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The Effects of 4MAT Teaching Model and Whole Brain Model on Academic Achievement in Science *

Gamze Tezcan [1], Hülya Güvenç [2]

Abstract

The aim of this study is to investigate the effects of 4MAT Teaching Model and Whole Brain Model on academic achievement in science and to compare those effects with the effect of inquiry based instruction, which suggested by the science course teaching program. This research is designed in static group pre test-post test design. The study group constituted a total of 68 sixth grade students, 29 in Experimental Group I, 21 in Experimental Group II and 18 in the control group. Experimental processes were carried out simultaneously in 3 groups during 32 class hours by one of the researchers. While 4MAT Teaching Model was used In Experimental Group I, Whole Brain Model was applied in Experimental Group II. The control group was engaged in inquiry based instruction. Kolb Learning Style Inventory III was applied to determine the learning styles of the participant students. Academic achievement test was applied as the pre test and the post test. While analyzing the data, the standard deviations and means were calculated and Paired Samples t-Test, One Way Analysis of Covariance (ANCOVA), Wilcoxon Signed Rank Test, Kruskal Wallis Test, and Mann Whitney U Test were conducted. As a result of the research, it was determined that all of the three instructions applied increased the academic achievement in science. Moreover, it was found that 4MAT Teaching Model was more effective than Whole Brain Model in terms of increasing academic achievement. However, it was determined that the effects of 4MAT Teaching Model and Whole Brain Model on the academic achievement in science did not differentiate from the effect of inquiry based instruction. In addition, it was detected that the effects of 4MAT Teaching Model and of Whole Brain Model on academic achievement in science did not differentiate regarding learning styles of the student. On the other hand, it was proved that inquiry based instruction did not support the academic achievement of the students with diverging learning style.

Keywords

4MAT teaching model
Whole brain model
Inquiry based instruction
Academic achievement

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[1] Çanakkale Onsekiz Mart University, Faculty of Education, Department of Mathematics and Science Education, Turkey, gamzesrt@gmail.com

[2] Yeditepe University, Faculty of Education, Psychological Guidance & Counselling Programme, Turkey, guvenchulya@gmail.com

Introduction

There are many physiological and psychological differences among individuals. Each individual is unique in his genetic makeup and past experience. These differences between individuals cause differences in cognitive, emotional and kinesthetic responses to the same teaching method. Thus, a teaching method can perfectly support the learning of a student, while being ineffective or even boring for the other (Açıkgöz, 2007).

Individual differences that affect learning include intelligence, ability, learning strategies, learning styles, prior knowledge, personality, interest, type and level of motivation, gender, age, etc. (Smith & Ragan, 1999). Among these, learning style which defines the best way of learning for each individual takes an important place. While Dunn and Dunn (1993) define learning style as the way of concentrating on new and hard information and processing and making it permanent; Kolb (1976) defines it as preferences about the way of perceiving and processing the new information.

Differences in individual's learning styles results from the differences in the brain parts that they frequently prefer to use (Herrmann-Nehdi, 2009). The studies indicated that each brain was unique and different patterns and changes emerge in each student's brain while learning and for this reason the best learning ways are differentiating (Caine & Caine, 1991). Therefore, while teaching according to learning styles, the studies that show the relationship between the brain, its structure and learning should not be ruled out.

The brain has parts which are specialized for some functions. Brain is composed of two hemispheres which has different tasks (Purves, Sadava, Orians, & Heller, 2001, p. 828).. While the left hemisphere is responsible for recognizing parts of the whole, analyzing, exploring the shapes and verbal communication; the right hemisphere is responsible for processing wholly and synchronously and abstract and intuitional issues (Duman, 2012).

Most of the people do not use two hemispheres of their brain equally; they develop Brain dominance. Brain dominance means that even if two hemispheres can be used together while solving a problem or learning something new, one of them is more often preferred than the other (Herrmann, 1981). Brain dominance provides advantages such as giving quicker responses to stimulants concerning the dominant part and display greater skills concerning the activities about this part (Lumsdaine & Lumsdaine, 1995). However, it is not possible to use only the right or the left hemisphere in life; they are both required (McCarthy, 1997). Today, what is needed is to use brain wholly (Herrmann-Nehdi, 2010). For this reason, the instruction applied should make both hemispheres to incorporate.

Brain dominance is an individual difference that affects learning. Each individual has his/her best way of learning arising from such kinds of individual differences. No matter how it is defined, learning style is an individual difference that has to be taken into consideration during learning process; since there are studies revealing that learning styles are related to academic achievement (Bozkurt & Aydoğdu, 2009; Gencel, 2008; Wilkerson & White, 1988). Therefore, the instruction applied in science education should be consider brain dominance and learning styles. One of the models that have been asserted based on these thoughts is 4MAT Teaching Model.

4MAT Teaching Model

4MAT (4 Modes Application Techniques) Teaching Model which is developed by McCarthy is based on brain dominance theory as well as Kolb's Experiential Learning Theory (McCarthy, 1990). Experiential Learning Theory is a learning cycle which explains how experience turns into concepts and how these concepts lead new experience (Kolb, 2000). According to Experiential Learning Theory, perception of information changes on the continuum that have concrete experience and abstract conceptualization on each side, and information processing changes on the active experimentation-reflective observation continuum. Kolb (1984) stated that the differences between individuals' perception and the way of processing new information cause difference in their learning styles. The learning styles are defined according to the preference of concrete experience versus abstract conceptualization in perception and the preference of active experimentation versus reflective

observation in information processing (Kolb, 1984). There are four different learning styles defined; namely diverging, assimilating, converging and accommodating.

Based on Kolb's this model, McCarthy (1990) called students with diverging learning style who mostly prefers concrete experience and reflective observation as Type 1 (Imaginative) learners; with assimilating learning style who prefers abstract conceptualization and reflective observation as Type 2 (Analytical) learners; with converging learning style who prefers abstract conceptualization and active experimentation as Type 3 (Common Sense) and with accommodating learning style who prefers concrete experience and active experimentation as Type 4 (Dynamic) learners. Type 1 (Imaginative) learners mostly focus on the question of "Why?", they learn by feeling their experiences, listening and sharing their ideas, whilst Type 2 (Analytical) learners look for answers to the question of "What?" and they learn by reflecting over their experiences and observing (McCarthy & McCarthy, 2006). Type 3 (Common Sense) learners concern with the question of "How?" and they focus on what they can do, they learn by practicing; Type 4 (Dynamic) learners learn from the consequences of their experiences and they act based on their emotions by looking for answers to the question of "What if it happens?" (Lumsdaine & Lumsdaine, 1995; McCarthy & McCarthy, 2006).

4MAT Teaching Model organize the cycle of Experiential Learning Theory by taking brain dominancy into consideration. This is why it separated each quadrant of the cycle in two steps which includes activities suitable for the right and also the left brain thinking mode (McCarthy, 1990). 4MAT Teaching Model respectively gives place to both the right and the left brain activities for each of the four learning styles. Therefore, it includes 8 steps given in Figure 1.

