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# Brain Based Learning in Science Education in Turkey: Descriptive content and Meta analysis of dissertations

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**Abstract**

This study aimed at performing content analysis and meta-analysis on dissertations related to brain-based learning in science education to find out the general trend and tendency of brain-based learning in science education and find out the effect of such studies on achievement and attitude of learners with the ultimate aim of raising awareness about increasing brain-based learning in science education in Turkey. The study was carried out with document analysis, which is one of the non-interactive qualitative research methods. Study sample consisted of 21 dissertations related to the effect of brain-based learning in science education. Both content analysis and meta-analysis were performed on the dissertations. The content analysis was carried out by using the "Paper Classification Form" by Sözbilir, Kutu & Yaşar (2012). In the second stage, a meta-analysis of the relevant dissertations was performed to determine the effect of brain-based learning on achievement and attitude. It was found out that brain-based learning is mostly applied in science and technology education (66,67 %) at secondary level-I; some studies, though few, are conducted in biology (23,81 %) and physics (4,76 %) education; however, no study is available in the field of chemistry education at secondary level-II and primary education. It was also found out that teaching is the most frequently studied subject matter (80,95 %), of these dissertations, 48,57 % aimed at investigating the effect of this learning model on students' achievement and 40 % about the effect of the same on students' attitude, interest and so on. Moreover, it was seen that brain-based learning research in science education is mostly conducted with quantitative research methods (90,58%), most of which (76,20 %) employs the quasi-experimental method. In relation with study sample; 76,19 % of the studies are carried out at secondary level-I (5-8 grades) with 31 to 100 participants (76,19 %). It was revealed that in data analysis, descriptive analysis as a type of quantitative data analysis is used the most (57,65%), which covers percentile, frequency (24,71 %) and the mean, standard deviation, etc. (23,53 %); while infrential statistics (31.76%) includes t-tests at the highest frequency (17,65%). According to the meta-analysis results, the effect of brain-based learning on achievement in science education is calculated to be 1.382, which is high or wide, and the effect on attitude is 0.466, middle, according to the random effect model. These results indicate a positive and significant effect of brain-based learning approach on achievement and attitude of learners. Based on the study results, it is suggested that brain-based learning should be more widespread in the fields of chemistry, physics and biology and primary education and that qualitative and mixed research as well as quantitative research methodology should be done for obtaining reliable, valid and in-depth results in the future.

**Keywords:** Science education, brain based learning, descriptive content analysis, meta analysis, Turkey.

## 1. Introduction

Learning is as natural as breathing which can be facilitated and prevented (Caine&Caine, 1990). Therefore, various learning theories, learning models and strategies have been developed in order to discover how learning takes place and to increase the effectiveness of learning from the past to the present day (Üstünlüoğlu, 2007; Thomas &Swamy, 2014). For example, the industrial revolution brought the understanding of standardized education for all learners in 1890s; then around 1950s and 1960s, John Watson and B.F. Skinner's behaviourist learning approach came according to which learning is evidenced by observable behaviours; which was followed by the rising of learning theories based on brain researches during the late 20th century (Jensen, 2005). So, it can be said that extraordinary phenomenal developments have been made towards understanding the nature of learning have taken place in the last 20 years (Willis, 2007). Earlier, it was believed that we cannot have a grasp of the functioning of the brain but we could only have an idea regarding how learning takes place by means of observing and measuring learners' behaviours. However, a new paradigm emerged within the last two decades of the 20th century, so there were developments that made it possible to understand what is happening in the brain (Jensen, 2005). These developments allowed seeing and understanding the inside of the human brain with brain scanning aids such as MRI (Magnetic Resonance Imaging) and PET (Positron Emission Tomography) (Jensen, 2005; Willis, 2007). Researches show that neurons and glial cells are responsible for

