# A Meta-analysis Study of Mind Mapping Techniques and Traditional Learning Methods

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**ABSTRACT** This paper aims to determine the effects of mind mapping techniques on learners' academic achievements, attitudes and retention scores through the meta-analysis method. Collected from national and international sources between the years 2005 to 2013, studies which have been applied to the pretest-post-test control group model were chosen for the paper. In this context, 15 studies were included in the meta-analysis, based on the inclusion criteria. For analyses, Comprehensive Meta Analysis and the MetaWin statistical program were used.When the studies of mind mapping concerning random effects model were analyzed, the effect size values of academic achievement, attitude and retention scores were found to be respectively 1.057, 0.627 and 0.431. Thus, the effect size value with regard to academic achievement was found to be large; attitude was medium; and retention was small according to Cohen's classification. The meta-analytic results indicate that mind mapping has a positive effect on academic achievement, attitude and retention.

## INTRODUCTION

The mind mapping technique developed by Buzan (Williams 2012) is a technique which presents associations among concepts, thoughts and information through a network or a non-linear diagram, using verbal and symbolic elements (Dhindsa et al. 2011). This technique was developed as a note taking technique at the end of the 1960s, and recently has risen to prominence through some characteristics which help reveal prior knowledge by encouraging creativity, retention and effective learning. In this technique, individuals usually use the left hemisphere of the brain to reflect their thoughts, and the right hemisphere to utilize visual elements in their maps (Evrekli and Balim 2010). As stated in the study of Aykac (2014), using both hemispheres facilitates learning and ensures the retention of knowledge. The purpose of this technique is to facilitate understanding using traits such as analysis and memorization in a diagram (Davies 2011). It differs from note taking techniques in that it does not have definite borders and shows how to support natural thinking processes (Meier 2007). Therefore, it can be described as an associative map (Buzan 1974; cited in Davies 2011). In this case, it is understood that mind mapping, with its visual quality, is different from the note taking technique and it describes relationships and associations among ideas.

A basic theme placed at the centre or a picture illustrating a theme is firstly used to compose a mind map. Sub-branches related to the subject are added to the basic theme, and associations among ideas are reflected visually. At this point, words rather than sentences have to be used for an effective mind map and colors can be beneficial for visual impact (Riswanto and Putra 2012). Paxman (2011) stressed that it is possible to add words, colors and visual appearances in order to help the conceptualization and contextualization of the brain's ideas with other ideas for the most effective mind mapping. Therefore, the emerging figure can be said to be like a colorful tree, as it binds all ideas together. These maps with a tree-like or hierarchical appearance are constructed in such a way as to account for a number of issues, such as a story's flow, the central topic, cause and effect relationships or the relationships of ideas to each other in a clear way. In this construct, more places are allocated to central ideas, while fewer places are given to supporting ideas (Madu and Metu 2012). The fact that ideas are placed in this way means that mind maps emphasize more important ideas. In addition, mind maps provide opportunities to approach a problem's solution holistically, and they are considered to be a learning tool which enables both the right and left brain to work (Wycoff 1991, cited in Somers et al. 2014). Mind mapping activates both sides of the brain.

Another important characteristic of this technique, which develops learning by ensuring information retention and remembering more easi-

ly, is its ability to increase creativity. The fact that individuals make an effort to find ideas about a subject will enable them to generate new ideas, and this can develop their creative performance. On the other hand, it should be noted that these maps have an effect on retention because of their visual quality. Therefore, it has to be stated that well-prepared mind maps operate on Gardner's visual and verbal intelligences together (Mona and Khalick 2008). The visual dimensions, key concepts and ideas contained in the maps provide the opportunity for visual and verbal intelligenceto be used together. Apart from this, mind mapping and brainstorming techniques are closely related when it comes to individual or group activities. Brainstorming means thinking through the concepts that have meaning relations, in other words using mind maps (Serig 2011). Moreover, mind maps can be likened to brainstorming in the sense that individuals are free and flexible in terms of putting forward their ideas in the process of creating a mind map. The main difference is that ideas are stated verbally in brainstorming, whereas ideas are expressed verbally and visually in mind maps (Kan 2012). In such a situation, mind maps can be described as visual and flexible learning tool. Akdal and Sahin (2014) specified that in a better learning environment, different methods, techniques and strategies should be applied. Parallel to their idea Gaff (1992) and Morey and Kitano (1997, cited in Aydin and Tonbuloglu 2014) added that the goal of education is to prepare students for a world of ever-increasing diversity. Thus it bears in mind that mind mapping is a distinct technique that has the power to diversify the educational atmosphere.