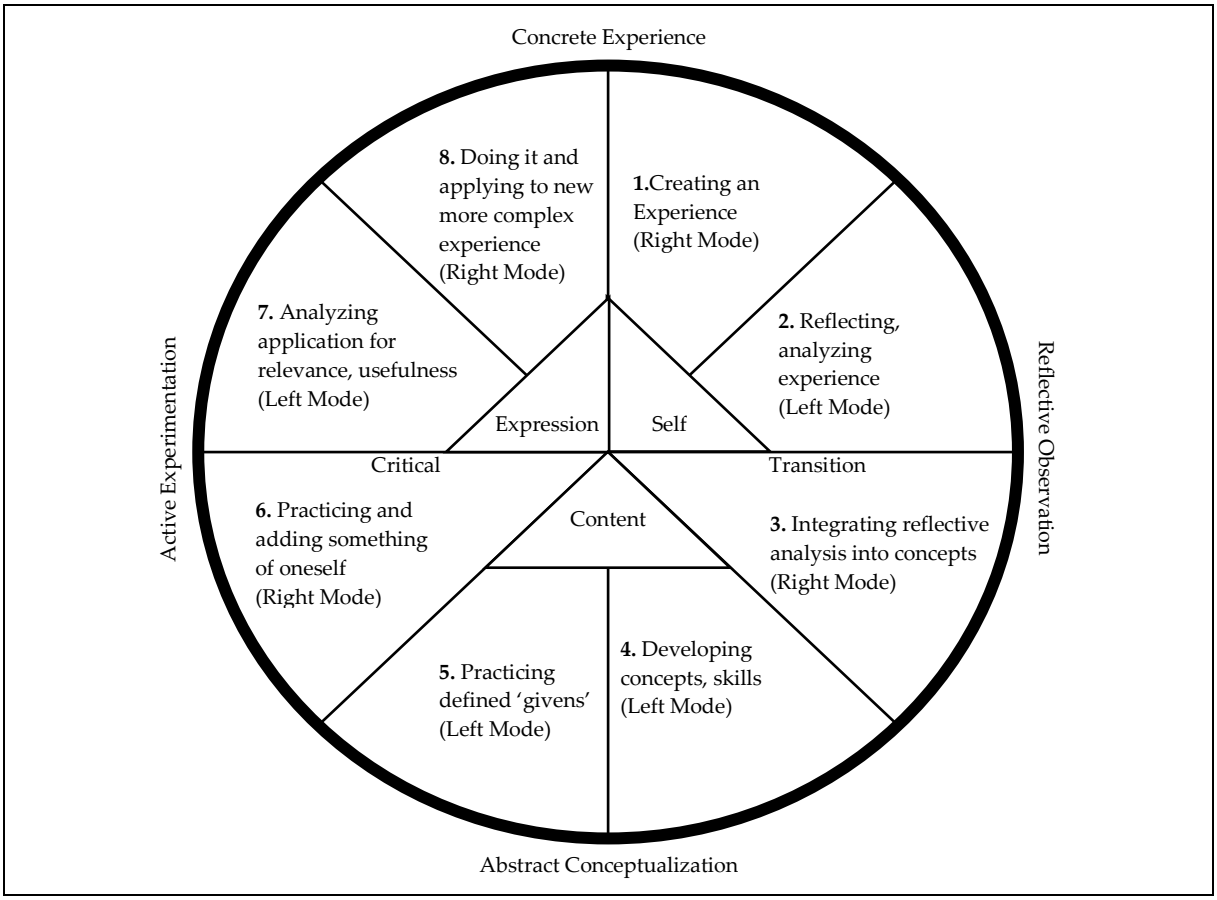

Figure 1. The 4MAT System (McCarthy, 1990, p. 33)

McCarthy and McCarthy (2006) explain the steps seen in Figure 1 as following; at the first step, intended for theright brain, students are exposed to an experience that can help them to make connections about the subject. At the second step related to the left mode of thinking, students are made to analyze their experiences that they have experienced at the first step; at the third step students are

made to imagine the notion as they understand it by their experience in a way that makes them use their right brain. Metaphors and visuals may be used at this step. The fourth step is an enlightenment step and it is intended for the left brain thinking mode. At this step, text book information about the subject is given to students. The fifth step is the practice step intended for the left brain. Students are made to gain expertise about what they have learned by practicing. At the sixth step, the discovery stage begins; students are expected to produce something by adding of themselves to enhance what they have learned. At the seventh step where the left brain is active, they criticize their own and their peers' products, which they have produced in the previous step, to improve them. Lastly at the eighth step which requires the right mode of thinking, they demonstrate the latest state of their products. At this step, they show how they associate what they have learned with themselves and how they use it by assimilating it. Another model which considers students' both learning styles and brain hemispheric preferences is Whole Brain Model.

Whole Brain Model

Herrmann's (1988) Whole Brain Model is also a learning style model which claims that the brain dominancy causes differences in learning styles. It aims to activate all parts of brain during learning process. Beside classically known cerebral right and left brain hemispheres, the model divides also the limbic system, which has an important function in transferring of information that comes to brain, into the right and the left hemispheres (Herrmann-Nehdi, 2008). Therefore, the model claims that brain has four quadrants which have different functions and named these quadrants as A, B, C and D quadrants. These 4 quadrants and their specialized functions are shown in Figure 2.

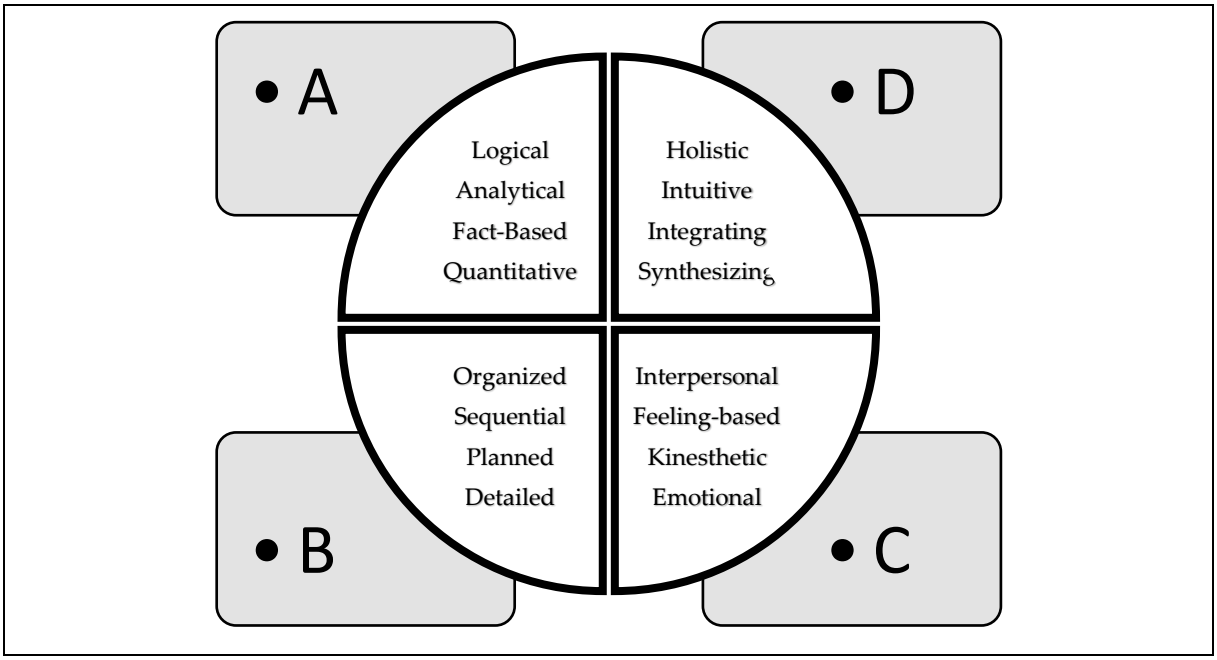

Figure 2. Whole Brain Model (Herrmann-Nehdi, 2008, p. 2)

As it is given in Figure 2, the model divides the brain into four separate quadrants; namely the upper right A quadrant, the lower right B quadrant, left lower C quadrant and left upper D quadrant. The upper quadrants (A and D) mostly concern with cognitive and intellectual operations, the lower quadrants (B and C) concern with instincts and emotional operations (Herrmann-Nehdi, 2008). While learning, individuals may use dominantly one or a few of A, B, C and D quadrants or they may use their whole brain (Herrmann, 1988). Individuals' different brain dominances cause difference in their learning styles too. The ones whose A quadrant is dominant tend to learn from a data or a teacher, while the ones whose B quadrant is dominant tend to learn practically and with activities; in addition, the ones whose D quadrant is dominant mostly learn by observing and with intuition, while the ones whose C quadrant is dominant tend to learn from experiences, discussions, feedbacks and values (Lumsdaine & Lumsdaine, 1995).