 

learning (Duman, 2015). The developments related to the brain in recent years have also shown themselves in the field of education, leading to development of the brain-based learning/teaching method. As a result, a close relationship has been started between neuroscience and education (Willis, 2007). For the purpose of laying the foundations of brain-based learning, a number of brain principles have been identified: The brain is a parallel processor; Learning engages the entire physiology; The search for meaning is initiate, the search for meaning occurs through patterning; Emotions are critical to patterning; Every brain simultaneously perceives and creates parts and wholes; Learning involves both focused attention and peripheral perception; Learning always involves conscious and unconscious processes; We have two types of memory: A spatial memory system and a set of systems for rote learning; The brain understands and remembers best when facts and skills are embedded in natural spatial memory, Learning is enhanced by challenge and inhibited by threat; Each brain is unique, etc. (Chaine&Chaine, 1990). Brain-based learning is a student-centred approach which is considered to help teachers enhance lerners' cognitive structures and facilitate their learning (Thomas &Swamy, 2014). Led by the brain research, scientists recommend that education should be organized accordingly by taking into consideration the facts about brain functioning (Özbay &Memiş, 2015). To this end, attempts have been made to document and implement learning theories as guided by the brain structure, capacity, functioning, and neurological research findings (Duman, 2015, p. 68). In brain-based learning, it is intended to shift from rote learning to meaningful learning (Chaine & Chaine, 1990), and hence to focus on three interactive processes or elements, such as relaxed alertness, immersion, and active processing for this purpose (Duman, 2015, p.68; Caine&Caine, 1989 cited by Caine&Caine, 1990).

Also in Turkey, research on learning is being closely followed and discussion is aroused for putting the research findings into use in the education process. Brain-based learning is an area studied in this scope. The Turkish context provides studies in this regard, though not many. These include investigation of the effect of brain-based learning on success in science education in Turkey (Çelebi & Afyon, 2011; Oktay &Çakir, 2011; Özden & Gültekin, 2008; Süral, 2014), students' opinions on brain-based learning (Erduran-Avcı &Yağbasan, 2010; Koyuncu & Erden, 2010), and developing suitable teaching materials (Paliç& Akdeniz, 2012). In addition, there are a few content analysis studies determining general trends in problem-based learning (Tosun & Yaşar, 2013; Tosun & Yaşar, 2015) and inquiry-based learning (Kızılaslan, Sözbilir& Yaşar, 2012) in science education in Turkey. Furthermore, studies are available which identify the general trends regarding science education (Sözbilir, Kutu & Yaşar, 2012), chemistry education (Sözbilir, 2013, Sözbilir, Kutu & Yaşar, 2013; Sözbilir, Akıllı, Yaşar & Dede, 2016), biology education (Gül &Sözbilir, 2015; Gül &Sözbilir, 2016) and physics education (Önder, Oktay, Eraslan, Gülçiçek, Göksu, Kanlı, Eryılmaz & Güneş, 2013). Besides, the number of meta-analysis studies on learning approaches in science education in the context of Turkey seems to be too small (Sözbilir, Kutu & Yaşar, 2012). As for the studies combining content analysis for general trends and tendencies with meta-analysis, the number seems to be even smaller in the Turkish context. Present study is aimed at closing this research gap by performing content analysis and meta-analysis on dissertations related to brain-based learning in science education in Turkey. Only dissertations were covered in this study because there are not many papers particularly about brain-based learning in science education in Turkey and also the existing papers are derived from the dissertations in this area. The study ultimately aims to raise awareness about the spread of brain-based learning in science education in Turkey. For the purpose of the study, answer was sought for the following research questions.

1. What general trends are in studies on brain-based learning in science education in the Turkish context?
   - What subject matters are frequently studied / investigated?
   - What science topics or units are frequently studied?
   - What research design/methods are frequently used?
   - What data collection tools are frequently used?
   - What samplings and sample sizes are frequently involved?
   - What data analysis methods/techniques are frequently used?
2. What effect value does brain-based learning have on achievement in science education in the Turkish context?
3. What effect value does brain-based learning have on attitude in science education in the Turkish context?

## 2. Methods

This study was carried out with document analysis method among non-interactive qualitative research

 

methods. Document analysis includes analysis of written materials containing information about the facts and events targeted for investigation (Yıldırım & Şimşek, 2008). The sample of the study is composed of 21 dissertations subjected to document analysis. The relevant dissertations were scanned on the Turkish Council of Higher Education database by using the key words brain based learning and teaching. The search yielded 36 dissertations, only 22 of were were related to science education. Of the 22 dissertations, one prepared in 2016 was not included in this study because of unavailability of the full text.

