School A



School B



School C



School D

Figure 4. Endorphine Secretion Records.

The above records of brain endorphin content show that image thinking training can significantly increase the endorphins secreted by students during design, indicating that the right brain function was more fully mobilized during design. In addition, the combined method of “decomposition and combination training + associative ability training” is more effective than “decomposition and combination training” or “associative ability training” alone.

Conclusions

The left and right brains of humans are both labour-divided and cooperative. Specifically, the left brain is mainly responsible for abstract thinking, and the right brain is mainly for image thinking. The different divisions of the left and right brains also determine the importance of the right brain function in architectural design. In this context, this study explored the importance of right brain function development to architectural design by designing the architectural teaching program. The specific conclusions are as follows:

(1) After imagination training, students' architectural design levels were improved significantly. More specifically, the improvement of students is mainly reflected in the creativity and aesthetic aspects of architectural design. The practicality of architectural design wasn't significantly improved.

(2) After image thinking training, students secreted more brain endorphins during architectural design. The content of brain endorphins is an important indicator of the right brain vitality. Therefore, this result shows that after the image thinking training, students' ability to mobilize the right brain is stronger.

(3) It is of great significance to include the content of image thinking training in the teaching program. It is more effective to use a combination of "decomposition and combination training + associative ability training" to train image thinking than using one single method.

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