Whole Brain Model is based on zig-zag around the model; from the activities suitable for one quadrant mode of thinking to another (Herrmann-Nehdi, 2008). The important point to consider is that all the key concepts should be instructed by the activities suitable for the each of the four quadrants (De Boer, Bothma, & Du Toit, 2011). By this way, whatever their learning style is, equal chance of learning is offered to all of students. Additionally, students have the possibility to use and develop the ability to think in different modes of brain quadrants that they do not have dominance. Likewise, Horak, Steyn, and DeBoer (2001) found that the Whole Brain Model develop the students' abilities in the other quadrants that they do not have dominance.

As it can be understood from the previous explanations, 4MAT Teaching Model and Whole Brain Model have some fundamental similarities. Firstly, both models accept that individuals' learning styles may change over time and even if they prefer one or two styles over others, individuals can improve themselves on other styles as well. In other words, both models accept learning styles as flexible learning preferences (Coffield, Moseley, Hall, & Ecclestone, 2004). For this reason, both models suggest an even distribution of learning style activities. Secondly, both models take brain domination into account. They include both the right and the left brain thinking modes during learning process. Thus, whatever the students' brain dominance is, a few of the activities will be appropriate for them.

In teaching, consideration of individual differences is consistent with constructivist learning theory that takes the student center. Constructivist learning theory argues that students and learning cannot be separated from each other and that information is constructed by students themselves according to their experiences (Yurdakul, 2005). In 2006, the science course teaching program was reformed and harmonized with the constructivist learning theory in order to improve the science achievement in Turkey. The science course teaching program has been renewed again by the 12 year uninterrupted education. The Primary Education Institutions Sciences Course Teaching Program (Ministry of National Education [MEB], 2013), which is in practice, recommends the implementation of inquiry based instruction that is in coherence with constructivism.

The inquiry based instruction is teaching approach that includes cognitive processes; such as analysis, synthesis, induction, deduction, beside science process skills (Dostál, 2015). In other words, inquiry based instruction is a science learning and teaching approach that reflects the construction of scientific information (Lee & Songer, 2003). The vision of the science course teaching program is making students scientifically literate people (MEB, 2013, p. 1). Scientifically literate individuals are the ones who use science process skills while solving problems and deciding on solutions, and who understand and use science concepts, laws and theories (MEB, 2006, p. 5). In this point of view, this approach matches with the goals of science course teaching program. Additionally, there are researches revealing that this approach increases academic achievement in science (Çalışkan, 2004; Çelik & Çavaş, 2012; Doty, 1985; Gençtürk & Türkmen, 2007; Suarez, 2011; Tatar & Kuru, 2006; Wallace, 1997).

Despite of these strong qualities, theoretically, inquiry based instruction takes neither learning styles nor the brain dominancy into account. There is the possibility that it is more appropriate for a group of students. Işık and Yenice (2012) have established a positive and significant relationship between Kolb's Learning Style Inventory III's assimilating and accommodating learning style sub-dimensions and inquiry skills. Also another study determined that science academic achievement of the students with assimilating learning style was higher than the others' (Koç, 2007). In this sense, teaching based on 4MAT Teaching Model or Whole Brain Model can be more advantageous for science education than inquiry based instruction. For this reason, the comparison between the effect of these models and the effect of inquiry based instruction would yield new information important for improving the quality of science education and contribute to the analysis and development of science course teaching programs.

The researches in the literature compare the effects of 4MAT Teaching Model and Whole Brain Model with the effects of traditional teaching (textbook teaching) which is based on question-answer, discussion and expression. There are many studies that compare the effects of 4MAT Teaching Model on academic achievement in science with the ones of traditional teaching (Aktaş, 2011; Delaney, 2002; Ergin, 2011; Jackson, 2001; Mutlu, 2004; Wilkerson & White, 1988). In addition, the effect of Whole Brain Model on academic achievement in science has been compared with traditional teaching's effect (Bawaneh, Md Zain, & Saleh, 2011). However, there are not any studies comparing the effects on academic achievement in science of these models with inquiry based instruction's effect.

It is important to compare the models' effects on academic achievement with each other as well as with inquiry based instruction; since, 4MAT Teaching Model and Whole Brain Model differentiate on some aspects despite of their previously stated similarities. Firstly, learning styles that they define are different. While one of them is based on the Kolb Learning Style Model which defines the learning styles based on the individuals' preferences in perception and in processing of the new information; the other takes the brain dominations into account. It is possible to theoretically identify the preferred quadrants of the brain quadrants determined by Herrmann for the McCarthy learning styles. Such a comparison has been made by Lumsdaine and Lumsdaine (1995). This comparison is given in Table 1 and since Kolb learning styles' names will be used instead of McCarthy's for the rest of the study, Kolb learning styles were also added to this comparison.

Table 1. The Comparison of Kolb, McCarthy and Herrmann Learning Styles

Kolb Learning Style	**McCarthy Learning Style**	**Herrmann Brain Quadrant Dominance**
Değiştiren	1. Tip (İmgesel)	C ve D Çeyrekleri
Özümseyen	2. Tip (Analitik)	A ve D Çeyrekleri
Ayrıştıran	3. Tip (Sağduyulu)	A ve B Çeyrekleri
Yerleştiren	4.Tip (Dinamik)	C ve D Çeyrekleri, Tüm Beyin

As it can be seen in Table 1, individuals having any one of the Kolb or McCarthy learning styles, do not directly correspond to a Herrmann brain quadrant. For example, Type 1 (Imaginative Learners) can be individuals who use quadrant C or quadrant D or both of them dominantly.

The second difference between the models is that 4MAT Teaching Model activates the brain hemispheres in a cyclic order; while Whole Brain Model activates the right and left hemispheres without following a cycle. In other words, while in one of them right and left hemispheres are activated in turns; in the other after an activity regarding the left hemisphere, another activity concerning the left hemisphere again can take place. Shortly, there isn't a necessity to follow a cyclic order between the left and hemispheres in Whole Brain Model. Therefore, the comparison of teaching effects is important to determine if these differences yield any differences in learning outputs. This kind of a research was not found in the literature.

Under the light of these thoughts, the main aim of this study is to investigate the effects of 4MAT Teaching Model, Whole Brain Model and inquiry based instruction on academic achievement in science. According to this aim, the following research questions were tried to be answered;

1. What are the effects of 4MAT Teaching Model, Whole Brain Model and inquiry based instruction on academic achievement in science?
2. Do the effects of 4MAT Teaching Model, Whole Brain Model and inquiry based instruction on academic achievement in science differentiate?
3. Do the effects of 4MAT Teaching Model, Whole Brain Model and inquiry based instruction on academic achievement in science differentiate regarding the learning styles?

Method

Research Model

In this study, the effects of different instructions on academic achievement have been serched. An experimental design has been used in this study in order to reveal the cause and effect relationship between the different instructions and learning outcomes (Büyüköztürk, 2001, p. 3). The research has been designed in static group (unbalanced control group) pre test-post test design which is one of the experimental designs (Frankel & Wallen, 2006). Designs in which pre-existing groups are used instead of forming new groups and if no matching is performed are called static group designs (Karasar, 2004). This design was preferred; since it enables the researchers to conduct the experimental procedures in the real and natural environments of the participants.