In data analysis, both descriptive content analysis and meta analysis were used. Descriptive content analysis is a statistical technique based on finding out the general trend of studies in a particular area, while meta-analysis is about collecting, summarizing and compiling quantitative research results (Çalık &Sözbilir, 2014). The content analysis was realized with the "Paper Classification Form" developed by Sözbilir, Kutu & Yaşar (2012). The meta-analysis was performed with the CMA (comprehensive meta-analysis software).

## 3. Results

The study results were given in two stages. First, the dissertations were subjected to descriptive content analysis and the general trend and tendency of brain-based learning in the field of science education in Turkey were identified. In the second stage, meta-analysis was carried out on the sample to find out the effect on success and attitude, and the results were displayed in tables.

### *3.1. Descriptive content analysis of dissertations related to brain based learning (BBL) in science education in Turkey*

As can also be seen from Table 1 below, the first study on brain-based learning in science education was conducted in 2005. There was an increase (23.81%) in 2010. However, the studies on brain-based learning in science education gradually decreased and ended during the years 2015 and 2016.

Table 1. Distribution of the dissertations according to years

| Year | 2005 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| f | 1 | 2 | 3 | 1 | 5 | 1 | 2 | 2 | 4 | - | - | 21 |
| % | 4.76 | 9.52 | 14.29 | 4.76 | 23.81 | 4.76 | 9.52 | 9.52 | 19.05 | - | - | 100 |

As seen in Table 2, the dissertations on brain-based learning in science education in Turkey consisted 15 graduate and 6 doctoral dissertations by 2016. Of those, 66.67 % are in the field of science and technology education; whereas only few studies are related to biology (23, 81%) and physics (4,76%) education, and even no studies in chemistry and primary education.

Table 2. Descriptive statistics for the thesis related to brain based learning in science education in Turkey (N=21)

| *Types of dissertations* | | f | % |
|---|---|---|---|
| Master | | 15 | 71,4 |
| Doctoral | | 6 | 28,6 |
| | Total | 21 | 100 |
| *Discipline that dissertations belonged* | | | |
| Science & Technology Education | | 14 | 66,67 |
| Biology Education | | 5 | 23,81 |
| Physics Education | | 1 | 4,76 |
| Chemistry Education | | 0 | 0 |
| Mixed | | 1 | 4,76 |
| | Total | 21 | 100 |

As Table 3 displays, the subject areas covered in the relevant theses on brain-based learning in science education indicate teaching (80,95 %), followed by material development (14,29 %), and learning (4,76 %), respectively.

 

Table 3. General studied subject areas in Brain Based Learning studies in science education in Turkey

| | f | % |
|---|---|---|
| Teaching | 17 | 80,95 |
| Developing Teaching Materials | 3 | 14,29 |
| Learning | 1 | 4,76 |
| Total | 21 | 100 |

As also shown in Table 4, in-depth analysis of the studies about teaching reveals that 48,57 % of the studies investigate the effect of brain-based learning on achievement in science education and 40.00% deal with the effect on attitude. Apart from these, the investigations include the effect of brain-based learning on retentive learning (25,71 %), on scientific process skills (8,57%) and on learner motivation (5,71%), though much less frequently.

Table 4. Frequently investigated subject matter of teaching

| | f | % |
|---|---|---|
| Effect of BBL on students' academic achievement | 17 | 48,57 |
| Effect of BBL on students' attitudes | 14 | 40,00 |
| Effect of BBL on retention of knowledge | 9 | 25,71 |
| Effect of BBL on students' scientific process skills | 3 | 8,57 |
| Effect of BBL on students' motivations | 2 | 5,71 |
| Total | 35 | 100 |

Table 5 displays the subjects and units covered in the brain-based learning studies. As seen in the table, the most studied subject is the unit on force and movement at secondary level-I with 23.81%. The percentage and frequency of the other units and subjects are listed in Table 5, too.