Mind maps are also described as maps that help us to use all parts of our brain, reduce the time needed for studying or memorization, and complement and process ideas through flows and associations in diagrams. When the results of the literature review in this context are reviewed, it can be seen that mind mapping techniques have advantages in terms of creative thinking, problem solving, focusing on a subject, and being able to see a subject holistically (Evrekli and Balim 2010). It is apparent that mind mapping has overwhelmingly positive aspects in terms of students' success and attitudes and retention of subject matter; furthermore, it facilitates remembering (Al-Jarf 2009; Kan 2012). When the positive aspects of mind mapping techniques based on the results of research are considered,

other studies must be examined in greater detail. In this paper the researcher aims to investigate the impact of mind mapping techniques on learners' academic achievements, attitudes and retention.

## Aims

Although there are some studies based on the effects of mind mapping on students' academic achievements, only a limited number on retention and attitude were found in the literature review. The area of synthesis of the research regarding the effect of mind mapping techniques on academic achievement, retention and attitude scores of students is an area that could benefit from increased research, and thus the purpose of the paper is to synthesize recent research on the impact of mind maps. This meta-analytic paper investigates the results of the research by addressing the following questions:

1. What is the effectiveness of mindmapping techniques on students' academic achievement in terms of effect sizes (ES) calculated from the recent research?
2. Are there any significant relationships between the effectiveness of mindmapping and retention scores of students?
3. Are there any significant relationships between the effectiveness of mindmapping and attitude scores of students?

## METHODOLOGY

### Literature Research

This paper aims to examine the effect of mind mapping techniques on students' academic achievements, attitudes and retention. Toward this purpose, a meta-analysis method in which a sample consisting of individual research was reviewed systematically. The research results were coded by being analyzed quantitatively and the combined analyzed data is used (Lipsey and Wilson 1993). In this method the theoretical structure of research results and relations among them are examined. These results are reported by analyzing the effect size and its effect on the variables (DeCoster 2004). The search was conducted using a number of national and international databases [Google Scholar, the Higher Education Council National Thesis and Dissertation Center, ScienceDirect, Ebscohost-Eric and Ebscohost-Professional Development Collection

(National Academic Network and Information Center)] as part of the process of reviewing the literature concerning mind mapping techniques. The literature was reviewed as "mind map" or "mind mapping" both in English and Turkish.

## Inclusion Criteria

In this paper, 91 studies were considered (25 theses and 66 articles) as part of the literature review, and 10 studies [$N_{academic\ achievement}$=10 (Kidik 2005; Yasar 2006; Camli 2009; Aydin 2011; Kartal 2011; Yetkiner 2011; Kan 2012; Yilmaz 2012; Sahin 2013), $N_{attitude}$=5 (Camli 2009; Aydin 2011; Kartal 2011; Yetkiner 2011; Kan 2012), $N_{retention}$=5 (Camli 2009; Aydin 2011; Kartal 2011; Yetkiner 2011; Kan 2012; Yilmaz 2012)] were chosen for the meta-analysis paper based on the inclusion criteria. In the selection of these studies, the criteria included sufficient quantitative data, such as sampling size, mean, and standard deviation. The studies were conducted between 2005 and 2013. Each study had control and experimental groups where a mind mapping technique was utilized.