During the research, three classes of a middle school were assigned randomly as Experimental I, Experimental II and control group. Through the experimental processes, the unit of 'The Systems in Our Body' was taught through 4MAT Teaching Model in Experimental Group I while it was taught through The Whole Brain Model in Experimental Group II. The control group was engaged in inquiry based instruction throughout the same unit. At the beginning and at the end of the experimental procedures, data about the academic achievement in science as a dependent variable were collected from all of the groups.

Study Group

This study was carried out with the participation of 68 6th grade students from an elementary school in Çanakkale city center; 36 of which is female and 32 of which is male. As stated above, the students were not regrouped, pre-existing classes were randomly assigned as Experimental I (n=29), Experimental II (n=21) and control group (n=18).

Instrumentation

The data collection instruments used in this study were Systems in Our Body Unit Academic Achievement Test and Kolb Learning Styles Inventory III.

Systems in Our Body Unit Academic Achievement Test: This achievement test was developed by researchers based on the outcomes of the sixth grade science course unit, "Systems in Our Body". The reason why the test was prepared for this unit is that the timing of the experimental processes corresponds to this unit according to the science course teaching program. In order to maintain the content validity of the test, firstly an indicator chart was created depending on the outcomes and contents of the Systems in Our Body Unit stated in the Primary Education Institutions Sciences Course Teaching Program (MEB, 2013). Afterwards in accordance with this chart, a draft form was generated constituting of 39 multiple choice items. The draft form was inspected by three experts and adjustments were made in the items based on the feedbacks. The pilot study was conducted on 147 sixth grade students. After the item analysis, the final form of the test was established.

Finally, a test is composed of 23 items with difficulty indexes changes in the range of 0.40 and 0.83 is gained. The average difficulty index of the test was calculated as 0.64. The discrimination index of the items varies between 0.30 and 0.73. The table of item analysis results is given in Appendix 1. KR20 reliability coefficient was calculated as 0.77 for this 23 items and it was seen that the test was reliable (Cohen & Swerdlik, 2013). Sample items are given in Appendix 2.

Kolb Learning Styles Inventory III: The third version of the Kolb Learning Style Inventory, KLSI-III, was prepared (Kolb, 1999). Inventory consists of 12 items which are completed with the 4 choices given below. Each choice is suitable for one of the abstract conceptualization (AC), concrete experience (CE), active experimentation (AE) and reflective observation (RO) activities. The participants score the choices by giving '1' for the least appropriate and '4' for the most appropriate one for them.

While analyzing the data gathered from KLSI-III, total AC, CE, AE and RO scores were calculated. In order to determine learning styles, the differences between AC and CE (AC-CE) and between AE and RO (AE-RO) are calculated. These two differences are compared with the reference points determined by Kolb (1999) to decide the learning styles.

The Turkish adaptation of the inventory was conducted by Gencel (2006) on the age group of 12-13. The total correlation between the Turkish and the English versions of the inventory was calculated as 0.77. The correlation coefficient between 0.70 – 1.00 indicates a high correlation (Büyüköztürk, 2009). Therefore the two forms were accepted to be equals in terms of language.

Reliability coefficients of the subscales (AC, CE, AE, RO, AC-CE, AE-RO) were calculated and it was revealed that the reliability coefficients ranged between 0.71 - 0.84 (Gencel, 2006). It is adequate for a psychological test to have a reliability coefficient equal to or over 0.7 (Büyüköztürk, 2009). Therefore the inventory was accepted as reliable.

The correlation between the dimensions of the inventory was calculated by Gencel (2006). It was concluded that there was a strongly negative relationship between the perception of the information through abstract conceptualization and concrete experience (r=-0.61, p<.01); and processing the information through active experimentation and reflective observation, (r=-0.45, p<.01). Furthermore, using the unified score calculations, it was concluded that there is a low correlation between abstract conceptualization - concrete experience and active experimentation - reflective observation learning styles (r=-0.19).

Operational Path

For the experimental study, firstly the pre-experimental processes were conducted, pre test was applied, experimental procedures were conducted and the study was completed by conducting the post test.

Pre-experimental Processes: At the beginning of the study, lesson plans and materials were prepared and then preparations were made for the experimental processes. At first, lesson plans were prepared by the researchers. The Sixth Grade Science Course Teaching Program (MEB, 2013) devotes 32 class hours to the unit "Systems in Our Body". There isn't another reason for choosing this unit for the study, except the overlapping of the timing of the study and of the unit. Lesson plans were prepared for all groups by following the outcomes, content, assessment and evaluation techniques stated in the teaching program. It was given importance to that the only difference in the groups' lesson plans would be in the learning-teaching process. The textbook and every material used were made sure to be identical for all groups. According to these, the lesson plans of all groups were prepared as described below.

Preparation of the Experimental Group I lesson plans: While preparing the lesson plans for this group in which 4MAT Teaching Model was applied, an 8 step cycle was followed for each subject matter. It was made sure that the cycle was completed in the total class hours devoted to that subject. While preparing the lesson plans, McCarthy and McCarthy's (2006) suggested route for preparing lesson plans was followed and four quadrant of the model were planned.

At the first quadrant, the 1st step which includes an experience that encourages students to learn was planned. As an example of the plans of the 1st step, the plan of the cell subject, which is a part of the 4 class hour cycle, can be given. In this plan, at the first step, it was planned to make students examine onion, leaf and each other's tongue and observe onion skin and tongue epithelium cells under microscope. Later, the 2nd step at which students analyze the experience that they have had at the 1st step, was planned. In the cell subject's plan, at this step a class discussion was planned to conduct by the help of the questions such as 'Which aspects of the leaf, tongue and onion cells are different?', 'Do these differences stem from belonging to a different living?'.

The first stage of the second quadrant, at the 3rd step, a non-verbal strategy was planned in order to combine the experiences of the students in the 1st step with their previous experiences. For example, in the cell subjects plans, it was planned to make students watch a video on The Cell Theory. Later, at the 4th step, enlightenment step, it was planned to make students observe the human blood tissue and muscle tissue under microscope. So that, they would conceptualize the cells are specialized for the tissue that they belong, and they would realize the main parts of the cells.

At the third quadrant, firstly the 5th step was planned and what kind of exercises to be used was decided. In the plans of the cell subject, it was planned to make students fill the exercises namely 'Let's Compare Plant and Animal Cells', 'Cell Crossword 'and 'From Cell to Organism' (Öcal, 2014, pp. 21, 22, 26). Afterward, the 6th step, at which students can interiorize what they have learned and add something of them to produce a novel product, , it was expected students to create a model which will be exhibited in the exhibition whose theme is 'From Unicellular Living to Multicellular'.

At the forth quadrant, by the planning of 7th step, it was aimed to decide that how the students' products produced at the 6th step, will be criticized in terms of suitability and practicality by their peers and teachers. Such as, in the plans of cell subject, at this step it was planned that students present the models that they have produced at the 6th step and refine it according to the feedbacks. Finally, the 8th step was planned and what the students should learn after the instructions and which skills they are expected to gain were determined. As an example, it was planned to prepare an exhibition by using students' organelle, cell and unicellular cell models.

Preparation of the Experimental Group II lesson plans: For the preparation of this group where Whole Brain Model based instructions were applied, the activities for cerebral right and left hemispheres and right and left limbic system were simultaneously applied without the need of a pattern such as 'left-right-left-right hemisphere'. But it was made sure that activities about the key concepts and focus points of the unit were aimed at both the right and the left brain thinking modes. Also, it was ensured that the flow of the activities is in an harmony and the transition from one brain quadrant to the other is soft.