Table 5. Units studied with BBL

| Grade level | Units | f | % |
|---|---|---|---|
| Secondary-I (5 to 8) | Force and motion | 5 | 23,81 |
| Secondar-II (grade 9) | Cell/ Matter transportation in cell | 3 | 14,29 |
| Secondary-I (grade 8) | Matter and Energy / States of matter and heat unit | 2 | 9,52 |
| Secondary-I (grade 8) | Cell division and inheritance | 2 | 9,52 |
| Secondary-I (grade 8) | Human and environmental uit, ecosystem and biodiversity issue, classification of living things | 2 | 9,52 |
| Secondary-I (grade 6) | Reproduction in living things, Growth and development unit | 1 | 4,76 |
| Secondary-II (grade 9) | Energy | 1 | 4,76 |
| Undergraduate | General biology units | 1 | 4,76 |
| Secondary-I (grade 7) | Systems in our body | 1 | 4,76 |
| Secondary-I (grade 5) | Light and sound | 1 | 4,76 |
| Secondary-II (grade 12) | Mixed units (General biology, chemistry and physics units) | 1 | 4,76 |
| Undergraduate | Brain based learning | 1 | 4,76 |
| | Total | 21 | 100 |

Table 6 displays the research types and methodologies frequently used in brain-based learning studies in science education. As can be seen from the table, the related studies were mostly carried out with quantitative research methods at 90.48%. Specifically, semi-experimental method was preferred as a quantitative research method at

 

76,20 %.

Table 6. Frequently used research types and methods

| Research types | Research methods | | f | % |
|---|---|---|---|---|
| | Quasi experimental | | 16 | 76,20 |
| *Quantitative design* | Descriptive | | 2 | 9,52 |
| | Survey | | 1 | 4,76 |
| | | *Subtotal* | 19 | 90,48 |
| *Qualitative design* | Case study | | 1 | 4,76 |
| *Mixed design* | Triangulation (quan.+qual.) | | 1 | 4,76 |
| | | Total | 21 | 100 |

Table 7 lists the samplings and sample sizes frequently used in brain-based learning studies in science education. As it can be seen from Table 7, most of the related studies, namely 61.91%, were conducted with participants attending the secondary level-I (grades 5 to 8) the sample size ranging between 31 and 100 with 76,19 %.

Table 7. Frequently used samplings and sample sizes

| *Samples* | f | % | *Sample size* | f | % |
|---|---|---|---|---|---|
| Secondary level-I (5-8) | 13 | 61,91 | Between 11-30 | 4 | 19,05 |
| Secondary level-II (9-12) | 5 | 23,81 | Between 31-100 | 16 | 76,19 |
| Undergraduate | 2 | 9,52 | Between 101-300 | 1 | 4,46 |
| Mix | 1 | 4,76 | | | |
| Total | 21 | 100 | Total | 21 | 100 |

In Table 8, data collection tools frequently used in brain-based learning studies are given. As can be seen from the table, those studies were mostly carried out with tools such as perception, attitude, and so on (35.36 %). It is followed by achievement tests with 26.83 % and various questionnaires with 25.61 %, respectively.

Table 8. Frequently used data collection tools

| Type of data collection tools | f | % |
|---|---|---|
| Achievement tests | 22 | 26,83 |
| *Multiple choice* | *19* | *23,17* |
| *Open-ended* | *3* | *3,66* |
| *Others* | *0* | *0,00* |
| Queationairre | 21 | 25,61 |
| *Likert type* | *4* | *4,87* |
| *Open-ended* | *7* | *8,54* |
| *Others* | *10* | *12,20* |
| Aptitude, attitude, perception, personality etc. tests | 29 | 35,36 |
| Interviews | 9 | 10,10 |
| *Semi-structured* | *9* | *10,10* |
| Observations | 1 | 12,20 |
| Total | 82 | 100 |

Table 9 contains the data analysis techniques and methods commonly used in brain-based learning in science education. As it can be seen in the table, descriptive analysis seems to be in the lead with 57.65 % preceding the

 

infrential statistical techniques with 31.76 % under quantitative research methods. On the other hand, descriptive and content analysis techniques hold a small proportion as types of qualitative data analysis with 10, 59 %.