## Meta-analysis Procedures and Inter-rater Reliability

The Comprehensive Meta-Analysis (CMA) statistical program and the MetaWin program were used to analyze the data statistically. The study effect meta-analysis method was applied to analyze the data. The effect size of this paper was calculated using "Hedges'd" which is attained by dividing the differences among processes into the combined standard deviation of the groups (Cooper 1989). In addition, the K-1 degree of freedom chi-square ($\chi^2$) heterogeneity test was used in this meta-analytic research (Higgins et al. 2003). This was suggested by Cochran and defined to be the most common test approach to determine heterogeneity. Fixed effects models (FEM) and random effects models (REM) were used to determine the effect sizes (Borenstein et al. 2009).

Lastly, in order to combine all the statistical data included in the analysis, the researcher firstly required a unit of measure; in other words, all these data had to be converted into a common effect size. The effect coefficients in this research were calculated according to the level of classification [0.20: small; 0.50: medium; 0.80 large effect size] stated by Cohen (1992). In addition, the coding reliability of the reviewed studies was calculated in order to increase the reliability of the research outcomes. All the reviewed research was examined by another reader who was academically acceptable. The reliability of the studies was carried out according to the formula formed as *[agreement / (agreement + disagreement) x 100]* by Miles and Huberman (1994) and a value of 100 percent was found.

## FINDINGS

In the meta-analysis paper, based on the results of the literature review, one article, seven-master's and two PhD theses provided mean and standard deviation values concerning the usage of mind mapping. A total of ten studies were considered in regard to the effect of mind mapping on academic achievement. When the studies are considered as a whole, it can be seen that the experimental group consisted of 244 students and the control group consisted of 246.

The effect of mind mapping on academic achievement in a learning environment was calculated according to FEM as seen in Table 1. Based on this calculation, the standard error was 0.096 and the upper limit for 95 percent of the confidence interval was 1.064, while the lower limit was 0.688 and the effect size was 0.876. It can be stated that the effect size of the model is positive and significant. As a result of the homogenous test, the Q statistical value occurred as 48.706. In a 95 percent significance level from the chi-square table, the approximate critical value of 16.919 and 9 degrees of freedom are accepted. It can be said that the distribution of the effect size is heterogeneous, as the Q statistical value (48.706) is greater than the critical value

**Table 1: The distribution of homogeneous values, average effect sizes and confidence intervals concerning the academic achievement points of the studies**

| Model type | n | Z | p | Q | ES | 95% confidence interval | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower limit | Upper limit |
| FEM | 10 | 9.140 | 0.000 | 48.706 | 0.876 | 0.688 | 1.064 |
| REM | 10 | 4.620 | 0.05374 | 16.847 | 1.057 | 0.609 | 1.506 |

df:9

(16.919). When the statistical significance was calculated according to the z-test, it was found to be p=0.000. In other words, the distribution of the effect size according to FEM was found to be heterogeneous.

As the homogeneity test of the studies in the meta-analysis was higher than expected, the model was converted into REM calculated as the variation of the random size component. Based on the calculation of the data in ten studies in the meta-analysis in regard to REM, the standard error was 0.229 and the upper limit for 95 percent of the confidence interval was 1.506, while the lower limit was 0.609 and the effect size was 1.057. The effect size value indicates a large effect size according to Cohen's (1992) classification. This indicates that the usage of mind mapping has a positive effect on students' academic achievement.

**Analysis of the Results of the Studies Concerning Attitude**

The distribution of homogeneous values, average effect sizes and confidence intervals for the studies concerning attitude (three master's and two PhD theses) based on the effect models included in the meta-analysis, are given in Table 2. Based on the analysis of the studies concerning attitude with regard to FEM, the standard error was 0.127 and the upper limit for 95 percent of the confidence interval was 0.845, while the lower limit was 0.349 and the effect size was 0.597. This result can be interpreted in such a way as to suggest that the attitude points favor mind mapping over traditional teaching methods. As a result of the z-test calculation for the purpose of statistical significance, the z value was found to be 4.713. According to the p=0.000 result obtained, the outcome can be said to be statistically significant. Additionally, as a result of the homogenous test, the Q statistical value occurred as 20.851. In terms of the 95 percent significance level from the $\chi^2$ table, the 4 degrees of freedom

value was found to be 9.488. It was observed that the distribution of $\chi^2$ with regard to 4 degrees of freedom with a Q statistical value 20.851 exceeded the critical value ($\chi^2_{(0.95)}$=9.488). In light of these values, it was determined that the distribution of the effect size according to FEM was heterogeneous. For that reason, the analysis was comparable to REM.