As an example of the lesson plans of the Experimental Group II, the learning-teaching process of the first 2 class hour lesson plan of the cell subject can be given. In this plan, it is considered that the students firstly observe the leaves in groups by the help of the magnifying glass. This is an activity for the quadrant C since it is a group work (Herrmann-Nehdi, 2009). Later on, the groups are asked to search the books for the answers to the questions, "Is it possible to see the cells with a magnifying glass in your hands?", "How are the shapes of the cells?", and report the answers. This activity is a quadrant A activity; since it involves investigating process and a quadrant B activity as it involves a report writing activity and also suitable for quadrant C as it requires a group study (Herrmann-Nehdi, 2009). Afterward, it was planned that the students watch a short video on Cell Theory. Learning by watching videos are for those whose quadrant D is dominant (Herrmann-Nehdi, 2009). Then the teacher would explain the cell theory, basic parts of the cell, organelles and tasks. The activity of listening the lecturer is suitable for the quadrant A (Herrmann-Nehdi, 2009). The groups practice 'Cell Crossword' (Öcal, 2014, p. 22). Exercising is an appropriate activity to the quadrant B (Herrmann-Nehdi, 2009). Finally, when considering the relationship between inventions and the information on cell, students are asked to think and share their opinions about the question "What will be known and improved about the cell in the future?". The D quadrant is active at this stage of the lesson, as it includes discovery and imagination, and the C quadrant is active also since there is a sharing with friends (Herrmann-Nehdi, 2009). As it can be understood from this plan, activities for all quadrants are included in the course flow without a pattern such as right-left-right-left order.

Preparation of the Control Group lesson plans: When preparing the lesson plans for inquiry based instruction suggested by the science course program in operation, the processes of 'Defining the Problem', 'Hypothesizing', 'Data Collection' and 'Analyzing the Data' and 'Conclusion' (Jacobsen, Eggen, Kauchak, & Dulaney, 1993) were included in accordance with the inquiry based approach. These processes were planned to be in the guidance of the teacher but in a way to put forward the responsibility of the student. Apart from these research activities, question-answer, discussion and lecturing about the subject were also included.

As an example to the lesson plans of the control group, the 2 class hour part of the lesson plans of the cell subject can be given. In this plan, during defining the problem step, it was planned that students in groups observe onion skin by the help of the magnifying glass. Later, teacher direct question of 'What is the living building block which composes of onion skin and what is it look like?'. While hypothesizing, it was planned to expect from students that they will hypothesize about onion skin compose of what and how it looks like. While collecting data it was planned that students would observe onion skin samples that were prepared by teacher under microscope and draw what they have seen. During data analysis step it was expected them to decide about the living building block of the onion skin by the help of their observations. At the conclusion step it was planned that groups share their conclusions with their peers. Teacher relates their conclusions with the Cell Theory and explains the main parts of the cell and organelles of the cells. Students would watch a video on the Cell Theory as a summary of the lesson. Finally, as a practice, it was planned to require students to fill the exercise of 'Cell Crossword' (Öcal, 2014, p. 22).

After the preparation of the lesson plans for all the groups, the plans were investigated by science instructors and teachers. The necessary arrangements were made according to the criticism and suggestions made. Once the planning step was concluded, an application was made to the Çanakkale City National Education Directorate and the necessary permits were obtained. The science course teachers in the school, at which the study will be conducted, were informed about the experimental procedures and experimental groups and control group were determined.

Pre-test applications: The Systems in Our Body Unit Academic Achievement Test, was applied to the students as the pre test in a lesson hour by one of the researchers. Kolb Learning Styles Inventory III was also applied prior to the experimental processes in order to determine the learning styles of the students.

Experimental processes: Experimental procedures were conducted by one of the researchers. Science course is taught 4 hours in a week at sixth grade. Thus the experimental procedures took 32 hours, therefore 8 weeks to complete.

Post-experimental processes: The Systems in Our Body Unit Academic Achievement Test, which had been applied during the pre-experimental processes section, was once again applied to the students in a lesson hour by one of the researchers. In order to prevent the students from preparing, the students were not informed about the application of the test.

Analysis of the Data

A descriptive analysis based on the distribution of the pre and post test scores of groups was conducted while determining the analyses to be conducted. By the help of descriptive analysis, coefficients of skewness and kurtosis were examined and whether the data normally distributed or not was identified. Table 2 includes the descriptive statistics for pre and post science achievement test scores.

Table 2. Descriptive Statistics for Pre and Post Science Achievement Test Scores

	Group	**n**	$\bar{X}$	**s**	**Skewness**	**Skewness Standard Error**	**Kurtosis**	**Kurtosis Standard Error**
Academic	Exp. I	29	5,45	2,10	-0,12	0,43	-0,51	0,97
Achievement	Exp. II	21	7,00	1,58	0,75	0,50	1,30	0,84
Pre Test	Control	18	7,50	3,45	0,82	0,54	-1,16	1,04
Academic	Exp. I	29	17,00	4,05	-0,37	0,43	-0,13	0,97
Achievement	Exp. II	21	14,90	4,26	-0,03	0,50	-0,17	0,84
Pre Test	Control	18	17,39	2,83	0,03	0,54	-0,97	1,04

When the coefficient of skewness is divided by the standard error of the skewness and the coefficient of kurtosis is divided by the standard error of the kurtosis, the results falling between -1.96 and +1.96 interval are regarded as the sign of the normal distribution (Can, 2014, p. 85). When Table 2 is examined, it is seen that the values resulted from the division of the skewness and kurtosis coefficients to their standard errors are in this interval. So that, it was determined that the pre and post achievement test scores are normally distributed. Therefore, Paired Sample t-Test was conducted to find out the change between pre and post test scores within the groups. In order to reveal if there was a difference in post-test scores between the groups or not, One Way- Analysis of Covariance (ANCOVA) was applied. ANCOVA, where the pre-test scores are controlled as co variable, is frequently used during the data analysis of experimental studies (Büyüköztürk, 2009, p. 112).

Prior the conduction of ANCOVA, firstly it was controlled whether the dependent variable's variance was equal for all groups, whether the co variable had a linear relationship with the dependent variable for each group and if the slopes of the regression curves were the same for all groups regarding the prediction of the dependent variable related to the covariable. Levene's test has revealed that the post test scores' variances were equal and the scatter plot showed the linear relationship. Also, the slopes of the regression curves regarding the prediction of the groups' academic achievement post test scores based on the pre test scores were found to be equal [$F(2, 62)=.82$, $p=.44$].

When deciding for the analyses to be used for investigating whether the effect of the instructions on academic achievement differentiate regarding the learning styles, distribution of the learning styles in groups were examined and it was concluded that for each learning style in the group, the student numbers that have that style were very few. Nonparametric techniques are used for very few samples (Green & Salkind, 2008). Therefore, Kruskal Wallis test was applied for determining whether academic achievement pre and post test scores differentiate regarding the learning styles of the students in experimental groups and control group. Kruskal Wallis Test is a nonparametric test which allows comparison for three or more groups having continuous variables (Kalaycı, 2010). In order to designate which of the two groups differentiate significantly from each other, Mann Whitney U Test was applied, which is known as the nonparametric alternative of Independent Samples t-tests (Kalaycı, 2010). In addition, the difference between the pre and post test scores of the students with different learning styles within the each group was analyzed using the Wilcoxon Signed Rank Test. This test is the non-parametric alternative of the Paired Sample t-Test (Kalaycı, 2010).

Results

The Effects of 4MAT Teaching Model, Whole Brain Model and Inquiry Based Instruction on Academic Achievement in Science

While analyzing the effects of 4MAT Teaching Model, Whole Brain Model and inquiry based instruction on academic achievement in science, it was searched that whether there is a significant difference between pre and post test scores of students within each groups. For that reason, Paired Samples t Test was conducted and the results are given in Table 3.