Table 9. Frequently used data analysis methods and techniques in Brain based learning

| Types of data analysis | | | f | % |
|---|---|---|---|---|
| Descriptive | f / % tables | | 21 | 24,71 |
| | Central tendency measures | | 20 | 23,53 |
| | Charts | | 8 | 9,41 |
| | | *Subtotal* | *49* | *57,65* |
| Infrential | t-test | | 15 | 17,65 |
| | Correlation | | 1 | 1,18 |
| | ANOVA/ANCOVA | | 6 | 7,05 |
| | Non-Parametric tests | | 5 | 5,88 |
| | | *Subtotal* | *27* | *31,76* |
| Qualitative | Content analysis | | 3 | 3,53 |
| | Descriptive analysis | | 6 | 7,06 |
| | | *subtotal* | *9* | *10,59* |
| | | Total | 85 | 100 |

*3.2. Meta analysis of dissertations related to brain based learning studies in science education in Turkey*

Table 10 displays the results of the general effect sizes regarding academic achievement of the studies related to the effect of brain based teaching. The Q statistical homogeneity test value is seen to be significant as the changes in the effect sizes is greater than that of changes due to sampling error (Lipsey & Wilson, 2001). Thus, REM (Random Effects Model) is accepted for the analysis of these studies. In addition, the distribution in Table 10 is seen to be heterogeneous so the efficiency of the instruction involving the use of brain based learning and that using traditional approaches are compared by means of REM. As a result of the analysis carried out in this way, the standard error is calculated to be 0.242 and the upper limit for a confidence interval of 95% is 1.857, while the lower limit is 0.908. The effect size, hereby is found to be ES= 1.382. It can be inferred from the statistical results that the value of the effect size is in a wide interval according to Cohen's (1992) classification.

Table 10. Homogeneity Values, Mean Effect Sizes, and Confidence Intervals in Effect Models of the Studies Included in the Meta-Analysis related to academic achievement.

| Type of Model | N | Z | P | Q | ES | SE | 95% Confidence Intervals | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Lower Limit | Upper Limit |
| FEM | 17 | 13.779 | 0.000 | 159.690 | 1.038 | 0,075 | 0.890 | 1.186 |
| REM | 17 | 5.706 | 0.000 | 19.321 | 1.382 | 0.242 | 0.908 | 1.857 |

df: 16, FEM: Fixed effects model, REM: Random effects model.

Table 11 presents the results of the general effect sizes regarding attitudes of the studies related to the effect of brain based teaching. As seeing that the Q statistical homogeneity test value is significant, and the fact that changes in the effect sizes is greater than that of changes due to sampling error (Lipsey & Wilson, 2001), REM is made use of for the analysis of these studies. As the distribution in Table 11 is seen to be heterogeneous, this causes the researchers to examine the efficiency of brain based learning through REM. The statistical analyses obtained through this way, the standard error is found to be 0.242; the upper limit for a confidence interval of 95% is seen to be 0.669, while the lower limit is 0.263. The effect size is ES= 0.466 which means that this is a medium size according to Cohen's (1992) classification. On the other hand, when it is considered whether there is a statistical difference or not; the z-test calculation shows that there is a statistical significance in favour of brain based learning (p=0.00).

 

Table 11. Homogeneity Values, Mean Effect Sizes, and Confidence Intervals in Effect Models of the Studies Included in the Meta-Analysis related to attitudes.

| Type of Model | N | Z | P | Q | ES | SE | 95% Confidence Intervals | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Lower Limit | Upper Limit |
| FEM | 14 | 6,012 | 0.000 | 25,640 | 0.438 | 0,073 | 0.295 | 0.581 |
| REM | 14 | 4.494 | 0.000 | 13.087 | 0.466 | 0.104 | 0.263 | 0,669 |

df:13, FEM: Fixed effects model, REM: Random effects model.