Based on the analysis results according to REM, the standard error was 0.292 and the upper limit for 95 percent of the confidence interval was 1.198, while the lower limit was 0.055 and the mean effect size was 0.627. The attitude points were calculated to be more in favor of mind mapping than traditional teaching methods. The effect size value is seen to be of a medium effect size according to Cohen's (1992) classification. As a result of the z-test calculation for the purpose of statistical significance, the analysis can be said not to be statistically significant (Z=2.150; p=0.45716).

**Analysis Results of the Studies Concerning Retention**

The distribution of homogeneous values, average effect sizes and confidence intervals for the studies concerning retention (three master's and two PhD theses) based on the effect models included in the meta-analysis are given in Table 2. Based on the results of the studies concerning the retention points in regard to FEM, the standard error was 0.134 and the upper limit for 95 percent of the confidence interval was 0.752, while the lower limit was 0.226 and the average effect size was 0.489. The retention points were calculated to be more in favor of mind mapping than traditional teaching methods. As a result of the z-test calculation for the purpose of statistical significance, the z value was found to be 3.647. According to the p=0.000 result obtained, the analysis can be said to be statistically significant. In addition, as a result of the homogenous

**Table 2: The distribution of homogeneous values, average effect sizes and confidence intervals concerning attitude and retention points of the studies**

| | Model type | n | Z | p | Q | ES | 95% confidence interval | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Lower limit | Upper limit |
| Attitude | FEM | 5 | 4.713 | 0.000 | 20.851 | 0.597 | 0.349 | 0.845 |
| | REM | 5 | 2.150 | 0.45716 | 3.6383 | 0.627 | 0.055 | 1.198 |
| Retention | FEM | 5 | 3.647 | 0.000 | 36.757 | 0.489 | 0.226 | 0.752 |
| | REM | 5 | 1.048 | 0.22383 | 5.6864 | 0.431 | -0.375 | 1.237 |

df:4

test, the Q statistical value was calculated as 36.757. In terms of the 95 percent significance level from the $\chi^2$ table, the 4 degrees of freedom value was found to be 9.488. It was observed that the distribution of chi-square in terms of 4 degrees of freedom with a Q statistical value of 36.757 exceeded the critical value ($\chi^2_{(0.95)}$=9.488). Based on this result, the distribution of the effect size according to FEM can be said to be heterogeneous. For that reason, the analysis was carried out using REM rather than FEM in that it was thought to remove the illusions stemming from the sampling's heterogeneous characteristics.

Based on the results of the analysis in regard to REM, the standard error was 0.411 and the upper limit for 95 percent of the confidence interval was 1.237, while the lower limit was -0.375 and the average effect size was 0.431. The retention points were calculated to be more in favor of mind mapping than traditional teaching methods. The effect size value was regarded to be in the small category according to Cohen's (1992) classification. As a result of the z-test calculation for the purpose of statistical significance, the z value was found to be 1.048. According to the p=0.22383 result obtained, the analysis can be said not to be statistically significant.

## DISCUSSION

When the analysis of the studies concerning students' academic achievement based on the criteria in the meta-analysis paper was conducted, the effect size (0.876) was seen to favor mind mapping techniques, in parallel with the analysis carried out according to FEM. In parallel with the meta-analysis results for the ten studies and the analysis carried out according to REM, the standard error was 0.229 and the upper limit for 95 percent of the confidence interval was 1.506, while the lower limit was 0.609 and the effect size was 1.057. This value can be described as a large effect size, and positive and significant according to Cohen's (1992) classification. The effect size concerning the related techniques in terms of academic achievement can be said to be high based on this result. This result shows consistency with the studies that do not meet the determined criteria, but with different studies in this regard, which have been carried out both domestically and abroad (Dhindsa et al. 2011; Noonan 2013; Somers et al. 2014). For this reason, the obtained result for the meta-analysis

studies concerning students' academic achievement can be said to be quite consistent with the related literature.