Table 3. The t Test Results of Pre and Post Science Achievement Test Scores

Group		n	$\bar{X}$	sd	df	t	p
Experimental I (4MAT)	Ön Test	29	5,45	2,10	28	15,29	,00
	Son Test	29	17,00	4,05			
Experimental II (Whole Brain)	Ön Test	21	7,00	1,58	20	9,20	,00
	Son Test	21	14,90	4,26			
Control (Inquiry)	Ön Test	18	7,50	3,45	17	11,61	,00
	Son Test	18	17,39	2,83			

As given in Table 3, a significant difference between the pre test and post test scores was detected within all the three groups. Firstly, the results indicated that in Experimental Group I, students'

post test scores was significantly greater than the pre test scores [t(28)=15.29, p<.05]. While examining the extent of this difference the effect size index (d), which gives information about how much means differ from each other was calculated. d value can compute by dividing t value to square root of the total sample size, and regardless of sign, d values of .20, .50 and .80 are interpreted as small, medium and high effect sizes, respectively (Green & Salkind, 2008, p. 165). According to this, the calculated effect size index (d=2.84) pointed out that the difference between students' pre and post test scores was at high level in Experimental Group I.

Secondly, it was detected that there was also a significant difference between pre test scores (M=7.00, sd=1.58) and post test scores in favor to post test scores of the students in Experimental Group II [t(21)=9.20, p<.05]. The effect size index, d, was calculated as 2.00. Therefore, it can be concluded that post test scores of the students in Experimental Group II is significantly higher than the pre test scores and this difference is high.

Finally, under this research question it was found that in the control group, students' post test scores was significantly greater than the pre test scores [t(17)=11.61, p<.05]. This difference between pre and post test mean scores was at high level (d=2,74).

The Difference between the Effects of 4MAT Teaching Model, Whole Brain Model and Inquiry Based Instruction on Academic Achievement in Science

While detecting if there was a difference between the post test scores of the students who were exposed to different instructions, one way analysis of covariance (ANCOVA) as conducted. During ANCOVA, pre test scores, which are effective on post test scores, were considered as covariate. In this way, when the effects of pre test scores were controlled, the adjusted means of post test scores are given in Table 4.

Table 4. Descriptive Statistics for Post Test Scores

Group	n	M	Adj. M
Experimental I (4MAT)	29	17,00	17,49
Experimental II (Whole Brain)	21	14,90	14,35
Control (Inquiry)	18	17,39	17,09

According to the adjusted means of academic science achievement post test scores given in Table 4, it was seen that the highest post test adjusted mean score was belong to the Experimental Group I. It was followed by the adjusted means of control group and of experimental group II respectively. ANCOVA results of post test scores are given in Table 5.

Table 5. ANCOVA Results for Post Test Scores

Source of Variance	Sum of Squares	df	Mean Squares	F	p
Pre Test	77,38	1	77,38	5,61	,02
Grup	96,84	2	48,42	3,51	,04
Error	882,71	64	13,79		
Total	19449,00	68			

According to the results given in Table 5, ANCOVA was significant [F(2, 64)= 3.51, p<.05]. The relationship between being in different instruction groups and post test scores were accounting for 10% of the variance of the post test scores (η^2=.10). That is, the post test adjusted mean scores of the students significantly differentiated with respect to their groups. Follow-up tests were conducted to evaluate pair wise differences among these adjusted means. According to Bonferroni Test results, academic achievement post test adjusted mean scores for Experimental Group I differed significantly from adjusted mean scores for Experimental Group II.

The Difference between the Effects of 4MAT Teaching Model, Whole Brain Model and Inquiry Based Instruction on Academic Achievement in Science Regarding the Learning Styles

Different statistical analyses were conducted to detect whether these three different instructions' effects on academic achievement in science differentiate according to students' learning styles or not. Firstly, Kruskal Wallis Test was conducted while analyzing if pre and post test scores differentiated according to learning styles within each group. The results were given in Table 6.

Table 6. Kruskal Wallis Test Results for Pre and Post Test Scores Regarding Learning Styles

	Group	**Learning Style**	**n**	**Mean Rank**	**df**	X^2	**p**
Pre Test	Experimental I (4MAT)	Diverging	4	11,13	3	2,57	,46
		Assimilating	8	18,69			
		Converging	4	14,13			
		Accommodating	13	14,19			
	Experimental II (Whole Brain)	Diverging	6	8,00	3	3,08	,38
		Assimilating	2	9,00			
		Converging	4	11,25			
		Accommodating	9	13,33			
	Control (Inquiry)	Diverging	2	16,50	2	7,18	,03
		Assimilating	0				
		Converging	9	10,72			
		Accommodating	7	5,93			
Post Test	Experimental I (4MAT)	Diverging	4	17,38	3	2,06	,56
		Assimilating	8	17,69			
		Converging	4	14,63			
		Accommodating	13	12,73			
	Experimental II (Whole Brain)	Diverging	6	7,5	3	3,06	,38
		Assimilating	2	13,75			
		Converging	4	13,50			
		Accommodating	9	11,61			
	Control (Inquiry)	Diverging	2	8,75	2	0,46	,98
		Assimilating	0				
		Converging	9	9,61			
		Accommodating	7	9,57			

As it was given in Table 6, the Kruskal Wallis Test results showed that in Experimental Group I, pre test scores [X^2 (df=3, n=29)= 2.57, p>.05] and post test scores [X^2 (df=3, n=29)= 2.06, p>.05] did not significantly differentiate according to learning styles. Similarly also in Experimental Group II, no significant difference among learning styles in pre tests scores [X^2 (df=3, n=21)= 3.08, p>.05] and in post test scores [X^2 (df=3, n=21)= 3.06, p>.05] were detected. However, in the control group's pre test scores, there was a significant difference among learning styles [X^2 (df=2, n=18)= 7.18, p<.05]. Such a difference was not detected in post test scores [X^2 (df=2, n=18)= 0.46, p>.05]. Mann Whitney U Test was conducted as a follow-up test to evaluate pair wise differences among learning styles in the control group's pre test scores. The results were given in Table 7.

Table 7. Mann Whitney U Test Results for Pre Test Scores of Control Group

	Group	Learning Style	n	Mean Rank	Sum of Ranks	U	p
Pre Test	Control (Inquiry)	Diverging	2	9,50	19,00	2,00	,09
		Converging	9	5,22	47,00		
		Diverging	2	8,50	17,00	0,00	,03
		Accommodating	7	4,00	28,00		
		Converging	9	10,50	94,50	13,50	,05
		Accommodating	7	5,93	41,50		

According to the results given in Table 7, in control group, the pre test scores of the students with diverging learning style were significantly higher than the ones with accommodating learning style, U=0.00, p<.05. There was no significant difference between the pre test scores of the students with diverging and converging learning styles, U=2.00, p>.05. Also any difference was not detected between the pre test scores of the students with converging and diverging learning styles, U=13.50, p>.05.

In addition to these findings, it was investigated that how the academic achievements of the students with different learning styles were affected from different instructions. Therefore, Wilcoxon Signed Rank Test was conducted. The results of the test were given in Table 8.