## 4. Conclusion and Discussions

The first thesis on brain-based learning in science education in Turkey appears to have been made in 2005. Furthermore, it is seen that by 2016, most studies had been conducted on science and technology education; less studies on biology and physics education; however, no example exists in the field of chemistry and primary education. The main focus of the studies on brain-based learning in science education (80.95%) is found to be predominantly about teaching as well as BBL effect on success and attitude. Such effect was mainly investigated on secondary level-I (grades 5 to 8) units particularly on the subject of force and movement (23.81 %). In the same direction, the analysis reveals that quasi-experimental method (76.20%), which is one of the quantitative research methods, was used in three out of every four studies. However, qualitative research and mixed research methods are found to have been rarely used, if not at all. Moreover, the most often used data collection tools include success and attitude tests in the theses. Regarding sampling, the majority were implemented at secondary level-I (grades 5 to 8) with the sample size ranging between 31 and 100. As for data analysis methods; descriptive and infrential statistical methods were mostly preferred as types of quantitative data analysis. Of these; the techniques such as frequency, percentile, mean, standard deviation and t-test seem to take the lead. It is thought to be in parallel to the research methods used. In these studies where quantitative research methods are often utilized, the frequent use of descriptive and inferantial statistical techniques is necessarily selected. Results of this study seem to be parallel with the Turkish examples on the trend and development of problem-based learning by Tosun & Yaşar (2013), Tosun & Yaşar (2015) and inquiry-based learning reported by Kızılaslan, Sözbilir& Yaşar (2012).

In Turkey, brain-based learning in science education is mostly based on academic achievement and attitude and so on. In order to identify the effect size on these variables, a meta-analysis was performed on the dissertations in this study. As a result of the meta-analysis, the effect size of brain-based learning in science education on academic achievement was found to be 1,382 and the effect size on attitude was 0,466. The reported effect was found to be at high level for academic achievement but at moderate level for attitude, and statistically significant with positive direction (Cohen, 1992). It can be suggested that brain-based learning increases academic achievement and contributes to develop a positive attitude in science education.

As a conclusion, it is thought that brain-based learning in science education is a new approach in Turkey which should be widespread in science education. It seems necessary to keep up to date with the latest brain research and to investigate its effect and contribution to education and to improve education and teaching accordingly. Furthermore, we believe that adjusting learning and teaching environments and curricula in the light of such developments will move science education forward in Turkey. Last but not least, spreading of brain-based learning researches in chemistry, physics and biology education could contribute to science education.

## References

Caine, R. N. & Caine, G. (1990). Understanding a brain based approach to learning and teaching. *Educational Leadership, 48*(2), 66-70.

Cohen, J. (1992). Statistical power analysis.*Current Directions in Psychological Science,1*(3), 98-101.

Çalık, M. & Sözbilir, M. (2014). Parameters of content analysis. *Education and Science, 39*(174), 33-38.

Çelebi, K. & Afyon, A. (2011). The effect of brain based learning on students achievement in elementary science teaching. *Selcuk University Ahmet Keleşoğlu Education Faculty Journal*, 31, 169-182.

Duman, B. (2015). *Neden beyin temelli öğrenme* [Why brain based learning?]. Ankara: Pegem Publications

Erduran-Avcı, D. & Yağbasan, R. (2010). The views of students related to brain based learning. *Kastamonu Educational Journal, 18*(1), 1-18.

Gül, Ş. & Sözbilir, M. (2015). Biology education research trends in Turkey. *Eurasia Journal of Mathematics*

 

*Science & Tehcnology Education, 11*(1), 93-109. DOI: 10.12973/eurasia.2015.1309a.

Gül, Ş. & Sözbilir, M. (2016). International research trends in biology education from 1997 to 2014: A content analysis of papers in selected journals. *Eurasia Journal of Mathematics Science & Tehcnology Education, 12*(6), 1631-1651. DOI: 10.12973/eurasia.2015.1363a.

Jensen, E. (2005). *Teaching with the brain in mind* (2nd ed.). Alexandria, VA, USA: Association for supervision & curriculun development.

Kızılaslan, A., Sözbilir, M., & Yaşar, M.D. (2012). Inquiry-based teaching in Turkey: A content analysis of research reports. *International Journal of Environmental and Science Education*, *7*(4), 599-617.