The meta-analysis for the studies involved an experimental group where mind mapping techniques were used and a control group in which traditional teaching methods were used (three master's and two PhD theses). These groups were used to compare students' retention. As a result of the calculations, the data concerning five studies carried out according to FEM can be said to be positive in terms of the effect size (0.489). According to REM, the mean effect size was calculated as 0.431, and this value was regarded as a small effect size according to Cohen's (1992) classification. Based on this result, the use of the related techniques can be said to have a positive effect on retention. It was seen that the results of the studies (Evrekli and Balim 2010; Yetkiner 2011) which were carried out on anational level concerning the degree of retention showed consistency with the results of the related section of this paper.

When the meta-analysis of the five studies concerning the effect of mind mapping techniques on students' attitudes was carried out according to REM, the average effect size was calculated to be 0.627. This value can be said to be a medium effect size according to Cohen's (1992) classification. These results show that mind mapping techniques are more effective than traditional methods in terms of students' attitude. In this respect Simonova (2014) asserted that in many countries, such as France, Finland, and theUK, mind maps have been included in educational curricula as it is considered an efficient educational tool and it supports learning retention. Moreover, from a study conducted by Kilinc et al. (2015) it can be inferred that teachers' primary mission is to develop effective classroom practices to enhance learning, which is thought to be created with the use of mind maps in the learning process as interpreted from the research results. On the other hand and opposed to these results, one group pretest-post-test model was used in a related study by Camli (2009), and an attempt was made to identify the effect of the applications supported with mind mapping on students' achievements and attitudes. As a result of the research, a significant difference was found in students' academic achievements, whereas a significant difference was not identified in students' attitudes towards the lesson.

## CONCLUSION

In this meta-analytic paper, an attempt was made to identify the effect of mindmapping techniques on students' academic achievements, attitudes and retention scores following a meta-analytic review of the studies chosen that met the inclusion criteria. When the analyses were conducted in terms of FEM and REM, the effect size of mindmapping on academic achievement was seen to be high. In addition, as a result of the calculation of the effect sizes related to mind mapping techniques on retention scores, it was clear that the retention scores of the experimental groups were higher than those of the control groups with regard to which traditional methods were applied. This result means that the effect size of mind mapping was small but it did have a positive effect. Moreover, the analytic results with regard to students' attitude scores indicated that there was an average effect size of the related technique concerning the students' attitude scores. In other words, while mind mapping techniques did not have a great effect, they had a normal effect on attitude towards lessons. The similar results of the studies considered in the literature review and related to academic achievements, attitudes and retention scores, may be interpreted to suggest that these results support the current research results.

## RECOMMENDATIONS

Based on the findings of the meta-analysis studies, it was found that mind mapping techniques were generally effective in terms of students' academic achievements, retention and attitude. Although the studies carried out in the context of mind mapping techniques are enough for a meta-analytic paper, it is suggested that more studies should be carried out in terms of the related issues, taking into account that there are not sufficient studies to be evaluated, especially with regard to retention and attitude in a national and international context. Moreover, it can be said that the present paper should be examined and compared with different studies, tests and applications, taking into account the fact that only one accessed study undertook an analysis concerning achievement. In addition, statistical data in the form of arithmetic mean, standard deviation, sample size and the application duration of the studies is known to be re-quired to calculate the effect sizes in terms of meta-analysis. However the lack of these data or ambiguous way of data inclusion in some studies can make it difficult to conduct a meta-analysis or can prevent such a study from being carried out completely. Thus, the statistical data should be given in a detailed and clear manner in the relevant section of each study.

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