Table 8. Wilcoxon Signed Rank Test Results

Group	Learning Style	Post Test - Pre Test	n	Mean Rank	Sum of Ranks	z	p
Experimental I (4MAT)	Diverging	Negative Ranks	0	0,00	0,00		
		Positive Ranks	4	2,50	10,00	-1,83	,07
		Ties	0				
	Assimilating	Negative Ranks	0	0,00	0,00		
		Positive Ranks	8	4,50	36,00	-2,53	,01
		Ties	0				
	Converging	Negative Ranks	0	0,00	0,00	-1,83	,07
		Positive Ranks	4	2,50	10,00		
		Ties	0				
	Accommodating	Negative Ranks	0	0,00	0,00		
		Positive Ranks	13	7,00	91,00	-3,18	,00
		Ties	0				
Experimental II (Whole Brain)	Diverging	Negative Ranks	0	0,00	0,00		
		Positive Ranks	5	3,00	15,00	-2,03	,04
		Ties	1				
	Assimilating	Negative Ranks	0	0,00	0,00	-1,34	,18
		Positive Ranks	2	1,50	3,00		
		Ties	0				
	Converging	Negative Ranks	0	0,00	0,00		
		Positive Ranks	4	2,50	10,00	-1,84	,07
		Ties	0				
	Accommodating	Negative Ranks	0	0,00	0,00		
		Positive Ranks	9	5,00	45,00	-2,67	,01
		Ties	0				

Table 8. Continue

Group	Learning Style	Post Test - Pre Test	n	Mean Rank	Sum of Ranks	z	p
Control (Inquiry)	Diverging	Negative Ranks	0	0,00	0,00		
		Positive Ranks	1	1,00	1,00	-1,00	,32
		Ties	1				
	Converging	Negative Ranks	0	0,00	0,00		
		Positive Ranks	9	5,00	45,00	-2,69	,01
		Ties	0				
	Accommodating	Negative Ranks	0	0,00	0,00		
		Positive Ranks	7	4,00	28,00	-2,39	,02
		Ties	0				

As it was seen from Table 8, there was asignificant difference between the pre test and post test scores of the students whose learning styles were assimilating ($z=-2.53$, $p<.05$) and accommodating ($z=-3.18$, $p<.05$) in experimental group I. According to the mean rank, the differences favored post test scores. However, there was no difference between the pre and post test scores of the students with diverging ($z=-1.83$, $p>.05$) and converging ($z=-1.83$, $p>.05$) learning styles.

When the Table 8 is continued to be analyzed for Experimental Group II, it is seen that there was a significant difference between pre and post test scores of the students with diverging ($z=-2.03$, $p<.05$) and accommodating ($z=-2.67$, $p<.05$) learning styles. As it can be understood from mean ranks, their post test scores were significantly higher than the pre test scores. On the other hand, there was no significant difference between the pre and post test scores of the students with assimilating ($z=-1.34$, $p>.05$) and converging ($z=-1.84$, $p>.05$) learning styles.

According to the results given in Table 8, the Wilcoxon Signed Rank Test was significant for converging ($z=-2.69$, $p<.05$) and accommodating ($z=-2.39$, $p<.05$) learning styles in the control group. When the mean ranks analyzed it was seen that, post test scores of these students were significantly higher than the pre test scores. In the control group, there was not any student with assimilating learning style. A significant difference was not detected between pre and post test scores of the students with diverging learning style ($z=-1.00$, $p>.05$).

Discussion, Conclusion and Suggestions

In this study, the effects of 4MAT Teaching Model, Whole Brain Model and inquiry based instruction on academic achievement in science were investigated. A comparison between these instructions' effects was made. In addition, it is investigated that whether their effects on academic achievement in science differentiate regarding the students' learning styles.

The results revealed that the academic achievement of the experimental and control groups were positively influenced by the instructions. In accordance with this result, other researches in the literature also show the positive effect of 4MAT Teaching Model (Aktaş, 2011; Ergin, 2011; Jackson 2001; Mutlu, 2004; Wilkerson & White, 1988), Whole Brain Model (Bawaneh et al., 2011) and inquiry based instruction (Çalışkan, 2004; Çelik & Çavaş, 2012; Doty, 1985; Gençtürk & Türkmen, 2007; Suarez, 2011; Tatar & Kuru, 2006; Wallace, 1997) on academic achievement in science. On the other hand, it was found that 4MAT Teaching Model had a more positive effect on academic achievement than Whole Brain Model. This difference between the models, despite the similarity of the activities applied in the both groups can be seen as the most significant outcome of this study. The basic difference between these models is the circular or zig-zag utilization of the activities regarding the right and the left brain hemispheres.

While the activities follow a circular pattern between cerebral hemispheres such as right brain-left brain- right brain in 4MAT Teaching Model, there isn't such a pattern in Whole Brain Model. The reason why 4MAT Teaching Model had more positive effect on academic achievement can be related to

the level of the difficulty in the transition between the brain parts. The transition between the right and the left cerebral hemispheres are easier than the transition between upper and lower quadrants diagonally (i.e. from upper right quadrant to lower left quadrant). The right and the left cerebral hemispheres, namely the upper quadrants, are connected by the nerve network namely 'Corpus Collosum', and two halves of the limbic system, namely the lower quadrants, are connected by 'Hippocampal Comissure'. However, there are not any crosswise bindings. Therefore the transitions between cerebral hemispheres (two upper quadrants) or between the hemispheres of the limbic system (two lower quadrants) are easier and less stressful than switching diagonally (Lumsdaine & Lumsdaine, 1995). Since, Whole Brain Model is not in the cyclic form, it enables to zigzag around the model (Herrmann-Nehdi, 2008). This means depending on the subject flow, the diagonal transitions such as the transition from the activities regarding the upper right hemisphere to those regarding the lower left hemisphere is possible in Whole Brain Model. In contrast, in 4MAT Teaching Model where movements are made between the connected cerebral hemispheres respectively in a circular pattern, harder diagonal transitions are not possible. Such a circular pattern of 4MAT Teaching Model might be advantageous for academic achievement in science. There are many other studies reveal that 4MAT Teaching Model increases academic achievement (Aktaş, 2011; Ardıç, 2013; Dikkartin Övez, 2012; Hsieh, 2003; Jackson, 2001; Mutlu, 2004; Özgen, 2012; Tatar & Dikici, 2009; Tsai, 2004; Uysal, 2009; Wilkerson & White, 1988). There has not been another research examining the effect of circular and zigzag designs in literature yet.

A significant difference was not detected between the effect of inquiry based instruction on academic achievement in science and 4MAT Teaching Model's effect. Similarly, there was no difference between the inquiry based instruction's and Whole Brain Model's effect. In fact, inquiry based instruction, which is accepted as an efficient way of teaching science, is an approach that is suggested for science instruction (National Research Council [NRC], 1996; MEB, 2013).This results showed that the models were as effective as inquiry based teaching in terms of increasing academic achievement in science.

On the other hand, when it was investigated whether these positive effects of these instructions on academic achievement in science differentiate regarding the learning styles, no difference was found regarding learning styles in the pre and post test scores of the students in both experimental groups. In short, it was concluded that the effects of 4MAT Teaching Model and Whole Brain Model on academic achievement do not differentiate with respect to students'learning styles.

From a theoretical point of view, it is an expected result that the effect of 4MAT Teaching Model on academic achievement does not differentiate regarding learning styles since it is based on Kolb Learning Style Model and includes educational activities towards each learning style. In the line with this finding, there are other researches show that the students' academic achievements do not differentiate regarding their learning styles in the groups where 4MAT Teaching Model was applied (Ergin, 2011; Jackson, 2001; Mutlu, 2004). But no other previous researches had come across supporting or disproving that the effect of Whole Brain Model on academic achievement does not differentiate regarding Kolb learning styles.

In the control group where inquiry based instruction was applied, it was found that the pre test scores of the students differentiated regarding their learning styles; nevertheless no difference was found in the post test scores. Whereas, pre test scores revealed that the students with diverging learning style were more successful than the students with accommodating learning style. In addition when the pre and post test scores were compared for each learning style, no difference in the pre and post achievement of the students with diverging learning style was detected. On the contrary there was difference between the pre and post achievements of the students with accommodating and converging learning styles. This is evidence that students with diverging learning style were not supported by inquiry based instruction.