Koyuncu, B. & Erden, M. (2010). Students' views on enriched brain compatible learning environment. *Educational Administration: Theory and Practice, 16*(1), 73-92.

Lipsey, M. W. & Wilson, D. B. (2001). *Practical meta-analysis.* Thousand Oaks, California: Sage Publications.

Oktay, S. & Çakır, R. (2013). The effect of technology supported brain based learning on students' achievement, retention level and metacognitive awareness. *Journal of Turkish Science Education, 10*(3), 3-23.

Önder, N., Oktay, Ö., Eraslan, F., Gülçiçek, Ç., Göksu, V., Kanlı, U., Eryılmaz, A. & Güneş, B. (2013). Content analysis of physics education studies published in Turkish science education journal from 2004 to 2011. *Turkish Science Education Journal, 10*(4), 151-163.

Özbay, M. & Memiş, M. R. (2015). Beyin araştırmalarına dayalı öğrenme ve yazma eğitimi [Brain researches based learning and writing education]. *Ana Dili Eğitimi Dergisi* [Journal of Mother Tongue Education], *3*(2), 1-34.

Özden, M. & Gültekin, M. (2008). The effect of brain based learning on academic achievement and retention of knowledge in science course. *Electronic Journal of Science Education, 12*(1), 1-17.

Paliç, G. & Akdeniz, A. R. (2012). Designing and evaluating a web supported instructional material based on brain based learning. *Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education, 6*(1), 67-93.

Sözbilir, M. (2013). Chemistry education research in Turkey. *Chemistry International, 35*(2), 12-14. Retrieved from http://www.iupac.org/publications/ci/2013/3502/3_sozbilir.html on February 28, 2017.

Sözbilir, M., Kutu, H. & Yaşar, M. D. (2012). Science education research in Turkey: A content analysis of selected features of papers published. In D. Jorde & J. Dillon (Eds.) *Science Education Research and Practice in Europe: Retrospective and Prospective* (pp.341-374). Rotterdam: Sense Publishers.

Sözbilir, S., Kutu, H. & Yaşar, M.D. (2013). Türkiye'de kimya eğitimi araştırmalarının durumu ve eğilimler [Status and trends in chemistry education research in Turkey]. In M. Sözbilir (Ed.). *Türkiye'de kimya eğitimi* (*Chemistry education in Turkey*) (pp.175-204). İstanbul: Türkiye Kimya Derneği Yayın No:22.

Sözbilir, S., Akıllı, M., Yaşar, M. D. & Kutu, H. (2016). Development of chemistry education research (CER) in Turkey: A comparison of CER papers with international research. In M.H.Chiu (Ed.), Science education research and practice in Asia: Challenges and opportinuties (pp.289-317). Singapore: Springer. Doi.10.1007/978-981-10-0847-4_16

Süral, S. (2014). The effect of brain based learning method on students' achievement of science lesson. *Adnan Menderes University Journal of Institute of Social Sciences, 1*(4), 33-42.

Üstünlüoğlu, E. (2007). A critical approach to brain based teaching. *Anadolu University Journal of Social Sciences, 7*(2), 467-476.

Thomas, B. M. & Swamy, S. S. (2014). Brain based teaching approach: A new paradigm of teaching. *International Journal of Education and Psychological Research, 3*(2), 62-65.

Tosun, C. & Yaşar, M.D. (2013). Comparision of Problem-Based Learning Studies in Science Education with the World: Content Analysis of Researh Papers, *Asia-Pacific Forum on Science Learning and Teaching, 14*(2), 1-24.

Tosun, C. & Yaşar, M.D. (2015). Descriptive Content Analysis of Problem-Based Learning Researches in Science educaion in Turkey. *Kastamonu Eğitim Dergisi* [Kastamonu Educational Journal], *23*(1), 293-310.

Willis, J. (2007). Review of research: Brain based teaching strategies for improving students' memory, learning and test-taking success. *Childhood Education, 83*(5), 310-315. DOI:10.1080/0094056.2007.10522940.

Yıldırım, A. & Şimşek, H. (2008). *Sosyal bilimlerde nitel araştırma yöntemleri* [*Qualitative research methods in the social sciences*]. Ankara: Seçkin Publications.