According to these results obtained from the control group, it can be inferred that the effects of inquiry based instruction differentiate according to students' learning styles. In the line with these results, Işık and Yenice (2012) also found a positive and significant relationship between Kolb Learning Style Inventory III's accommodating learning style subscale score and inquiry skills. This finding of their study can be interpreted like that students with accommodating style, whose inquiry skills are better than others, could be more positively influenced from inquiry based instruction. On the other hand, another research in Turkey revealed that the effect of inquiry based instruction on science class academic achievement does not differentiate with respect to learning styles (Ağgül Yalçın & Avinç Akpınar, 2010). Nevertheless the fact that this study and the similar ones conducted in Turkey are limited by short application time should not be ignored. It is also not possible to extend the application time; because of the spiral structure of the program. For instance, "Force and Motion" unit follows the "Systems in Our Body" unit for which the application was conducted, and since there are no prior condition relationships between these two units, the application time could not be extended by means of achievement variable.

In conclusion, the effects of 4MAT Teaching Model and Whole Brain Model on academic achievement do not differentiate with respect to learning styles. However, because of its circular structure, 4MAT Teaching Model has a more positive effect on academic achievement. Although inquiry based instruction generally has a positive effect on academic achievement, it does not support all the students with different learning styles.

Based on these results, it can be said that the emphasis of inquiry based instruction for science course teaching program should be reviewed. The suggestion here is not that inquiry based instruction, which is in great harmony with the nature of science education, should be abandoned. The suggestion here is that the process of teaching and learning in science lectures should be enriched to support all learning styles and all brain dominance preferences.

Resting upon the results of this research, it can be concluded that there is a need for other studies examining the effects of circular and zig-zag patterns of activities regarding different brain hemispheres. It can be proposed to include long term applications for the following researches. Moreover, it is suggested to repeat a similar study at high school level. Since the learning styles and brain dominancy preferences clearer at those ages, it is thought that such a study would yield clearer results. Furthermore, the effects of 4MAT Teaching Model, Whole Brain Model and inquiry based instruction on different learning outputs, especially affective learning outputs, should be studied.

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Appendix 1

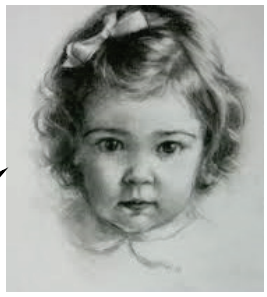
		A	B	C	D	Empty	Correct Answer	Discrimination Index	Difficulty Index
1	Upper Group	0	0	0	40	0	D	0.52	0.74
	Lower Group	10	6	5	19	0			
2	Upper Group	0	0	0	40	0	D	0.73	0.64
	Lower Group	9	8	10	11	2			
3	Upper Group	2	3	35	0	0	C	0.40	0.68
	Lower Group	8	7	19	6	0			
4	Upper Group	0	0	1	39	0	D	0.50	0.73
	Lower Group	3	6	12	19	0			
5	Upper Group	38	0	2	0	0	A	0.50	0.70
	Lower Group	18	6	9	7	0			
6	Upper Group	36	0	3	0	1	A	0.45	0.68
	Lower Group	18	5	13	2	2			
7	Upper Group	0	1	0	39	0	D	0.58	0.69
	Lower Group	13	4	7	16	0			
8	Upper Group	1	35	1	2	1	B	0.40	0.68
	Lower Group	9	19	7	5	0			
9	Upper Group	1	38	0	1	0	B	0.50	0.70
	Lower Group	5	18	12	5	0			
10	Upper Group	2	1	30	7	0	C	0.55	0.48
	Lower Group	8	7	8	17	0			
11	Upper Group	5	24	4	6	1	B	0.40	0.40
	Lower Group	14	8	8	10	0			
12	Upper Group	5	0	31	4	0	C	0.48	0.54
	Lower Group	15	7	12	6	0			
13	Upper Group	0	39	0	1	0	B	0.48	0.74
	Lower Group	5	20	7	8	0			
14	Upper Group	0	1	39	0	0	C	0.30	0.83
	Lower Group	7	2	27	4	0			
15	Upper Group	3	4	1	32	0	D	0.38	0.61
	Lower Group	7	8	8	17	0			
16	Upper Group	38	2	0	0	0	A	0.45	0.73
	Lower Group	20	13	5	2	0			
17	Upper Group	3	29	2	6	0	B	0.42	0.51
	Lower Group	7	12	9	12	0			
18	Upper Group	3	37	0	0	0	B	0.70	0.58
	Lower Group	13	9	6	12	0			
19	Upper Group	2	2	5	31	0	D	0.55	0.45
	Lower Group	11	2	14	13	0			
20	Upper Group	21	3	7	6	3	A	0.25	0.40
	Lower Group	11	4	9	15	1			
21	Upper Group	2	0	38	0	0	C	0.33	0.79
	Lower Group	6	5	25	4	0			
22	Upper Group	2	2	2	34	0	D	0.68	0.51
	Lower Group	15	11	7	7	0			
23	Upper Group	0	0	0	39	1	D	0.60	0.68
	Lower Group	14	4	7	15	0			

Appendix 2

6.

Tek hücreli canlılar var mıdır?

…….



Ege Müge

Ege'nin sorusunu cevaplamak isteyen Müge aşağıdaki resimlerden hangisini göstermelidir?

A.

Bakteriler

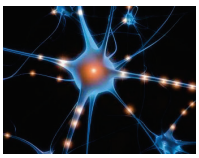
B.

Akyuvarlar

C.

Sperm hücreleri

D.



Sinir hücreleri

13. Yandaki haberi okuyan Özgür, omurga sağlığını korumak için yapacaklarını belirliyor. Buna göre aşağıdakilerden hangisinin Özgür'ün yapacakları arasında yer alması gerekmez?

OMURGA SAĞLIĞI İÇİN EGZERSİZ ŞART

28 Kasım 2014 Haber

Ani hareketler, yanlış duruş, oturuş, yatma ve eğilme pozisyonları fıtıktan kamburluğa kadar pek çok rahatsızlığa sebep oluyor. Omurga sağlığınızı korumanın en önemli yolu egzersiz yapmaktır.

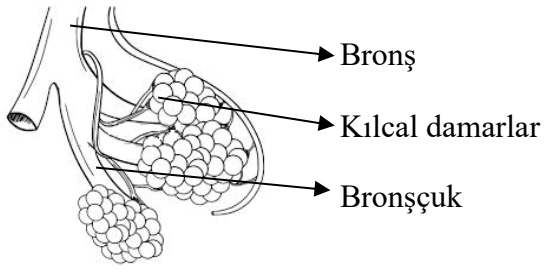
A. Sandalyede dik oturmak

B. Yüksek yastık kullanmak

C. Yere eğilirken dizlerini bükerek eğilmek

D. Bir yükü taşırken tek el yerine iki eli de kullanmak

15.



Yukarıdaki şekil ile ilgili olarak aşağıda verilenlerden hangisi yanlıştır?

A. Alveollerde gaz alışverişini göstermektedir.
B. Kılcal damarlardaki karbondioksit alveollere geçer.
C. Alveollerdeki oksijen kılcal damarlardaki kana geçer.
D. Dokulardan gelen oksijen alveollere geçer.

20. Aşağıdaki tabloda kan ve lenf karşılaştırılmıştır. Buna göre tabloda verilenlerden hangileri doğrudur?

		Kan	Lenf
I	Alyuvar	Var	Yok
II	Akyuvar	Var	Var
III	Kan pulcukları	Var	Var
IV	Kan plazması	Yok	Var

A. I ve II **B.** I ve IV **C.** II ve III **D.** I, II ve III